Exploring the Role of Technology in Formative Assessment in an International Baccalaureate Secondary School: Perspectives of Students and Teachers

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University has been acknowledged.

Signature:

Abstract

Although technology has been available in secondary school teaching and learning practices for some time, research suggests that teachers and students in some contexts have been slow to adopt and integrate technology in formative assessment and feedback processes. This presents a challenge to advancing pedagogy in the 21st century, since the use of technology in formative assessment and feedback by teachers during the learning process is increasingly regarded as instrumental in achieving improved outcomes for students.

This study used a conceptual framework that blended affordance theory, the Technology Acceptance Model from information systems research, and constructivism as learning to explore this problem and the intersection between formative assessment and technologies to reveal students' and teachers' corresponding attitudes, perceptions, use and utilisation.

A mixed methods research design comprised surveys, observations, and semi-structured interviews in a London, UK secondary school context. The study highlights changes and limitations in technological affordances and the amount of teacher and student involvement and autonomy arising from their utilisation. The study found disparities and variability in the utilisation and perception of technology-assisted formative assessment and feedback among participants and discipline groups. These disparities diminished the efficacy of the teachers in measuring student progress and evaluating teaching methods using the technology, while concurrently presenting obstacles to students gaining the support they require. Therefore, the study recommends that developers focus on subject-specialist pedagogy-based and teacher-led

software, while continually updating and supporting technology systems integration with teaching and assessment. Moreover, teachers should receive discipline-appropriate technology-aided formative assessment and feedback training, and students should have a technological framework to guide them in receiving and responding to teachers’ formative assessment and feedback practices. Such a holistic application should be the next aim for more effectively integrating technology in the International Baccalaureate school education system.

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List of Abbreviations

ATTU Attitude

BI Behavioural Intentions

EFL English as a foreign language

FA Formative Assessment

FC Perceived Facilitating Conditions

GHC Gartner Hype Cycle

HL High Level

IB1 International Baccalaureate Diploma First Year (Year 12)

IB2 International Baccalaureate Diploma Final Year (Year 13)

IBO International Baccalaureate Organisation

IBDP The International Baccalaureate Diploma Programme is a two-year educational programme primarily aimed at 16-to-19-year-olds

ICT Information and Communication Technology

IWB Interactive Board (Smartboard)

KCR Knowledge of the correct response

LMS Learning Management System

LRD Learner Response Devices

MYP Middle Years Programme (MYP) is for students aged 11-16. In this study MYP refers to MYP5 (Year 11) which is the last year of MYP.

PEU Perceived Ease of Use

PTSF Perceived Technological Self-efficacy

PU Perceived Usefulness

SL Standard Level

TAM Technology Acceptance Model

TPB Theory of planned behaviour

TRA Theory of reasoned action

UX User Experience

ZPD Zone of Proximal Development

Chapter 1. Introduction

One of the significant issues in education is that there have been substantial efforts over the years to improve the pedagogy teachers employ in their classes at all levels of education, from preschool through high school and in tertiary education at the undergraduate and graduate levels. While teachers play an essential role in fostering student achievement, the relationship between teacher effort and student motivation and performance is complex (Anderman & Wolters, 2006; Reeve & Jang, 2006; Wentzel, 2002). While some research suggests that students are naturally inclined to seek out challenges and strive for mastery (Deci & Ryan, 2015), others argue that factors such as student engagement, intrinsic motivation, and self-efficacy play a crucial role in driving student achievement (Bandura, 1997; Fredricks, Blumenfeld, & Paris, 2004; Pintrich & Schunk, 2002). Additionally, students may have different goals and motivations for learning, which can impact their desire to achieve (Dweck & Leggett, 1988; Elliot & McGregor, 2001). While teacher efforts can contribute to student motivation and performance, it is essential to recognise the complex interplay of factors involved in student achievement. There is a constant attempt to raise achievement standards, particularly in the UK. In the past, the traditional approach to learning assessment was to test students and provide feedback mainly based on conventional tests and exams at a fixed point in time (Clark, 2012; Wang & Heffernan, 2010).

However, formative assessment has been found to boost student success, and motivation among the numerous instructional strategies teachers employ in the classroom (Andersson & Palm, 2017; Faber et al., 2017; Green, 2019), although it would need restructuring the teaching methods. Perrenoud (1991) reported that if teachers want to use formative assessment, the teaching method should oppose the students' established habits. Students must shift from passive receivers of knowledge to active learners who can assume responsibility for their learning which inclines a pragmatic approach to formative assessment. Black (2003) reported that the learning environment required in formative assessment necessitates an unexpected, disturbing atmosphere in the class.

The innovative teaching methods teachers adopt should change the traditional norms to a more student-centred approach which aligns with Dewey's pragmatic views about classroom practices. Dewey advocated for student-centred learning experiences and the individual's social development in real life with significant connections that arise in classroom learning to contribute to creating learning experiences. He called for a mediating dichotomy, promoting student engagement, democratic contribution, and development. In this sense, there have been attempts to shift how teachers assess learning outcomes in the education field using technology (Aidinopoulou & Sampson, 2017; Jones & McLean, 2018; Sergis et al., 2018). Moreover, focus on more technology-aided formative assessment practices to build students' autonomy and learning skills. If utilised often and accurately, formative assessment may be an excellent approach for changing education (Andersson & Palm, 2017; Ozan & Kincal, 2018).

As Black and Wiliam (1998c) described, formative assessment provides teachers with ongoing feedback regarding students' weaknesses and strengths and informs the following stage in teaching and learning. It aims to support and develop student learning by monitoring their learning, not just in terms of a limited set of test questions at a particular time. With the use of technology, formative approaches could assess the student over the entire learning process on a continuous and more extensive basis as it enables students to facilitate learning, lead to better outcomes, improve motivation, communication and self-regulation and actualise the lifelong learning imperative (Clark, 2012b; Lo et al., 2018). Despite the growing use of technology in school, teachers need to use formative assessment effectively to reap the full benefit of the practice (Cotton, 2017; Wiliam, 2011). There is still a need to understand how technology facilitates formative assessment, how it influences its delivery, and how teachers and students perceive the affordances and constraints of these technologies as there is a mismatch among research and practise (Box et al., 2015).

According to Black and Wiliam (1998), adopting a formative approach to learning can lead to increased educational technology use in various teaching and learning contexts. They argue that formative assessment provides ongoing feedback to students and teachers, allowing for real-time adjustments to instruction and learning activities. In turn, this can lead to greater use of educational technology, as teachers may use technology tools to provide student feedback and track their progress more efficiently (Wiliam, 2011). Additionally, adopting a formative approach to learning can create a more student-centred classroom environment, promoting greater use of technology tools (Moeller & Reitzes, 2011). Overall, these factors suggest that adopting a formative approach to learning can be accompanied by increased educational technology use in various teaching and learning contexts.

Technology has made accessing information much simpler and more convenient. It has also made writing, produced materials, and shared information via the internet more accessible. Incorporating online technology and platforms has also facilitated classroom engagement, interaction, and collaboration opportunities which stresses a *constructivist* classroom that builds on students' prior knowledge and more student-centred than teacher centred (Lin & Tsai, 2011). In this sense, the role of teachers is to participate in discussions with students to support them in constructing their knowledge; students work mainly in pairs or groups. *Pragmatism* and *social constructivism* share close interests in learning and education, engagement, interaction, social communication, democracy, inquiry, theory and practice (Garrison, 1995; Gordon, 2009; Hickman et al, 2009; Jackson, 2012) which cannot be overlooked. For the reasons above, this study used both pragmatic and constructivist lenses regarding learning theories.

According to Drew (2019), technology and constructivism have a symbiotic connection, with each benefiting from the application of the other. The constructivist perspective asserts that learning occurs in contexts, emphasizing the importance of meaningful and authentic learning experiences (Machado & Laverick, 2015). On the other hand, technology plays a crucial role by providing the designs and settings that engage learners and support constructivist approaches (Voogt & Knezek, 2008). However, interestingly, the traditional "*instructionist*" approaches to education, where students are expected to absorb information more passively, have been surprisingly resilient (Furtak et al., 2016; Johnson, 2005). In the *instructionist* perspective of education, there is less attention to the process or active part of learning and much more to measuring the knowledge gained. Although a balance between *instructionalist and constructivists* would benefit teaching and learning within the context of individual significance and individual interest, as Johnson (2005) suggested.

A key component of formative assessment is feedback. Feedback is considered formative if it is followed by further chances for learners to practise or resubmit their work. Formative feedback aims to help students through learning about a particular topic in different stages, with formative feedback meant to support them through learning (Black & Wiliam, 1998a). Formative feedback activities are ungraded ways to test student knowledge and abilities. It helps teachers focus on student learning, and students realise their knowledge boundaries and how to improve and therefore their achievement (Hattie and Timperley, 2007; Hattie, 2009). In contrast, summative feedback provides students with an overall assessment of their learning after the learning process. It evaluates student and class learning and is graded. By identifying what students have learned and what is unclear, teachers can better satisfy their needs, boosting student motivation and self-regulation (Greenstein, 2010; Sadler, 1989; Shute, 2008; Box et al., 2015). Research studies have consistently highlighted the benefits of timely and individualized feedback in promoting positive student learning outcomes (Hattie & Timperley, 2007; Nicol & Macfarlane-Dick, 2006; Wiliam, 2011). Providing specific, actionable feedback and focusing on the learning process effectively improves student performance and understanding (Higgins, Hartley, & Skelton, 2001; Hounsell, 2007). However, it is important to acknowledge that implementing this feedback approach can present challenges due to time constraints and the number of students (Box et al., 2015; Topping, 1998). When teachers examine the use of formative assessment and formative feedback, they must consider several obstacles and factors, ranging from workload and time concerns to the value put on the activities and feedback and how they connect to the student learning experience. Consequently, formative assessment theory does not always reflect teachers' formative assessment practises (Cotton, 2017). Incorporating technology as a significant tool in feedback could result in a proliferation of technology-based activities. Wiliam (2011) reported how feedback and formative assessment might affect and improve student learning and this current study is going to explore how technology would influence the delivery of feedback.

Integrating classroom technology has become imperative for effective teaching and enhanced learning experiences in the twenty-first century. Students' growing affinity for technology and digital tools is pivotal in inspiring and motivating their engagement with academic content. While there was initial resistance from educators and teachers in the 1980s and 1990s when computers started gaining mainstream usage (Ertmer, 2005; Marcinkiewicz, 1993), the past years have witnessed more profound transformations in education through the use of technology (Badia & Iglesias, 2019; Collins & Halverson, 2018; Johnson, 2005; Tallvid, 2016).

The pervasive presence of technology in students' lives from an early age and the increasing immersion in digital environments have contributed to their high proficiency and comfort with technology. As a result, research efforts continue to explore how technology can be optimally leveraged to enhance the quality of learning, broaden access to education, and facilitate knowledge acquisition (Haleem et al., 2022; Hind, 2019).

Technology has been a significant supporter of in teaching and learning, especially in assessing student learning. With technology-aided formative assessment and feedback, teachers could fast deliver real-time feedback to students. In addition, students interact with their work, receive teacher feedback, and become invested in and driven by their education (Timmis et al., 2016). Formative assessment is one of the most critical and intriguing uses of online classroom systems to increase student learning. According to Irving

(2015), technology supports the formative assessment process by enabling classroom settings that allow students and teachers to assess learning and offering methods to demonstrate information about student learning throughout teaching processes. With the ongoing emergence of technologies and their role in education, there is a need for research to investigate the role of technology in the teaching and learning process in general, formative assessment in specific, and their effect on enhancing the interactive teaching and learning environment (Timmis et al., 2016, Voogt et al., 2019; Wiliam, 2011).

Over the past four decades, education has gradually transformed to incorporate greater use of technologies, particularly in recent years (Fuchs & Fuchs, 1986; Black & Wiliam, 1998; Kingston & Nash, 2011; Klute et al., 2017). While some studies have reported a positive impact of formative assessment on reading achievement (Fuchs & Fuchs, 1986; Black & Wiliam, 1998; Kingston & Nash, 2011; Klute et al., 2017), others have highlighted challenges related to finding useful tools and incorporating technology into the assessment process (Lane et al., 2009).

In the context of an International Baccalaureate programme in the UK, this thesis explores the intersection between formative assessment and new technologies, specifically examining how teachers and students perceive and utilise technology with formative feedback. The study aims to analyse the value attributed by teachers and students to both the technologies employed, and the feedback provided within their learning experiences.

The primary focus of this study was to explore and understand the role of technology in formative assessment and feedback in teaching and learning in a secondary school in the UK. More precisely, what teachers and students use and what influences the choices and utilisation of these technologies, how they are using it, and the technology-aided formative assessment effect on teachers' and students' teaching and learning experiences; affordances and limitations. In this study, I investigated teachers' and students' attitudes, perceptions and utilisation regarding the technology-aided formative assessment process to understand what drives their utilisation and choices and the challenges they face in the utilisation of these technologies. I wanted to understand how technologies are helping teachers provide better and more detailed formative assessments and feedback for students. Moreover, if technologies make it easier for teachers and students to provide more detailed formative assessments and feedback and if these benefit student learning. Finally, I wanted to explore the role of subject understanding in their choice for technology-aided formative assessment and feedback, whether it is their perception, availability of technology or the nature of the discipline or knowledge.

1.1 Nature of the Problem

The slower integration and transformation of technology in education, despite its rapid assimilation in other areas of society, can be attributed to the persistence of certain elements of traditional pedagogy, such as teacher-centred classrooms and routine memorization (Tallvid, 2016). This resistance to change hinders the shift of power towards learner-centred instruction (Hannafin et al., 2014; Ochoa & Wise, 2021). However, interactive online technologies have the potential to facilitate this transfer of power and enable students to engage with the content at their own pace, promoting student-centred learning and limiting dependency on teachers (London et al., 2010; Shank & Cotten, 2014; Spooner, 2015).

In recent years, there has been a growing recognition of the potential of technology to supplant traditional forms of education, particularly in developed countries (Lai & Bower, 2020). This coincides with adopting new pedagogical approaches, where teachers have increasingly embraced formative assessment techniques to provide continuous and constructive feedback to students (Lo et al., 2018). These pedagogical shifts, coupled with advancements in technology, offer opportunities for more learner-centred instruction and the empowerment of students in their learning journey.

Assessment is central to the interaction between students and teachers and thus is an essential part of how researchers measure and quantify student learning (James & Pedder, 2006; Timmis et al., 2016). Assessment is an umbrella term covering all activities related to gathering evidence about learning outcomes (Stobart, 2008). Formative assessment is a newer variation of assessment. It aims to change how learning outcomes are measured, shifting the focus from the assessment of learning to the assessment for learning (Swaffield, 2011a). Black and Wiliam (1998) have shown how formative assessment develops students' "learning to learn" skills as it emphasises the learning and teaching process rather than the assessment itself (OECD, 2005). Black and Wiliam (2009), who are scholars at the forefront of theories and research on formative assessment, describe it as follows:

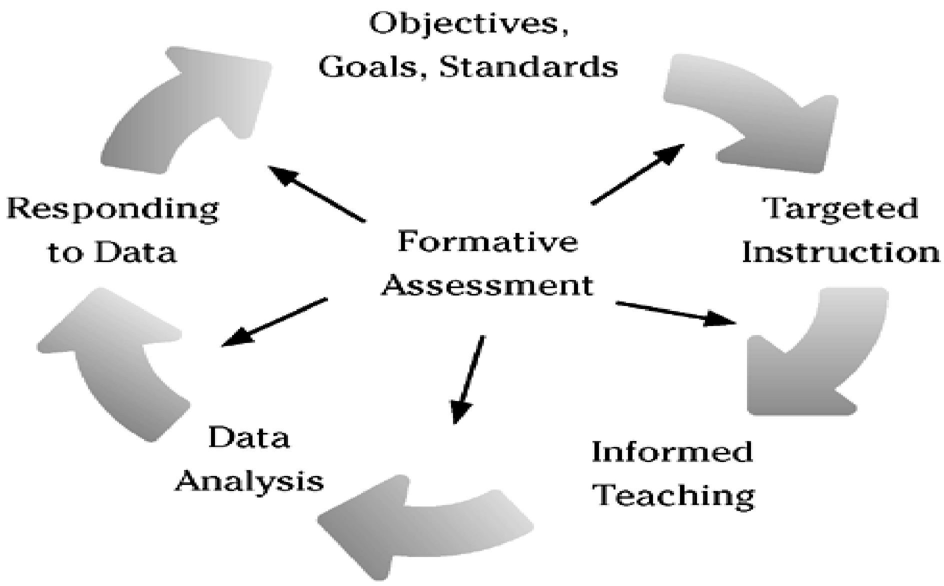
Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (p. 9)

One of the critical extensions of these principles is that formative assessments provide feedback that students can then interpret to help them better understand a subject or process and decide on the next steps (Black & Wiliam, 2009).

It was recognised early that feedback is a significant dimension of learning. For example, Cohen (1985) pointed out that feedback "is one of the more instructionally powerful and least understood features in instructional design" (p. 33). More recently, the recognition of the importance of feedback has grown and become widely accepted in pedagogical theories for effective classroom instruction. However, there still has been little reflexive consideration of how the increased use of feedback and formative assessment has more widely impacted teaching philosophy or pedagogy (Collins & Halverson, 2018) . Overall, forms of learning are still thought of as widely uniform. Thus far, recent innovations, such as using new technological -aided formative assessment, have not changed the existing practices of standardised summative assessments or the teacher-centred classroom learning model (Collins & Halverson, 2018). Consequently, there has not been sufficient reflection or synthesis on how technologies-aided formative assessments might be able to benefit students and learners in substantive ways and how they might change underlying assumptions about education and learning (Collins & Halverson, 2018; Salomon, 2016). In this sense, formative assessment transforms teaching and assessment into a cyclical process for continued growth, with every phase feeding another (Greenstein, 2010), as seen in Figure 1.1 below.

Figure 1.1

The Cycle of Instruction With Formative Assessment (Greenstein, 2010)



According to Alemán de la Garza et al. (2019), Hattie et al. (2016) and Wu et al. (2019) there is a perception that little progress has been made in changing traditional pedagogies with the new tools of formative feedback and the complementary use of technologies in the classroom. Panero and Aldon (2016a) considered technology as one aspect of the teaching environment that facilitates formative assessment. While Herman et al. (2015) reported mixed relationships between teachers' knowledge and assessment practices, findings highlight challenges in bringing the effective formative practice to actuality and the need for continued research. Nkengbeza et al. (2022) repored that inadequate technological skills and training is a major challenge that teachers face and affects the implementation of technology. Mai and Liu (2021) highlighted the importance of schools and teachers developing a student-centred learning environment and a new teacher-student relationship to increase students' sense of autonomy, competence, and relatedness in learning in a flipped classroom environment. There is still a great more to do in theoretical systematisation of contemporary practices in teaching to see how pedagogies might also need reformulation. There has been little empirical research to date that examines how teachers use formative feedback and instructive or assessment technologies in the classroom (Aidinopoulou & Sampson, 2017; Herman et al., 2015; Panero & Aldon, 2016a), as well as, little work has been done on how students perceive the new approaches to learning using feedback (Boud,& Molloy,2013).

There has been some research on formative assessment and the use of educational technologies in the application of formative feedback and technologies in maths and science subjects (Aidinopolou & Sampson, 2017; Herman et al., 2015; Panero & Aldon, 2016). However, this literature is largely focused on reviews of specific technological tools and finding evidence of their effectiveness in improving academic performance. Therefore, to overcome this gap in the research, this study builds on the body of literature by delving more deeply into classroom implementations that merge technologies and formative feedback to determine the perspectives of teachers and students involved in this implementation process. It will do this by closely examining a case of high school students and teachers regarding the new assessment techniques and technologies they are concurrently implementing and learning how to use, both in the classroom and for doing homework and self-study beyond the school. The study will extend the existing research by using a survey, observation, and interviews to capture some of the use, utilisation, perceptions, and beliefs that teachers and students have regarding the technology affordance and influence in their daily use in teaching, learning and formative assessment. To aid in the understanding of how technologies support formative assessment practices.

1.2 The Rationale for the Study

Technology-aided formative assessment affordances in the classroom have been controversial, and attitudes towards learning technologies have been complex. Collins and Halverson (2018) highlight the transformative potential of technology in rethinking education in the digital age. Mai and Liu (2021) conducted a systematic review exploring the affordances of technology-enhanced formative assessment in the classroom, shedding light on its benefits and implications. Moreover, Spector (2017) emphasises using technology-enhanced formative assessment practices to promote learning and motivation. Consequently, there is a need to reveal what influence the use of technology and formative assessment in secondary school classrooms in the UK has. Furthermore, there is a lack of research to determine teachers' and students' usage and utilisation of emergent trends of technology-aided formative assessment. These gaps in the literature demonstrate the importance of further investigation, aligning with the rationale for undertaking this research. This then forms the rationale for undertaking this research. To examine this issue, I divided my primary research question about technology-aided formative assessment into three research questions. My first research question explores teachers' and students' usage and utilisation of the technology-aided formative assessment; what they use, in what context and in what way. The second question investigates how teachers and students adopt and adapt to technological tools for formative assessment in their practices, and what are their influences on teachers teaching and students learning. I wanted to explore technology-aided formative assessment affordances and limitations. My third research question sought to understand the perceptions and attitude of teachers and students towards using technology-aided formative assessment tools. I wanted to understand how teachers and students perceive the usefulness and ease of use of the technology-aided formative assessment and how it affects their direct perception and therefore their utilisation. Teachers' beliefs and attitudes regarding the use of technology-aided formative assessment in teaching and learning have always been regarded as central to the successful implementation of new technologies in the debate surrounding technology integration into schools (Ertmer et al., 2012; Tondeur et al., 2012; Hew & Brush, 2007). These studies highlight the critical relationship between teachers' beliefs and their technology integration practices. They emphasise the importance of understanding teachers' perspectives and perceptions in addressing the challenges and opportunities associated with integrating technology in the classroom.

Furthermore, the application of technology in the classroom has been recognised as somewhat contentious due to concerns that technology can empower students to the point where teachers may struggle to control or guide the flow of information appropriately (Brink et al., 2019; Stockman, 2017; Timmis et al., 2016). This aspect raises important questions and warrants further investigation to examine the potential impact and implications of technology-aided formative assessment on the dynamics of teaching and learning. Exploring the implications of this phenomenon is valuable to gain insights into the changing dynamics of teaching and learning and to inform effective strategies for utilising technology-aided formative assessment in the classroom. And partly because technology-aided formative assessment would work as a support for shifting from a teacher-centred approach to a learner-centred approach or balancing between both approaches. In this view, smartphones, for example, are something to keep out of school and the classroom because they are distracting and give students a window where they can look for information themselves, perhaps challenging teacher authority (Kyriacou & Zuin, 2016). There has been some backtracking or reluctance to use technologies in the conventional classroom for this and other reasons (Timmis et al., 2016a) .

In information science, considerable work has been done on the different contributing factors that lead to the acceptance or rejection of technology. One of the most widely used models of technology acceptance, known as the technology acceptance model (TAM), was developed within the field of information science and further diffused to different areas of knowledge, including education. A key dimension of the TAM that is relevant to this study and technology and education more widely is “the degree to which a person believes that using an IT will be free of effort,” (Davis, 1989, p. 320) .The TAM model is important to the present study because it helps to operationalise perceptions about technologies, and it helped me during the research to understand attitudes towards using technologies. The actual acceptance and use of the technology in the classroom for formative assessment purposes is likely to depend on how easy it is for teachers to use the technology and how useful they perceive it to be in their practice (Davis, 1989) there are also external factors that are discussed later the theoretical framework section (see 2.5). Their prior knowledge and perceptions towards using technology-aided formative assessment tools is also a factor to shed light on critical factors that impact teachers and students’ adoption of technology and if there are external factors affecting these adoptions. All these factors participated in the development of a conceptual framework proposed in the study (see 2.5.9).

Further, it is important to note that technology acceptance is a complex social and personal process. The differing perceptions of students also matter and are likely to have a determining effect on the actual use of technology in the classroom. As Straub (2009) has noted, technology adoption is an inherently social process that develops over time. It is complex because individuals have their own perceptions and reactions to technology. There are cognitive, contextual, and even emotional concerns to consider when trying to understand technology adoption in educational environments (Straub, 2009).

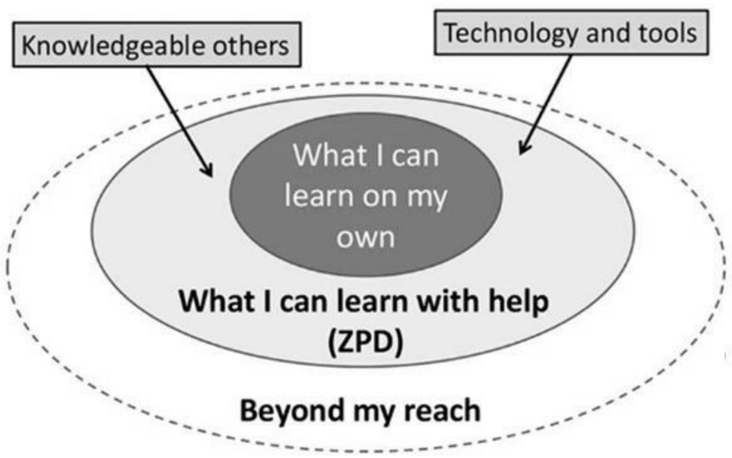
The constructivist view of learning is also important in the justification of this study because in the constructivist view, learning is a highly social process that is constructed and depends on inputs from both teachers and students and other participants or contributing factors, such as the technologies and the learning materials (Freire, 1972; Gredler, 1997; Merriam et al., 2012). Philosophically, constructivism sees reality as constructed by the people who are living it (Charmaz, 2006). Constructivists believe that no form of knowledge can be truly objective in the sense that everyone has their own subjective experience of what transpires or how they perceive or understand it (Poerksen, 2013). This perspective is represented by multiple theories and is widely used in many different research fields, including science, psychology, technology, and mathematics; for example, as a scientific and cognitive theory in psychology and as an epistemology and science theory (Gerstenmaier & Mandl, 1995) .

In education, researchers use the constructivism concept to emphasise how: “learning is a process of constructing meaning” (Merriam et al., 2007, p. 291). Consequently, constructivism is one notion that enables an understanding of more profound epistemological questions about learning and how students engage with knowledge acquisition (O’Donnell, 2014; O’Donnell & King, 1999). I am interested in the role technologies play in formative assessment and feedback in their environmental and cultural context. Hence, I chose this topic for my research because I wanted to understand how users adopt and adapt to the formative feedback tools that they use at school and while teaching and learning.

Teachers and students construct meaning together as they participate in teaching and learning practices. Research suggests that assessment, teaching, and curriculum content are interconnected and should be aligned (Kulasegaram & Rangachari, 2018). These elements of education should be considered interconnected not only since they inform each other but also because they give the potential for deep learning and development on the part of the student by better clarifying the role and responsibilities of students more concretely with more detailed instructions. Thus, students become more participative and more aware of the learning process through formative feedback (Brown et al., 2009; Harlen, 2014).

Figure 1.2

The Zone of Proximal Development (Greenstein, 2010)



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1.3 Context of the Study

This empirical study was conducted at an International Baccalaureate academy based in London, UK from 2019-2020. The student population was 16-18 years old. The study explored the uses and utilisations, adoption and adaptation, and perceptions and attitudes of teachers and students towards technology-aided formative assessment. Furthermore, the study used survey, classroom observations and interviews with teachers and students while at school to determine how and in what ways the technology-aided formative assessment was utilised and what influences their utilisations and its effect on teaching and learning.

The International Baccalaureate Organisation (IBO) is a non-profit organisation that, since 1968, has designed and implemented four educational programmes for students aged three to 19. The IBO programmes have been recognised since their founding for their thoroughness and solid academic standards for educating students within the context of a globalised cultural and economic world. The IBO aims to develop lifelong learners who thrive and make a difference (IBO, 2022). For that reason, IBO encouraged and implemented technology excessively in their schools that covered assessment practices. The use of technology in teaching and learning can be noticeably observed in their main portal, "ManageBac". It is characterised by its system's constant development to accommodate change. This continuous change is mirrored in the IB curriculum, professional development, and assessment practices.

The International Baccalaureate Middle Years Programme (MYP) is an educational curriculum for students between the ages of 11 and 16. The last year of MYP is equivalent to the GCSE, designed to prepare students for the IB Diploma Programme (IPDP). In the final three years of IB school, the IB provides the MYP and then two years of IBDP for students aged 16-19. Moreover, in the final three years of IB (MYP and IBDP), the IB curriculum assignments and assessment activities are primarily incorporated through ManageBac.

The case school is a co-ed, international IB curriculum academy focusing on Islamic and Arabic education. It targets children from age 3-19 in the Islamic community in London. The programmes teach Primary Years Programme (PYP) for students aged 3-12 years old, Middle Years Programme (MYP) for students aged 12-16, and Diploma Programme (DP) for students aged 16-18. The school is non-profit, generously sponsored by a governmental entity (Saudi Arabia) that offers educational support to Islamic community education. The school offers well-equipped educational and technological tools, free laptop devices for all teachers and students, and in-school free Internet.

In both the United Kingdom (UK) and Saudi Arabia, International Baccalaureate (IB) schools have gained popularity over the years. In the UK, there are currently over 200 schools offering the IB programme, catering to both public and private institutions. The IB programme is highly regarded in the independent school sector as it is often viewed as a rigorous alternative to traditional A-levels. On the other hand, Saudi Arabia has a smaller number of IB schools, with approximately 15 IB World Schools as of 2021. Nonetheless, the Saudi Arabian government aims to increase the number of IB schools in the country through its Vision 2030 initiative, which seeks to enhance its education quality (Saudi Arabian Ministry of Education, 2018). As for the prevalence of IB schools in Saudi Arabia, there are currently only a few IB World Schools in the country (IBO, 2021). This is likely since the IB programme is relatively new in Saudi Arabia and is still gaining recognition and acceptance (Alfaraidy, 2020).

However, there is growing interest in the programme, particularly among international schools and private schools catering to expatriate families (Alfaraidy, 2020).

Regarding the population of IB schools in the UK, data from the International Baccalaureate Organisation (IBO) show that there were 157 IB World Schools in the UK as of May 2021 (IBO, 2021). This includes state-funded and independent schools, which have steadily increased over the years (IBO, 2021). Students enrol in IB schools to pursue higher education, particularly at top universities (Witkowsky & Clayton, 2020). The IB programme is recognised worldwide for its high standards and rigorous curriculum, preparing students for university success and beyond. In addition, the programme emphasises critical thinking, creativity, and international mindedness, which are highly valued in today's globalised world (IBO, 2021).

The International Baccalaureate (IB) programme has been recognised for emphasising developing students' language skills, mainly through studying a second language. This is particularly relevant for students attending the case IB school in the UK, as Arabic is one of the six official languages of the IB programme (IBO, 2021). The case school in the UK context is located in London. The school was established in 1985 by the Saudi Arabian government to provide an education that is both Islamic and international in outlook. Arabic is a core subject throughout the school, and all students are expected to achieve proficiency in the language by the time they complete the DP. In addition, the school offers a range of other languages, including French, Spanish, and Mandarin, to provide students with a well-rounded education and the opportunity to develop their language skills in a multicultural environment.

Research suggests that learning a second language can benefit students, including improved cognitive abilities, enhanced cultural understanding, and increased career opportunities (Bialystok, 2017; Mackey & Gass, 2015). For international students attending IB schools in the UK, the opportunity to study a second language, such as Arabic, can be particularly valuable for maintaining connections to their Islamic culture and preparing them for a globalised future.

The rationale behind my choice of the case school is that technology is a part of the school's culture as an IB school. Moreover, IB organisations and IB schools provide teachers with ongoing professional development programmes related to technology and assessment practices. This will allow me to focus on the role of technology followed by the attitude and use, as the students and teachers possess basic knowledge of technology, with formative assessment skill levels added for teachers.

The second research sub question examined the use of technology-aided formative assessment on student learning in different group disciplines, including STEM, humanities and languages. I was interested in the perceptions of the students in order to understand if technology facilitated teacher assessment, peer assessment, and self-assessment. I used *affordance theory* to help amplify the significance of such perceptions and to call attention to the importance of the potential or possibility for action in addition to the action or object itself. Affordance theory was first formulated in the field of psychology by James Gibson (1977), who coined the term *affordances* to describe the possibility for action. Affordances help to conceptualise the key role played by perceptions in the school. Technologies are a good example of objects that have powerful affordances because there are many different ways, they can potentially be used (Jayarathna et al., 2020). Indeed, many individual students or technology users are not aware of all the different affordances possible with a piece of technology (Hegedus & Moreno-Armella, 2020). For instance, nowadays many mobile phones or Smartphones can act as a wireless hub for Internet connections, irrespective of whether the user is aware of that.

The third research sub question helps to break down the overarching question about student and teacher impressions of technology and formative assessment and focused on the perception and behaviour on the part of teachers. It explored whether technology-aided formative assessment influenced teachers' learning regarding their instruction and whether there was potential to use technology for better instruction. Affordance theory was used again in analysing this aspect of the project because it helps to identify potential improvements in terms of the impact that formative assessment can have on current and future instruction.

Because of the focus in this study on the lived experience of a particular group of teachers and students at the school and the opinions and perceptions of students and teachers within that group, the data gathering techniques and the theoretical framework accommodated and helped to assess how students and teachers are actually using the formative feedback approaches and tools in the classroom. For this reason, I needed to use data gathering techniques and a theoretical framework that allowed for flexibility and gathering data from a number of different sources. Accordingly, I used a pragmatism framework as the paradigmatic stance or theoretical orientation of the study.

I chose this orientation for my research subject because I wanted to explore how the students and teachers use the teaching tools provided to them. I also wanted to capture the meaning they assign to their practices in the form of behaviours, attitudes, and perceptions. Quantitative and qualitative methods of participant survey, observation and semi-structured interviews allowed me to develop questions out of the experiences I witnessed as students used new technologies while learning and as they used the feedback provided to them by teachers when they did their homework and performed other school-related tasks. It was also important to be able to discuss at length with the teachers how they view teaching and learning and how the new tools have impacted their teaching process. Qualitative data gathering techniques were most appropriate for this type of study because they allowed me to collect detailed information and to follow users as they implemented the new feedback tools in their teaching and learning.

1.4 Gaps in the Existing Research: Significance of the Study and Contribution

Current research indicates that despite the growing evidence that assessment has a great deal of influence on the quality of teaching and learning, the theories of assessment are being developed separately from those on learning, and more conceptual work is needed to form a bridge between these areas of education (Baird et al., 2017). According to an exploratory study carried out in school science classes, there is a positive relationship between formative assessment practices by teachers and the quality of students' learning (Herman et al., 2015). Although scholars like Torrance (2012) have drawn attention to some applications that may take a mechanistic and too literary understanding of formative assessment, there is still considerable uncertainty about how formative assessment is carried out in practice and how teachers and students link the feedback provided to learning. Researchers still have not arrived at a clear understanding of the positioning of assessment as learning because there is still little empirical research documenting how notions of assessment and learning are different (Dann, 2014a). Thus, the theoretical gap between assessment and learning is far from being filled. Moreover, while technological advances are transforming classrooms, technologies lead to even more questions about the relationships between assessment and learning. This research aims at addressing this knowledge gap.

There is a gap in understanding how the move to use formative assessment as part of the learning process is facilitated by emerging technologies and how they can help teachers to assess materials more rapidly and to personalise feedback in a way that would take more time and energy were it not for the assistance of technology (Baird et al., 2017).This study will address this gap between assessment and learning by looking at the intersection between technology and formative assessment in an educational setting. Both the increasing use of technologies and a shift from summative to formative assessment have been important changes in pedagogical trends in recent years (Timmis et al., 2016b; Twist, 2021). My goal is to assess the perceptions, attitudes and behaviours of the teachers and students in order to understand to what derives their adoption to technology-aided formative assessment and feedback in the classroom, what affordances technology provides to formative assessment and feedback, and whether there are implications in the case school that can be used to inform further research.

Existing literature, as explored in the literature review, such as by Faber and Visscher (2018), Sheard and Chambers (2014), and Vasquez et al. (2017), presents various studies that have investigated the use of technology for formative assessment. However, despite these contributions, a comprehensive search of pertinent academic databases identified a notable research gap: the need for studies examining the specific application of technology for formative assessment within the context of International Baccalaureate (IB) schools.

It is also worth noting that the COVID-19 pandemic has had a considerable impact on education worldwide, particularly in technology-aided formative assessment in classrooms, according to recent research (Barbour et al., 2020; Polat, 2021; UNESCO, 2022). The pandemic has led to the closure of schools and universities, resulting in widespread changes to teaching and assessment practices, as well as the suspension or postponement of educational research. In-person data collection, observation, and interaction with teachers and students have become challenging due to the pandemic, making traditional classroom-based research difficult to conduct (O'Leary et al., 2020). Some educational researchers have shifted their focus to studying the impact of technology-aided formative assessment in online and hybrid learning environments (Shute & Rahimi, 2021). Although the COVID-19 pandemic has created significant obstacles for educational research, it has also presented novel opportunities for studying the impact of technology-aided formative assessment in different learning environments (Darling-Hammond et al., 2020).

This represents a clear gap in the literature, as IB schools are growing in popularity worldwide, and many are looking for ways to use technology to enhance their teaching and assessment practices. Given the unique demands of the IB programme, it is essential to understand how technology can be used effectively for formative assessment in this context.

More research is needed to explore the potential benefits and challenges of using technology for formative assessment in IB schools and the factors that may influence its implementation and effectiveness. Such research could provide valuable insights for IB educators and administrators seeking to improve their assessment practices and better support student learning.

1.4.1 Aim of the Research

1- To critically assess the role of technology in formative assessment and feedback.
2- To understand what attitudes and perceptions students adopt in regard to the technology-aided formative assessment process in an International Baccalaureate programme in the UK.
3- To understand what attitudes and perceptions teachers adopt in regard to the technology-aided formative assessment and feedback process in an International Baccalaureate programme in the UK.
4- To understand the technology use and utilisation of teachers and students to facilitate the generation of feedback and how it is affecting the learning.

1.4.2 Objectives of the Research

1- To critically assess how teachers and students are using formative assessment feedback in the teaching and learning they are using in the school environment.
2- To critically assess how teachers and students are adopting the use of technologies to facilitate the generation of feedback and how it is affecting the learning.
3- To build a theoretical and conceptual argument about how to harness the potential for improved learning in formative assessment and technologies in the school environment.
4- To make recommendations to improve the quality of instruction and student learning with formative assessment and technologies.

1.4.3 Research Questions

The main research question for this project is the following:

What is the role of technology-aided formative assessment in teachers' teaching and students' learning in an International Baccalaureate Academy in the London, UK context?

There are three sub-questions that help to break this larger question down into more manageable subthemes:

1- How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?

2- How does technology support formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?

3- How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?

1.5 Summary

There have been profound changes in how teachers assess learning outcomes in recent years. One key area is the emergence of formative assessment practices. The shift from a summative to a formative approach to education has been accompanied by increased use of information technology. However, traditional "instructionist" approaches to education have been surprisingly resilient. There is a great need to do more theoretical systematisation of more contemporary practices in teaching. Little empirical research has examined how teachers use formative feedback and instructive or assessment technologies in the classroom. Moreover, there is a need for more understanding of how emerging technologies facilitate the use of formative assessment as part of the learning process.

The chapter describes how the study extended existing research by using a survey, observation and interviews to capture students' and teachers' perceptions, impressions, and beliefs about these technologies in an IB secondary school. The use of technology in teaching and learning can be noticeably observed in the case school. My research aimed to identify and explain how technology aids teachers and students in teaching and learning by understanding how technology facilitates formative assessment and feedback. I wanted to understand how technologies are helping teachers to provide better and more detailed formative assessments for students and how teachers and students perceive the technology's usefulness and ease of use. The different perceptions of students also matter and are likely to have a determining effect on the actual use of technology in the classroom. In the constructivist view of learning, learning is a highly social process that is constructed and depends on inputs from both teachers and students. Moreover, I wanted to develop a conceptual framework that would aid in understanding the adoption of technologies in formative assessment and feedback.

I used the theoretical lens of affordance theory, as well as the insights from TAM. TAM theory was used to explore the perception and attitude of teachers and students as an indirect influence on the affordance of technologies. Affordance theory was used to conceptualise the critical role played by perceptions in the school. My goal was to assess teachers' and students' perceptions, attitudes and behaviours concerning technology-aided formative assessments and feedback in the classroom. The main research question for this project is "What is the role of technology-aided formative assessment in teachers' teaching and students' learning in an IB secondary school in UK context?".

Chapter 2. Literature Review

This chapter reviews the body of literature on assessment, paying particular attention to the theory of formative assessment and the role of feedback. Furthermore, it discusses the literature on the role of technology in education and presents the most notable findings from recent research in this important area of study. My study aims to evaluate the effect of technology on the formative assessment and to contribute to these streams of literature on the subject. To do so, I use the theoretical lens of affordance theory, as well as the insights from TAM, which is discussed in greater detail in the theoretical framework subsection (see 2.5.9). The chapter concludes with a detailed discussion of the theoretical framework and rationale for using it.

2.1 Educational Assessment

This section offers a review of previous research on educational assessment, while also presenting the most notable findings and contemporary views in the literature. The discussion starts with a broad focus on assessment, its role in learning and teaching, and continues with the in-depth coverage of formative assessment research. This is followed by the presentation of the previous research findings in relation to motivation and learning and concluded by the brief presentation of the implementation of formative assessment in practice. This chapter aims at presenting the most notable findings of formative assessment research and understanding the main characteristics and benefits of implementing these practices in classrooms. A clear picture of existing research advances in the field is of crucial importance for the study to ensure an accumulation of knowledge and to avoid duplication of effort.

2.1.1 Summative and Formative Assessment

Assessment is the umbrella term covering all activities related to gathering evidence about the outcomes of learning (Stobart, 2008). It is of paramount importance and is argued to be one of the foundations of the learning process (James, 2006; Timmis et al., 2016). According to the Joint Information Systems Committee (JISC), which provides vision for the higher education sector in the UK, effective assessment is the:

practice that equips learners to study and perform to their best advantage in the complex disciplinary fields of their choice and to progress with confidence and skill as lifelong learners, without adding to the assessment burden on academic staff (JISC, 2010, p. 8).

Thus, prior research has established that assessment is the instrument that equips students with a set of cognitive and metacognitive strategies that eventually will make them effective self-learners (Black & Wiliam, 2009).

The general research and practical tradition are to divide all approaches to assessment into two major groups: summative and formative assessment. The terms “formative assessment” and “summative assessment” are used to describe different roles played by the assessment process (Clark, 2012a; Johnson & Scriven, 2015). While summative assessment can be viewed as the evaluation of a student's achievement by formal more standardised methods at a particular point in time, formative assessment deals with monitoring the student's activity over a time period.

The process of assessment leads to summative assessment, that is, a judgement which encapsulates all the evidence up to a given point. This point is seen as a finality at the point of the judgement. A summative assessment can have various functions which do not impinge on the process (Taras, 2005, p.468)

It is important to highlight that the relationship between summative and formative assessment remains a highly debatable topic in the research (Black & Wiliam, 2018). Aside from the more mainstream research theorising more or less conventional approaches to assessment and learning, there is also a position expressed by critical scholars who raise the important questions about the overall selection of material "worth to be studied" and, accordingly, assessed (Flórez Petour, 2017). The importance of assessment is hard to overestimate as it “shapes how societies, groups and individuals understand themselves” (Stobart, 2008, p. 1). Sufficient research has been done to evaluate the impact of summative assessment and formative assessment alike (e.g., Black & Wiliam, 1998; Harlen, 2009).

Studies on summative assessment have identified that summative assessment may contribute to making the performance at the point of assessment more important than the learning itself, negatively impact the self-esteem of students, accentuate the knowledge gap between students, and adversely affect the teaching methods (Assessment Reform Group (ARG) 2006, as cited in Harlen, 2009). Moreover, while summative assessment is commonly perceived by governments and school administrators to be superior in validity and reliability to the formative assessment based on the teacher's judgement, the research shows that this perception is wrong (Harlen, 2009). Formative assessment, on the other hand, is meant to inform and facilitate the learning process (Black & Wiliam, 2009), yet there remains resistance to the concept as a means of measuring student performance. This research will examine this contradiction in greater detail to determine the views of teachers and students.

Overall, research suggests that assessment, teaching, and curriculum content are interconnected and should be aligned, not only since they inform each other, but also because otherwise, they would not contribute to deep learning and development of the students' responsibility for their learning process (Harlen, 2014). Therefore, the next subsection presents the ideas from the existing research on how assessment is related to teaching and learning.

2.1.2 The Relationship Between Teaching, Learning, and Assessment

According to Baird et al. (2017), much of the early scholarly writing on learning and assessment treated the two subjects as if they were "fields apart" with little relationship to each other. The researchers of the early-to-mid-20th century argued that learning could enhance the abilities of the students. However, they did not include assessment in this process in any way, except for being the means of "checking" what was learned (Wiliam, 2017). The idea that assessment, in reality, could inform teaching and thus improve learning was first emphasised by Benjamin Bloom in 1968 (as cited in Wiliam, 2017).

Since then, research has established that the relationship between assessment and learning is more complicated than generally understood, both on the individual and on the aggregate level (Wiliam, 2017). Learning and assessment theories should collaborate better closely if assessments are to fulfil educational purposes (Baird et al., 2017). Further, it has been shown that learning and performance are not necessarily correlated; learning may take place despite the absence of observable changes in performance (Soderstrom & Bjork, 2015), which questions the usefulness of quantifying performance and, thus, of summative assessment overall (Baird et al., 2017).

Current research points out that despite the presently confirmed enormous effect that assessment has on teaching and learning, the theories of assessment are being developed separately from those on learning, and these fields require bridging (Baird et al., 2017). According to an exploratory study carried out in the empirical setting of school science classes, there is a positive relationship between formative assessment practised by teachers and students' learning (Herman et al., 2015). Recently the notion of assessment as learning received scholarly attention to address the concern about the mechanistic nature and too literal application of formative assessment. However, the researchers did not arrive at a clear understanding of the positioning of assessment as learning between the notions of assessment and learning themselves (Dann, 2014).

2.2 Defining the Formative Assessment

The terms *formative assessment* and *assessment for learning* (as opposed to assessment of learning) are sometimes referred to in the literature with slightly different meanings (Swaffield, 2011b). Other researchers tend to use them interchangeably (Bennett, 2011; Black & Wiliam, 2009); the latter approach is adopted in this review of the literature. Thus, this study will follow the definition offered by Black and Wiliam (2009):

Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (p. 9)

However, it is worth mentioning that this definition is not a unique one and was criticised by other scholars. For example, Bennett (2011) argued that it is too broad and lacks the identification of measurable outcomes.

A critical literature review conducted by Black and William in 1998 offered ample evidence that the use of formative assessment positively affects the achievements of students (Black & William, 1998). Furthermore, it develops students' "learning to learn" skills as it emphasises the learning and teaching process, rather than the assessment itself, actively involves students, improves students' peer- and self-assessment skills, develops students' understanding of their learning process, and facilitates the development of learning strategies (OECD, 2005).

2.2.1 The Theory of Formative Assessment

Black and William (2009) proposed the most influential theory of formative assessment in their seminal paper "Developing the theory of formative assessment" (Black & Wiliam, 2009). Today, this theory remains the most influential abstract conceptualisation of formative assessment that does not depend on the context and presents a universally applicable framework of formative assessment. The concept of formative assessment is central to my study and consequently the further sections are devoted to the detailed discussion of the phenomena, theoretical views on it presented in research, and its essential elements, implications, and practical use. Further, my research provides an overview of technological advances in education and describes the knowledge gap in the intersection of the two concepts. Consequently, a thorough understanding of all aspects of formative assessment is essential for the positioning of my research.

Black and Wiliam (2009) argue that formative assessment is a process that uses a specific set of tools or strategies. According to their theory, formative assessment can be thought of as a concept that involves five key strategies presented by Black and Wiliam (2009, p. 8):

1. Clarifying and sharing learning intentions and criteria for success,
2. Engineering effective classroom discussions, questions, and learning tasks that elicit evidence of learning,
3. Providing feedback that moves learners forward,
4. Activating students as instructional resources for one another,
5. Activating students as owners of their learning.

The theory locates these practices in the space, where, on the one hand, there are three actors, namely, the teacher, the learner, and the peers while, on the other hand, three reference states are described in the following way:

- Where the learner is going,
- Where the learner is right now,
- How to get there. (Black & Wiliam, 2009, p. 8)

An important contribution of the formative assessment theory developed by Black and Wiliam (2009) is acknowledging the importance of the roles of learners and peers rather than only the role of the teacher in the formative assessment. The resulting framework is presented in Table 2.1.

Table 2.1

Aspects of Formative Assessment (Black & Wiliam, 2009, p. 8)

<table>
<tr><th></th><th>Where the learner is going</th><th>Where the learner is right now</th><th>How to get there</th></tr>
<tr><td>Teacher</td><td rowspan="3">1. Clarifying, sharing and understanding learning intentions and criteria for success</td><td>2. Engineering effective classroom discussions, questions, and learning tasks that elicit evidence of learning</td><td>3. Providing feedback that moves learners forward</td></tr>
<tr><td>Peer</td><td colspan="2">4. Activating students as instructional resources for one another</td></tr>
<tr><td>Learner</td><td colspan="2">5. Activating students as owners of their own learning</td></tr>
</table>

In all five strategies shown in Table 2.1, technological tools can be used and may affect the practice and outcome of formative assessment. The process nature of assessment strategies implies that the continuity and the technology potentially can affect these processes at any point on that continuum. Consequently, analysing the interaction between formative assessment and technology calls for a theoretical lens that explicitly theorises the process. Therefore, my research uses affordance theory complemented by the insights from TAM, which will be discussed in greater detail in the theoretical framework section (see 2.5). The study evaluates how technology affects formative assessment in general and all the procedures it entails, discussed in the following subsection in greater detail.

2.2.2 The Interrelation Between Assessment Procedures

Research indicates that the assessment procedures are interrelated in formative assessment. The Organisation for Economic Co-operation and Development (OECD) identified six key elements for formative assessment that are of crucial importance. These include the establishment of a standard or expected level of student performance, a gathering of information on a student's current performance, the development of a mechanism to compare the two performance levels, the development of a mechanism to alter the gap, actions that teachers and students carry out to alter a learning gap or to arrive at a shared vision of learning objectives, the degree of student involvement in the assessment process, and the meaning attributed by teachers and students to assessment practices and their effects (OECD, 2008). The interrelation of these elements is shown in Figure 2.1. The research also emphasizes that technology can play a vital role in supporting formative assessment in general and the identified procedures in particular. Establishing a classroom culture that encourages interaction and using assessment tools is an essential element of formative assessment. Studies suggest that students are more likely to feel comfortable making mistakes in such an environment, thus making more apparent what is challenging for them and facilitating learning. Monitoring individual student progress towards pre-defined goals is more effective than traditional grading and peer comparison. Students' emotional styles and abilities to manage their emotions vary significantly, and teachers can facilitate learning by finding ways to connect novel concepts to students' prior experiences.

In support of the importance of varied instruction methods to meet diverse student needs, research suggests that there is a need for a detailed understanding of the relationships between the variability among students and the approaches to adapting formative assessment approaches to cater for individual needs. Teachers more aware of cultural differences and variations in individual comprehension styles are more likely to facilitate the students' learning process. However, there is a need for more research to fully understand how formative assessment can be adapted to accommodate cultural and language diversity in classrooms. A study by Sadler and Good (2006) shows that formative assessment can improve learning outcomes for students with different language backgrounds. The study indicates that formative assessment strategies, such as feedback and questioning, can be tailored to suit the needs of diverse student populations, including students who speak different languages. Another study by Jain et al. (2018) shows that using formative assessment to personalize learning can improve learning outcomes for students with learning disabilities. Therefore, it is crucial to adopt assessment procedures that meet the diverse needs of students to ensure equitable access to education.

The Organisation for Economic Co-operation and Development (OECD) undertook an extensive study of formative assessment based on the published research and global case-studies (OECD, 2008). Building on the detailed reviews of studies published in English (Black & Wiliam, 1998) and in French (OECD, 2008) they identified key elements that are of crucial importance for formative assessment, namely:

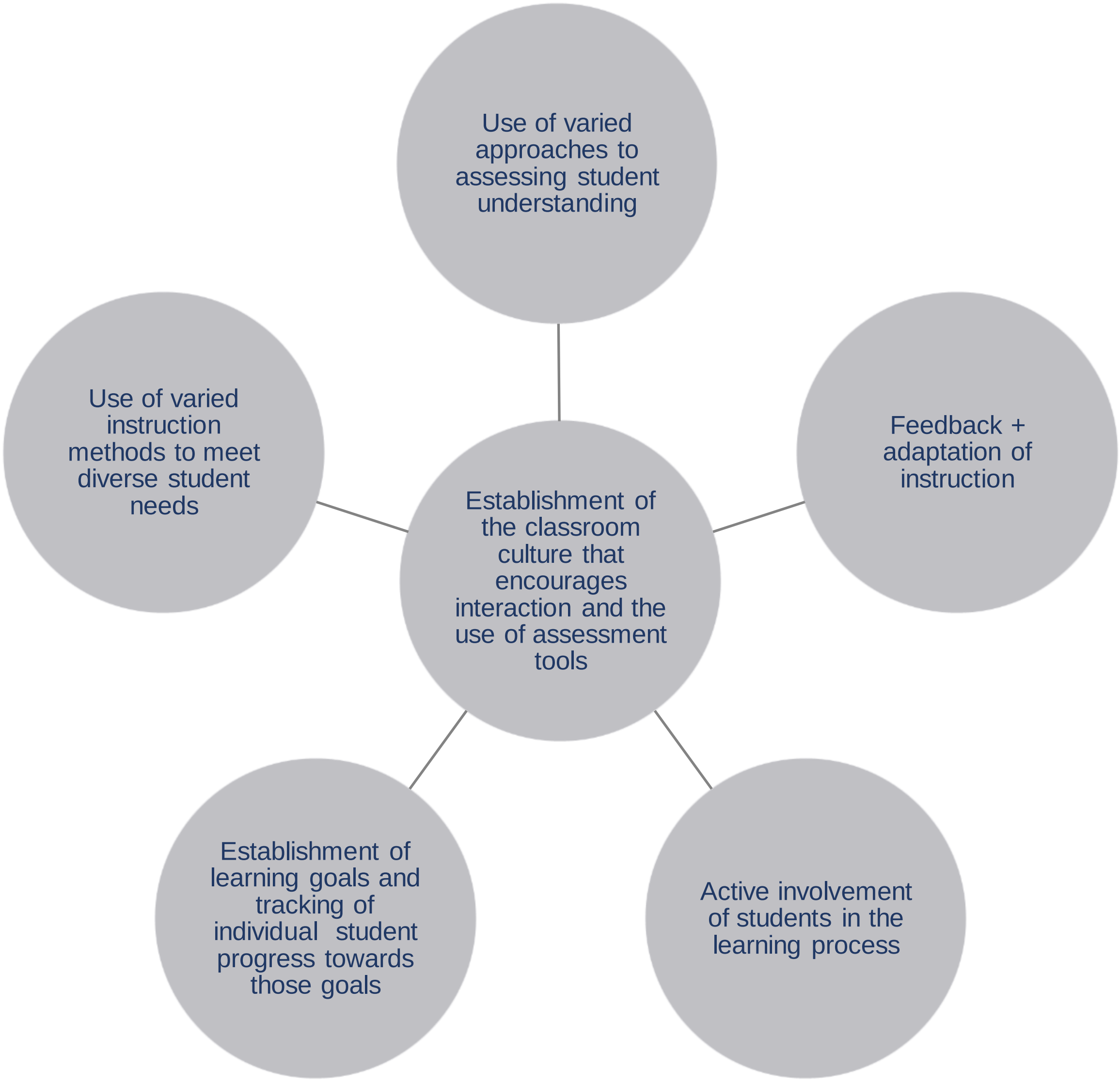
- Establishment of a standard or expected level of student performance,
- Gathering of information on a student’s current performance,
- Development of a mechanism to compare the two performance levels,
- Development of a mechanism to alter the gap,

- The actions that teachers and students actually carry out to alter a learning gap or to arrive at a shared vision of learning objectives,
- The degree of student involvement in the assessment process,
- The meaning attributed by teachers and students to assessment practices and their effects (OECD, 2008).

Accordingly, assessment is considered to be formative if the information obtained from it is used for addressing the student's knowledge gap (Black & Wiliam, 1998c, 1998b) and if formative assessment is embedded in the classroom culture by regular use of formative assessment tools and supporting the interactions among teachers and students (OECD, 2008). The relationships between these elements are presented in Figure 2.1, showing which procedures contribute to the establishment of the classroom culture that encourages interaction and the use of assessment tools. The circle in the centre represents this classroom culture, while the other circles represent the elements and specific procedures aimed at contributing to the establishment of the classroom culture. This research examines how the implementation of technology affects formative assessment in general and these procedures in particular using a specific theoretical lens, which is discussed in the theoretical framework section 2.5. Thus, my research contributes to the theory of formative assessment by elucidating the role of technology.

Figure 2.1

The Six Key Elements of Formative Assessment (OECD, 2008, p. 7)



Further to these six elements of formative assessment shown in Figure 2.1, each is discussed in greater detail as follows:

Element 1: Establishment of the classroom culture that encourages interaction and the use of assessment tools (OECD, 2008, p. 7).

Nowadays, the expert community generally accords that formative assessment should be an integral part of the teaching and learning process, and is one of the foundations of education (OECD, 2008). According to the results of an OECD global study, when the classroom culture facilitates interaction and is in line with the spirit of formative assessment, students are more likely to feel comfortable to make mistakes in the class, thus making more apparent what is challenging for them and accordingly facilitating learning (OECD, 2008). Such an environment is conducive to the development of self-awareness, self-control, and information analysis skills (Meškauskienė & Guoba, 2016; OECD, 2002; Trautwein et al., 2006).

Element 2: Establishment of learning goals and tracking of individual student progress towards those goals. (OECD, 2008, p. 8)

According to the studies undertaken in various countries, monitoring of the individual student’s progress towards a pre-defined goal is more effective than the traditional grading and comparison with peers (Cameron & Pierce, 1994; Heckhausen & Heckhausen, 2018; Kluger & Denisi, 1996; Krug, 1999, as cited in OECD, 2008).

In line with the studies mentioned earlier, the teachers from the OECD research case schools discontinued the use of traditional grading as it is grounded in the idea of comparing the students with each other. Instead, they were evaluating the individual student's progress towards the established goals, which enhances the transparency of the process as students are well aware of what is expected of them (OECD, 2008). Experimental evidence supports positive effects associated with the evaluation of students' progress over time, in particular, in respect of facilitating intrinsic motivation, self-esteem, academic self-concept and, most importantly, learning (Cameron & Pierce, 1994; Köller, 2001; Krampen, 1987; Meškauskienė & Guoba, 2016; Schumacher & Ifenthaler, 2018; Trautwein et al., 2006).

Element 3. Use of varied instruction methods to meet diverse student needs (OECD, 2008, p. 8).

Students’ emotional styles and abilities to manage their emotions vary significantly (OECD, 2002), as well as their background knowledge and experiences that they encounter in their lives outside of schooling that affect their learning (Bransford & Schwartz, 1999; Bruner, 1996). Furthermore, children are significantly affected by their culture, socio-economic class, ethnicity, and other personal factors (OECD, 2008). Teachers can facilitate learning by finding the ways to connect novel concepts to the prior experiences of students. Moreover, teachers who are more aware of cultural differences and variations in the individual comprehension styles are more likely to facilitate the students' learning process (Bishop & Glynn, 2003). However, a detailed understanding of the relationships between the variability among students and the approaches to the adaptation of formative assessment approaches to cater for individual needs is constantly developing (Hattie et al., 2016; OECD, 2008), especially with all the technological advancements.

Element 4. Use of varied approaches to assess student understanding (OECD, 2008, p. 9).

The typical toolbox of summative assessment methods includes written and oral examinations (often conducted under pre-defined time restrictions) and tests, designed to ensure the possibility of direct comparison of the results and undertaken at set intervals. In contrast, formative assessment methods include observations, feedback, questioning, self- and peer-assessment and keeping of the students’ records (Black et al., 2003). According to the OECD, students' performance varies depending on the task to be performed; consequently, some students reveal better performance with one type of assessment, while others succeed with other types (OECD, 2008). On this note, it is important to point out that summative assessment methods can and should be used in the formative assessment process as long as they are not the only type of methods used and the results are used to inform the learning process (Dolin & Harlen, 2018; OECD, 2008).

Element 5. Feedback on student performance and adaptation of instruction to meet identified needs (OECD, 2008, p. 9).

While feedback is recognised as one of the foundations of formative assessment, not all types of feedback are conducive to formative assessment. For feedback to be effective, it must be timely and specific, include improvement-related suggestions and connect to the expectations towards the student's performance (Hattie & Timperley, 2007; Shute, 2008; Wiliam, 2011). Further, research has shown that students perform better when working towards process rather than product goals and when they can track their progress towards the overall learning goals (MCC, 2018; Moeller et al., 2012; Schunk, 1996). By incorporating these elements into the feedback process, educators can enhance student learning and promote a formative assessment culture in the classroom.

Moreover, using a system of grades as a performance measure may have an adverse effect and undermine the positive effect feedback has on performance (Butler & Winne, 1995). In addition, the process of giving feedback benefits teachers as well as students because the process draws the teacher’s attention to the stronger and weaker areas of knowledge of the particular students and directs teaching towards catering for individual needs (Hattie & Timperley, 2007; Irons & Elkington, 2021; OECD, 2008). Due to the paramount importance of feedback to the formative assessment practice, it will be discussed later in much greater detail.

Element 6. Active involvement of students in the learning process (OECD, 2008, p. 10).

The OECD (2008) argues that the ultimate goal of the learning process is to develop student's learning skills and metacognitive strategies to facilitate independent learning in the future. These strategies, commonly referred to as "control strategies," include the application of problem-solving skills in daily life, finding answers, and tackling new challenges in unfamiliar environments (Kalyuga et al., 2010; OECD, 2008; Seel, 2012; Wegner et al., 2013). Research by Pintrich (2004) highlights the importance of assessing motivation and self-regulated learning in college students, emphasizing the role of self-efficacy in learning. Similarly, Zimmerman (2000) emphasizes that self-efficacy is an essential motive for learning. Schunk and Ertmer (2000) discuss self-regulation interventions that enhance self-efficacy in promoting academic learning.

Additionally, Efklides (2008) defines *metacognition* as essential for self-regulation and co-regulation. Once students become aware of the most suitable learning strategies for them, they can better set their own goals, develop strategies to achieve them, and independently monitor their progress. However, students' active employment of control strategies relies on their motivation and self-confidence. Consequently, fostering intrinsic motivation and building self-confidence are key learning outcomes (OECD, 2008; Zimmerman, 2000).

While the assessment procedures are presented separately, they are profoundly interconnected and related to each other. In the original article, Black and William (2009) argue that any formative interaction must be related to the planned teaching activities as well as to the cognitive and affective processes of students. Ultimately, all the procedures discussed in this chapter constitute a teaching and learning framework in which all elements are interconnected and enhance each other. For example, the teacher should involve the students in the definition of their learning goals, clearly communicate those goals to them, assess their progress by the means of observation, peer- and self-evaluations, and questioning. Finally, the teacher communicates the progress to the students using formative feedback that discusses the achievements and advises on how further progress can be made. This framework allows teachers to identify learning goals, create the classroom environment that is conducive to learning, involve the students in the process, and guide them towards their learning goals (OECD, 2008).

2.2.3 Formative Assessment Techniques to Support Student Motivation and Achievement

The information to inform assessment can be obtained from different activities, for example, classroom work, discussions, grades, or results of tests and examinations. However, assessment becomes conducive to learning when this information is used to inform the learning process and adjust teaching practices accordingly to better provide for the individual needs of students (Black et al., 2004). Consequently, teaching activities should be designed in such a way that the students are actively engaged in the learning process and assume responsibility for it. The studies suggest that monitoring student progress and providing relevant feedback are the key processes to enhance the strategic use of assessment for learning (Wiliam, 2011). While monitoring informs the teacher about the student's current position in relation to learning goals, feedback is a crucially important tool of communicating this information to the student (Hattie & Timperley, 2007; Nicol & MacFarlane-Dick, 2006). Feedback is important because it informs the student about their progress and helps identify the gap between their current state and the learning goals they want to achieve. When engaging in a productive dialogue with a teacher during feedback, a student is actively developing meta-cognitive knowledge that allows them to evaluate their learning strategies, thus developing control strategies (Clark, 2012b). In addition to teacher feedback, it is important to recognise peer-to-peer feedback as a powerful tool for development and goal achievement (Nicol & Macfarlane-Dick, 2004). Moreover, facilitating self-assessment is conducive to the development of meta-cognitive strategies by actively engaging the student in the process of comparing their current state to the set learning goals (Butler & Winne, 1995). Thus, self-assessment and monitoring of their learning teach students to select and employ better learning strategies to advance towards their learning goals (Sadler, 1989). Consequently, monitoring activities themselves are not sufficient for the assessment to be conducive to performance (Baas et al., 2015).

In order to facilitate the learning process and boost achievement, the monitoring practice should be complemented by scaffolding, which is an explicit method of support extended by the teacher to the student for the purpose of ensuring that the student can complete the task (Shepard, 2005). Once the student has been evaluated as capable of accomplishing that task, the teacher reduces support while instructing the student on their further learning steps (Black & Wiliam, 2009). In that way, both motivation and achievement are facilitated because students have a clear understanding of their learning goals and evaluation criteria (Nicol & Macfarlane, 2006). It follows that in order to facilitate learning, feedback should not only provide the information of the current state of the student's learning process but also elaborate on the future steps to be undertaken in order to achieve the learning goals (Sadler, 1989). In addition, the studies suggest that feedback conducive to learning stimulates students to reflect on their learning process and actively engage in developing the steps to close the gap between their current state and desired goals, rather than merely instruct them on the future steps (Baas et al., 2015). In particular, the information that facilitates self-regulation of the learning process is conducive to the development of deep processing and learning (Hattie & Timperley, 2007).

Furthermore, it was established that the descriptive feedback that offers information about learning facilitates the employment of better learning strategies by students. For example, adjustment of the learning goals, planning of their studies, selection of learning strategies and adjustment of them when required, are conducive to the development of control strategies (Butler & Winne, 1995; Clark, 2012). In addition, studies have found that engaging students in the active development of their study programmes increases their motivation to learn (Walters et al., 2017). The relationship between formative feedback and learning strategies has been tested and confirmed quantitatively. Baas et al. (2015) found that monitoring activities coupled with constructive and informative feedback are a predictor for students' task orientation and planning. Furthermore, their study suggested that adequately designed scaffolding activities are positively related to the employment of in-depth learning strategies and the depth of the post-factum self-evaluation process (Baas et al., 2015). Their study concluded that assessment for learning practices should provide students with sufficient opportunity to take responsibility for their learning process.

2.2.4 Formative Assessment in Classroom Practice

In practice, however, assessment often does not constitute the foundation of the learning process due to the narrow focus on reporting achievements, accountability, and economic well-being (Timmis et al., 2016). Torrance (2007) draws attention to a set of weaknesses that may emerge in the process of using assessment as a means for learning. The extensive use of coaching and tutoring students through every stage makes learning less challenging and diminishes the quality of achievement by displacing student self-learning with what the teacher has told them. Torrance (2007, p. 282) argues that assessment has come to replace learning in that now it is more about "criteria compliance," reducing the quality of what the students genuinely know themselves and reducing their capacity to learn without coaching and extra tutoring by the teacher or even a third party.

Relatedly, despite sufficient theoretical and administrative support extended towards implementation of formative assessment methods in practice, the evidence suggests that this process faces significant difficulties, which are related to three concepts: effective learning, negative impact, and managerial role of assessment (Black et al., 2003). While in theory summative and formative assessment are viewed as distinct concepts, in reality, they are often mixed and confused in schools and in assessment design (Dolin & Harlen, 2018; Harlen & James, 1997). According to numerous studies, formative assessment is conducive to the understanding and deep learning of students, especially when it employs such methods as peer-to-peer assessment, questioning, feedback, and is necessarily an integral part of the daily teaching practice (Black & William, 1998). Despite these insights about the advantages of formative assessment which have been gleaned from the research, the summative assessment methods are still in more common use (Black & William, 1998). Moreover, researchers argue that the methods of summative assessment are still perceived as ensuring "accountability". One quantitative evaluation showed that the perceptions of formative assessment being actually implemented differ dramatically between teachers and students, while there was also evidence of the use of assessment methods directly contradicting the assessment for learning approach (Maclellan, 2001). Other studies have suggested that the whole system of once-a-year evaluation is not conducive to the development and engagement of formative assessment (Stiggins, 2002).

More recent studies, however, point out that the trend is being slowly reverted towards greater use of assessment for learning. Ruiz-Primo and Furtak (2007) explored the more informal side of formative assessment practices among the teachers and students of three middle school science classrooms and found there were differences in how the teachers practised assessment. The authors present a model to elicit, recognise, and use information and link these three components to the epistemic frameworks and concepts that are part of scientific inquiry. Ruiz-Primo and Furtak (2007, p. 57) described what they observed in their research, and developed a framework they call ESRU cycles, as "the teacher *Elicits* a question; when the *Student* responds; the teacher *Recognises* the student's response; and then *Uses* the information collected to support student learning." The researchers found the students with the higher performance outcomes were those whose instructor used the complete ESRU cycles the most when compared with the other two instructors (Ruiz-Primo & Furtak, 2007). The authors concluded that the ESRU model is a useful way of understanding the informal processes that teachers use to assess student learning. These practices are highly varied, yet they can be useful and may be associated with better levels of student achievement in science topics.

However, teachers' professional development, students' support, and school support offer a more profound understanding of formative assessment are vital in fostering the shift from summative to formative assessment. According to a longitudinal qualitative case study, high-school teachers are more inclined to using formative assessment methods when provided more information about it and when the use of formative assessment enjoys administrative support (Brink & Bartz, 2017). Another case study focused on the high-school students' understanding of a specific method of formative assessment, namely peer-to-peer evaluation, and concluded that anonymity is of high importance for the success of this assessment method (Foley, 2013). Despite the recent evidence of an increase in the use of formative assessment in classrooms (Brink & Bartz, 2017; Foley, 2013; Ruiz-Primo & Furtak, 2007), it can be concluded from the literature that the results of research have had limited influence on improving the practice of assessment, which is still mainly summative, and on the perception of formative assessment as the norm, which is quite far from today's reality.

Brink et al. (2019) conducted a mixed methods study of the understanding of formative assessment from the perspective of three teachers to gain insights and understandings in order to enhance their planning and individualisation of course content to improve student learning. The study was carried out over a period of two years in a Midwestern high school in the United States. Crucial to the understanding of formative assessment for the three teachers participating in the project was developing a "roadmap" that aligned the course goals with the other course components, such as learning objectives, activities, instructional methods, and assessment. The in-depth case studies revealed that the teachers became more positive about the assessment when they received some staff development, which also resulted in the teachers being more successful at implementing formative assessment in practice. Thus, staff development needs to be tailored to individual teachers, and there needs to be a support network provided for staff development.

Nowadays, research is increasingly concentrated on the effect of new technologies on assessment practices and outcomes. While some ten years ago, researchers claimed that the traditional mainstream education generally failed to incorporate the use of technology in the teaching process (Craven, 2009), the situation is rapidly changing (Timmis et al., 2016). More recently, it has been argued that technological solutions might enhance the transparency of the learning process, by both making the students’ learning and the assessment more visible (Martínez et al., 2015; Martínez-Torres et al., 2008; Vásquez et al., 2017). Case study research has shown that increased transparency may lead to better serving students' needs and more tailored support on behalf of the teachers (Martínez et al., 2015). In addition to this, while technological advancements are commonly perceived to be conducive to summative assessment, in practice the models facilitating formative assessment were proposed and successfully tested (Whetton & Sainsbury, 2007). Researchers point out that the opportunities opened by using technologies in the assessment process are accompanied by some associated risks and challenges, such as ethical concerns related to social inclusion and risks of using big data (Timmis et al., 2016). Clearly, the role technology plays in the assessment process demands a further investigation to enhance understanding and inform research, practice, and policymaking alike. The next section presents the overview of the existing research on feedback, discusses the definition, types and focus.

2.3 Feedback

One of the cornerstones of formative assessment is feedback (Black & Wiliam, 2009). Therefore, it is essential to review the research on it to gain a clearer understanding of formative assessment. This section provides an overview of the literature related to feedback in education. Feedback has been widely recognised as an essential part of learning and an influential tool for teachers that has more to contribute to the learning process than just assessment. It was early recognised that feedback is a significant dimension of learning. For example, Cohen (1985, p. 33) pointed out that feedback "is one of the more instructionally powerful and least understood features in instructional design". While there are ample discussions of the potential to enhance learning processes with substantive feedback, there is still little systematisation of substantive feedback about student performance and learning processes into the teaching philosophies and daily lesson planning that shapes practices in the classroom (Wiliam & Thompson, 2019).

2.3.1 Defining Feedback

As a means to gauge learning effectiveness and teaching effectiveness, feedback is defined as the information provided by an agent as a "consequence" of performance (Hattie & Timperley, 2007, p. 81). In a broad sense, feedback can be an evaluation of behaviour, student performance or skill provided by teachers, parents, or peers. Teachers and administrators use different levels of feedback when they assess student performance and learning, and there are different typologies to describe these levels of feedback in the literature. Hattie (2016), for example, describes four levels of feedback: task, process, self-regulation, and self. Others categorise feedback as knowledge of response, knowledge of correct response, answer until correct, elaborated feedback, and “bug-related”, which refers to feedback that gives explanations for the correction of errors in addition to the correct response (Narciss & Huth, 2006; Schimmel, 1988). Butler and Winne (1995, p. 5740, cited in Hatie & Timperley, 2007, p. 82) pointed to the value in feedback in the learning process because “feedback is information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies”.

2.3.2 Formative Feedback

Although feedback has long been used to gather data on learning effectiveness and teaching effectiveness, there is still little systematisation of the methods and techniques for using feedback as a useful teaching tool and a way to continually assess learning in the classroom at the instructional level. As Stiggins (2002) has noted, assessment should not just happen for assessment’s sake; it should help researchers to discover what makes students want to learn and how students can feel they have more ability to learn. Additionally, if feedback on learning outcomes is only sought once-a-year with the application of broad, system-wide assessment tests, then feedback is not providing teachers with the daily information they need to know to make adjustments in their instructional practices (Stiggins, 2002). Therefore, Black and Wiliam (1998) reported that although teachers, educational administrators and policymakers perceive assessment for learning as beneficial for their students, it needs to be used to help inform everyday classroom practices to improve the quality of instruction at the individual pupil level in the classroom.

Research that has explored the effects of feedback noted that feedback is one way to implement assessment at the classroom level; it gives teachers a tool to continually engage with individual students and to gauge their learning process (Hattie, 1999; Sadler, 1989). Integrating formative feedback into teaching practice is complicated because there are many different kinds of feedback, as has been mentioned above.

Further, Kulhavy (1977)) informed that learners could reject feedback; it is not always a reinforcer of positive learning behaviours for every student. Therefore, some attention also has to be paid to how students are receiving feedback (Dann, 2014b). It is also essential that students receive feedback not just from teachers but also their peers and other influencers like their parents. There is recognition in the literature that some kinds of feedback are more helpful to students or learners than others. For example, feedback can be positive, highlighting the attributes and skills that shone through on an assignment, or feedback can be negative, only drawing out a student's weaknesses. It has been found that negative feedback is not conducive to learning for a significant proportion of learners (Hattie & Timperley, 2007). Negative feedback can have negative effects on learners with both high self-efficacy and low self-efficacy, although the effects are different. Whereas Nease et al. (1999) have found that people with high task-relevant self-efficacy are less likely to respond well to negative feedback than those who have low self-efficacy, other research shows that students with low self-esteem tend to perform at decreased levels when they receive negative feedback (Brockner et al., 1987). The complex and varied nature of feedback is further shown in research demonstrating that persons with high self-esteem perform better after receiving negative feedback (Fedor et al., 2016).

What is more, research has shown there are subtle ways to make the feedback more amenable to learning. For example, Cianci et al. (2010)

demonstrated that students appear more willing to accept negative feedback when something is labelled a “learning” task, as opposed to a “performance” task in a population of undergraduate students (Cianci et al., 2010). Thus, there seem to be a high number of moderators involved in the way that learners accept and process feedback (Kluger & DeNisi, 1996). Feedback needs to be combined effectively with other teaching practices so that students are given concrete ways to address their weaknesses that seem feasible and actionable, like framing the task as a trial more than a performance task at first, as given in the example from Cianci et al.’s (2010) research above. It is essential to individualise and accommodate feedback so that it is implemented in the ways that genuinely target the student at their level. It needs to be precise at getting to what practices will help students to improve their understanding (Hattie & Timperley, 2007). Sadler’s (1989) theory of formative feedback is that feedback must motivate learners to close the gaps between their actual status and desired goals. Building on Sadler’s ideas, Black and Wiliam (2009) have provided a framework for formative assessment that also speaks to the “gap” between where the learner is going, where the student is right now and how they can get to where they need to be academically. As mentioned above, the authors proposed five strategies that will lead to the formative use of feedback. Black and Wiliam (2010) explained that these strategies would help the teacher to mitigate the “gap” that is also inherent to the notion of formative feedback and help the instructor to navigate the contingency in the classroom. Contingency moments are those moments where students may struggle before making gains in their understanding and where teachers may need to adjust their strategies to be more successful (Sadler, 1989).

Another concept that will help to amplify the use of different technologies and formative assessment in the classroom context is the concept first developed by psychological theorist Lev Vygotsky (1978) called the zone of proximal development (ZPD) (see Figure 1.2). The theory of ZPD emphasises the potential factors in education versus the actual development levels of students at the present time. The ZPD notion is useful because it allows assessment of learning in gradual stages, and there is development in the sense of what the students actually know how to do in the present. Furthermore, the notion is useful because it also suggests there is a latent area in learning where there is potential to know and do more. Vygotsky (1978) called on education to recognise that students are developing their skills in stages that will potentially lead them to a higher level of problem solving. The emphasis on this potential has assisted me in analysing how the formative assessment practices used in the learning process are contributing to greater overall educational goals.

2.3.3 Feedback for Learning

Several seminal studies establish the significant influence that feedback has on learning. Hattie and Timperley (2007) reported their findings from a study that combined the results of over 500 meta-analyses, including 450,000 effect sizes from 180,000 studies, representing somewhere between 20 to 30 million students. This meta-analysis looked at more than 100 factors influencing student achievement. They established that the average or typical effect of schooling was 0.40 (*SE* = 0.05). They used this as a benchmark figure to measure the influence of other factors influencing education, like feedback. The authors then used the data from 12 previous meta-analyses on feedback in classrooms. The data from these studies were much smaller than the general study with 196 studies and 6,972 effect sizes, but the average effect size was 0.79. As Hattie and Timperley (2007) explain,

To place this average of 0.79 into perspective, it fell in the top 5 to 10 highest influences on achievement in Hattie's 1999 synthesis, along with direct instruction (0.93), reciprocal teaching (0.86), and students' prior cognitive ability (0.71). It can also be contrasted with other influences such as acceleration (0.47), socioeconomic influences (0.44), homework (0.41), the use of calculators (0.24), reducing class size (0.12), and retention back one year (–0.12). (p. 83-84)

These data have been used to state that feedback is one of the greatest influences on learning effectiveness and the quality of teaching. In a later article, Hattie et al. (2011) used Sadler's (1989) idea of a "gap" to explain that feedback is powerful because it helps students to get closer to where they should be academically. Feedback helps the individual student with what the authors call the "fundamental feedback questions" including "where am I going," "how am I going," and "where to next" (Hattie & Gan, 2011).

In a similar light, Black and Wiliam (1998) also carried out a meta-synthesis that included over 600 studies that examined the effects of feedback and other means of formative assessment. The researchers found that the effective use of formative assessment in the classroom contributed to higher levels of student achievement (the researchers stated the effect sizes ranged from between 0.4 to 0.7 standard deviations) (Black & Wiliam, 1998). Other studies have found effect sizes that are somewhat smaller but still substantial. For example, Nyquist (2003) found effect sizes for formative feedback ranging from 0.3 to 0.5 standard deviations.

2.3.4 The Focus of Feedback (Four Levels)

Hattie and Timperley (2007) outlined four different levels of feedback that can be applied in the classroom. First, feedback can be about the task the student is performing or the product they are producing, for example, completing a lab assignment or writing an essay. At the task level, feedback should indicate whether the student is correct or incorrect, and relay information. This type of feedback is what students tend to receive most. Other names for it are corrective feedback or knowledge of results. This kind of feedback can be powerful when the learner is just beginning to learn because it is specific to them. Task-based feedback is the basis for the other levels of feedback; it provides the basics that instructors use to build on level 2 feedback (about the process of learning) and level 3, about students' self-regulation.

The second level is feedback that addresses the processes the student follows to complete the task. This involves strategies and reassessments and cueing students to understand steps in the learning process. Feedback at the process level seems to enhance the quality of learning, making it more effective than the one at the task level at engaging students more deeply with the material. This can assist the learner in gaining more task confidence and self-efficacy, which is a person's belief in their capacity to achieve their goals. This, in turn, gives the learner better resources for more useful information searching and building better strategies. For example, Chan and Lam (2008) carried out an experiment where they created a failure situation and then assessed the acceptance of feedback among the learners. They found that feedback was more likely to enhance self-efficacy among the learners when it was formative rather than summative. It also was more motivational for the students if the feedback referred to them personally without comparing them to other individuals in their peer group.

The third level of feedback is self-regulation where the students learn to monitor their learning processes and rely less on the instructor. Feedback at this level can enhance students' skills in self-evaluation. They can gain another level of confidence which will help them continue to engage in the task and seek out further feedback to continue mastering these skills.

The fourth level is feedback directed to the "self" (e.g., "You are a great student," "Well done"). This kind of feedback does not give direct attention to the task. It is the kind of praise that students welcome and is traditionally used in almost any classroom setting, although it does very little to increase achievement or learning. However, when Kessels et al. (2008) gave feedback without any correspondent fourth-level praise, there were lower levels of engagement observed. This may show that students have been accustomed to this kind of praise from teachers. Hyland and Hyland (2006) discovered in their study that close to fifty per cent of the teachers' feedback was in the form of praise. Others point out that premature and gratuitous praise can discourage revisions of work such as essays, requiring various iterations of development (Skipper & Douglas, 2012).

2.3.5 Feedback As an Assessment Component: Efficient or Not?

Formative assessment is meant to guide future learning because it makes inferences about what a student is doing at present and what they can do in the future (Wiliam et al., 2004). As was discussed previously, according to Black and Wiliam (2009), assessment is formative when the evidence of student performance is collected and used by teachers to make decisions about instruction in the future. The results from almost any evaluation or assessment can be used in this way to improve instruction. These instructional adjustments will help improve student learning. However, Dann (2014) has argued that assessment as learning (AaL) is complex because it mixes teaching, assessment, and learning. Therefore, students should become more self-aware of their learning progress, which in itself is another cognitive level of learning that is not often taught explicitly (Dann, 2014). In their study of formative feedback and technologies, Panero and Aldon (2016) draw on the research of others to say that the teacher's role has become more complicated with the introduction of different technologies. That is because now they orchestrate information and the student is at the centre of their learning process (Clark-Wilson, 2010; Roschelle et al., 2002), which clearly demands more comprehensive evaluation, as was undertaken in the present study.

Although research findings strongly support the importance of students' use of self-regulatory processes in learning, it is evident that there are challenges in the classroom due to inadequate preparation by teachers in fostering independent learning (Zimmerman, 2002). Moreover, the limited opportunities for students to engage in complex assignments, teamwork, and self-evaluation further hinder their cognitive and motivational development (Zimmerman, 2002; Dann, 2014). These studies emphasize the need for a symbiotic relationship between assessment and learning, where students have greater control over their learning process and interpretation of feedback, ultimately bridging the learning gap for many students.

The previous sections have provided a review of assessment research with a particular focus on formative assessment and the role of feedback in this process. Understanding of the current state of research on formative assessment is vital for this research as it offers the background information on what is already known about formative assessment and thus prevents the duplication of efforts. It is important to highlight that although research extends great support towards the use of formative assessment and feedback in education, the numerous studies reviewed in this chapter point to difficulties in practical implementation of formative assessment due to several reasons. Furthermore, it was established that the introduction of technology in the learning process adds another level of complications, which is likely to affect the use of formative assessment directly. Consequently, a great deal of ambiguity remains in respect of the role of technology in education in general and assessment practices in particular, and additional research on the topic is likely to benefit the scientific community, practitioners, and policymakers alike. The next section presents the overview of the existing research on technology in education, discusses the adoption of technologies in schools in theory and practice, and pays particular attention to the role of technology in formative assessment and, especially, feedback.

2.4 Technology in Education

This section provides an overview of the existing body of research on the role of technology in education with the purpose of narrowing and specifying the identified knowledge gap in the relationship between technology and formative assessment.

Initially, in the 1980s and 1990s, it was believed that integrating computers into education would drastically transform classrooms, schools, and teaching practices (Bates, 2005; Halverson & Smith, 2009; Papert, 1980). During that time, the constructivist view on learning suggested that the advent of computers would fundamentally change the relationship between students and teachers. Teachers would take on a role more akin to guides rather than simply imparting knowledge as they had done previously. It was thought that technology would empower students to experiment independently and test various knowledge claims on their own (Papert & Harel, 1991; Vygotsky,1978). However, it is important to note that the dominance of constructivism varied depending on the era. Eventually, scholars came to understand that the transformative power of information and communications technology would encounter significant barriers in achieving widespread adoption in the classroom. This was because most formal education (K-12) schools were organized around traditional "instructionist" methods, which conventionally relied on passive learning approaches (Cuban, 1986; Papert & Harel, 1991). Students were expected to engage less and primarily absorb information. In this old instructional vision, disciplinary measures were applied if students failed or performed poorly – quite the contrary to the ideas of formative assessment, outlined in the previous section.

Researchers found that instructionist views of knowledge acquisition were highly resistant, as at the time computers were introduced into the education system, most of the classroom instruction still resembled traditional practices that had persisted for several decades (Cuban, 1986). Technology integration in the early years witnessed two primary reactions from K-12 schools. Some schools opted to incorporate technological tools such as film projectors, radio, educational television, and early computer systems to reinforce existing traditional practices (Powell, 1985). On the other hand, some schools marginalized these technologies by banning them from the classroom altogether (Christensen et al., 2008). This resistance to change was rooted in the prevailing school organizational model, which upheld that schools had control over the learning experience and assessed students based on the teacher's terms.

2.4.1 How Technology Did Not Change Education

Although some scholars believe technology has helped to democratise education, making it available to almost everyone, everywhere (Chen et al., 2009), others are sceptical, believing that too much is just taken at face value when it comes to discussions of technology and education (Selwyn, 2015). In an editorial article entitled "Assessment for the Digital Age," Mcfarlane (2003) explained how traditional forms of assessing students seemed to slow the adoption of technology-enabled practices for classroom instruction. Since then, the development of new social network technologies has revealed the "awkward relationship between new ‘21st-century' media practices and existing educational systems" (Hickey et al., 2010, p. 107).

While there are assumptions that the use of technology necessitates the use of higher-order skills, it is important to critically examine this perspective. Moir (2016) raises doubts about the direct impact of technology on the development of higher-order skills such as problem-solving, creativity, and critical thinking. According to Moir, when students engage in activities like constructing a wiki, they often involve competency-based tasks like cut-and-pasting and cooperating, which differ from higher-order skill development. This highlights the need for a balanced perspective, recognizing that formal education still plays a crucial role, and technological offerings should not be seen as outright replacements. Furthermore, Selwyn (2010) emphasizes the importance of moving beyond simplistic categorizations of technology as 'good' or 'bad.' Instead, it is crucial to explore the actual mechanisms at play in the lived experiences of teachers and students to understand how technologies are used and how they impact learning (Selwyn, 2011).

Other researchers have noted that overall, the forms of learning that are used are still widely uniform and thus far technologies have not changed the existing purpose of education or benefitted students and learners in substantive ways (Collins & Halverson, 2018; Salomon, 2016b). On the other hand, Boyles and Klein (2018) question the convention that more connectivity is necessarily a positive influence on teaching and learning. The authors argue that the claims to provide better learning are specious. The unthinking and enthusiastic pursuit of new technologies is like a form of determinism; the ontological assumptions underlying the idea of the apparent importance of technologies are not neutral (Boyles & Kline, 2018).

Consequently, it is clear that further research is needed to address those issues and expand the discussion beyond the binary evaluation of technology as either "positive" or "negative". Among other issues, this research investigates how the technology-aided formative assessment affects teaching practices and answers the question: are these changes beneficial from the perspective of teachers? To examine the issue, my research uses the theoretical lens of affordance theory complemented with the ideas of TAM, which will be discussed in greater detail in the theoretical framework section. From the theoretical standpoint, it is expected that the introduction of technology should facilitate and simplify the formative assessment process because technology acts as affordance that offers the possibility of practising formative assessment, by, for example, simplifying the monitoring process. However, it is likely that the attitudes of the teachers are to a great extent affected by their perceptions. Do they perceive the technological affordances at all? Do they find them useful? Do they find them easy to use? If the answers to those questions are positive, the teachers are likely to express positive views on the use of technology and believe that technology is beneficial for formative assessment. However, if they do not perceive the technological means as an affordance, they are likely to find it not beneficial and consequently not use it.

Another possible scenario is that the teachers perceive the technology as an affordance but do not find it useful. For example, they may believe they are more efficient in practising formative assessment without being aided by technology, or they may not trust technological means (Chen et al., 2009; Selwyn, 2010). In this case, the teachers may also be reluctant to use technological advances, and consequently, there will likely be no or somewhat limited effect on formative assessment processes (Mcfarlane, 2003; Hickey et al., 2010). It is also possible that the teachers perceive technology as a useful affordance but perceive it hard to use, which is likely to hinder the adoption of technology in the classroom and limit its effect on formative assessment processes (Moir, 2016; Selwyn, 2015).

Different combinations of these factors are expected to define the extent to which technology changes formative assessment processes. Similarly, students are expected to perceive technological means as conducive to their learning if they perceive those means as enablers of the process, useful, and easy to use. The perceptions of students shape the second part of this interactive social process and different combinations of students' and teachers' perceptions are expected to shape different outcomes in respect of the actual use of technological means in the formative assessment processes, the choice of technology, and the effect it has on formative assessment.

Concerning this issue of acceptance of technology in education, it is important to review the scientific views on the adoption and use of technology and what are the theoretical underpinnings of those processes. The next section presents some of the technology adoption theories proposed in the literature and discusses those that provide insights into the adoption of technological advances in schools.

2.4.2 Technology Adoption in Schools: Theories

As Straub (2009) has noted, technology adoption is an inherently social process that has developed over time. It is complex because individuals have to change perceptions of technology that influence their impressions and reactions to it. There are cognitive, contextual, and even emotional concerns to take into account when trying to understand technology adoption in educational environments (Straub, 2009).

Technological advances can generally be viewed as innovations; therefore, the views on the diffusion of innovation form important background knowledge for understanding the adoption of technology. Rogers' (1995) theory of innovation diffusion has influenced many disciplines as a comprehensive approach to understanding the adoption and diffusion of innovations, such as technologies in collective populations. According to Rogers's (1995), innovation diffusion is "the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system" (p. 11). The author's theory provides a broad foundation for understanding the factors that influence an individual when adopting an innovation. A number of other authors have explored this theory of adoption and diffusion (He & Berry, 2022; Pennington, 2004; Pinho et al., 2021).

In addition to other authors’ work in the general area of innovation diffusion, early studies have proposed theories on the adoption of innovations in the educational context. The concerns-based adoption model (CBAM) can be traced back to the work of Fullan (2012a) who developed a three-stage classification of teachers' concerns. In adopting an innovation, the teacher's first apprehension is about student outputs, and the second concerns their worries about being able to carry out the task. Finally, the task stage entails their daily teaching duties and how they perform them, considering especially the aspects that might constrain their work, such as the lack of resources. Fullan’s (2012) CBAM framework has been used in many studies exploring teacher concerns in adopting new materials and practices, such as their acceptance of educational innovations (Christou et al., 2004). Dobbs (2004) also used the CBAM model to discuss faculty responses in higher education to the use of interactive television (ITV) classrooms. At the time, Dobbs (2004) found that faculty members need to be supported with accurate information to develop skills to teach in these non-traditional mediums. The CBAM model is useful in understanding the process of technology adoption; it is not a question of being either used or not used. For a teacher to become a skilled user of technology a process is involved, not an event (Hall, 2010, p. 233). As Hall (2010) remarks, "teachers and schools are not non-users of a particular technology one day and expert users the next day." Implicitly, however, research has often taken a dichotomous approach to the study of adoption of technology in the classroom. Consequently, studies have not accounted for the gradual process of trial and error as teachers learn how to use and incorporate the device or programme into their lesson plan (Hall, 2010).

Becoming skilled in using a new programme or wireless piece of instructional equipment takes time. This is a process that is becoming more complex as most new applications of technology require new infrastructure every few years, such as greater memory or bandwidth, which inhibit what administrators who usually have to manage via restricted budgets can adopt (Hall, 2010). It is commonly believed that the younger generations are more accustomed to technologies and they have grown up with computers all their lives and those adjustments will be easier in the future. However, Straub (2009) did not find any empirical or longitudinal data providing evidence of this at the time his article was published.

Finally, the implications of applying technology in education are not just limited by classroom use. The peripheral systems that support student learning, such as information systems, payroll, and changes in how the school communicates with parents and the surrounding community, all have their effect. Mobile phones have given students more ability to communicate with people outside their school environments throughout the day, and the mobile, Internet-enabled devices are making the current generation of technologies more pervasive. This development has blurred the lines between what is a pedagogical technology and what is non-pedagogical (Straub, 2009). Devices such as smartphones and tablets empower students to independently search for information or to take a picture and exercise much agency throughout the school day. Yet, these personal devices can also be a distraction from normal studies and can divert students from learning to become obsessed with social media or inappropriate web content.

Therefore, it can be seen that the adoption of technologies in classrooms is a topic that has been extensively discussed in the literature with a number of important theories having been developed. However, the questions surrounding the integration of technologies in schools and adaptation of teaching practices remain a complex area of research with little consensus among authors. Hence, my research focusses on practice as one of the factors that will contribute to knowledge about the issue.

2.4.3 Technology Adoption in Schools: Practice

Discovering the factors that most help to integrate technology into the classroom has been one of the key topics developed and debated in the field of educational technology (Tondeur et al., 2008). Practice-oriented research recognises a broader range of effects of introducing technological advances in education than the mere dichotomous view of "positive" and "negative" effect thereof. For example, Bilbao-Osorio and Pedró (2010) argue that there are two different effects that digital technologies have had in education: (a) digital technologies can enhance student performance because students develop better ICT skills and improve their academic performance in basic subjects, and (b) digital technologies improve learning and introduce new and innovative methods of instruction. Some research attention has been devoted to studying the role and effect of introducing particular technologies and devices in the educational process. Thus, within this literature, it is widely recognised that wireless technologies, such as handheld devices and tablets, are among the technologies that bring the most positive results according to teachers putting new products to use in the classroom (Voogt et al., 2013)

Introduction of new teaching practices is a positive impact of ICT adoption that has received the most systematic attention in the literature. For example, Donnelly et al. (2011), Hennessy et al. (2005), and Sorienta and Jimoyiannis (2008) have all described important changes in classroom practices brought about by the integration of computers in learning. Attention to the enhancement of student performance has also been researched extensively, as many of the empirical studies in this review show. However, the results of the empirical research are less theorised and systematised, and there are less conclusive arguments to emerge from this body of research as of yet. Understanding the role of the teacher in adopting technologies is a more well-developed topic with some categorisations and analyses of the kinds of resistance teachers exercise to the idea of relying more on technology in formative assessment (Donnelly et al., 2011; Siorenta & Jimoyiannis, 2008). In using technology in an educational setting, the perception is that the role of the teacher changes profoundly; they become more like engineers facilitating learning environments for students than sources of knowledge themselves (Roskos & Neuman, 2012). Teachers are tasked with enabling increasingly digital learners to navigate the new digital knowledge landscape.

However, there is also still considerable resistance or backlash to the unilateral adoption of digital technologies in the classroom. There are persistent advocates of instructionist methods in pedagogical practices and other counter pressures (Johnson, 2005). For example, where teaching staff still experience much pressure to raise achievement levels of the students, teachers are pressured to take on more responsibility for student learning. Teachers in these situations feel pressure to spoon-feed students, so they have the information they need to perform well on tests (Paris et al., 1991; Wiliam, 2004). For example, No Child Left Behind is a United States government programme that implements accountability sanctions on schools and school districts if the students are not performing up to standards of academic achievement set by federal policies (Marion & Perie, 2009).

In their article, Badia et al. (2014) devised a model to understand the way that primary and secondary school teachers viewed digital technologies and any instructional benefits. The authors' research model focused on specific ways that digital technology helped the teachers perform the following: formulate learning goals, develop curriculum content, allocate educational resources, develop new material for curricula, and implement new means of assessment. Primary and secondary school teachers from Spain (*N*=702) were given surveys to test their model. Badia et al.'s (2014) findings suggested that the teachers' gender, subject area, the degree of digital literacy, ICT training, and the frequency of Internet access at work or home showed the strongest correlation with teachers' perceptions regarding the effectiveness of digital tools for instruction. This is consistent with other studies (Inan & Lowther, 2009) that found digital literacy of teachers was influential in increasing their level of acceptance and use of technology in classroom practice. However, unlike other research by Perrotta (2013), Badia et al. found that characteristics of schools had no significant impact on technology adoption. Finally, there were other aspects of digital technology that had a more modest association with effectiveness for the teachers, such as ICT teaching policy and the kind of infrastructure for ICT at the institution.

In their study that examined the acceptance of ICT-supported instruction among physics teachers, Siorenta and Jimoyiannis (2008) found there were three different stances on ICT among the teachers: traditional teachers, non-traditional teachers, and undecided teachers. These findings speak to the ideas behind the CBAM model and the view that the adoption of technology is a process that does not happen overnight. Further, in line with the TAM model, the perceptions of teachers in respect of the usefulness of the technology played an important role and likely led to the observed differences in the outcomes. In their study that tested the use of a Virtual Chemistry Laboratory, Donnelly et al. (2011) developed a model to describe a similar series of different teacher categories and how they can be expected to react to the introduction of new ICT. The model appreciates the process-based nature of the adoption process and may be useful to educational stakeholders who are concerned with adopting a new ICT resource into schools.

Similarly, Donnelly et al. (2011) identified four different teacher stances represented in the question of technology adoption, (a) a contented traditionalist, (b) a selective adopter, (c) an inadvertent user, and (d) a creative adapter. The authors also identified two areas where teachers tend to diverge on their philosophies about education regarding teaching and technology. Some teachers feel empowered while others are fatalistic. Hennessy et al. (2005) noted that because of nationally prescribed curriculum and assessments, it is difficult to change the culture of instruction among the teachers. However, with professional development and giving the teachers ownership, Donnelly et al. (2011) argued, it might be possible to have a traditionalist become a selective adopter, for example. Although these studies did not explicitly incorporate the TAM model in the explanation of the obtained results, it is evident that the adoption of technologies in education is to a great extent shaped by the perceptions of teachers.

Røkenes and Krumsvik (2014) reviewed empirical studies on the digital competence of student teachers and the ICT-training they receive. Using thematic analysis, the authors identified eight approaches to ICT training in teacher education represented in the literature that included collaboration, metacognition, combining methods, modelling, deep learning, student-active learning, assessment, and bridging the gap between theory and practice (Røkenes & Krumsvik, 2014). Digital competence and professional training are the approaches that teacher education programmes promote in order to improve digital skills and educate teachers professionally in how to use ICT in their future teaching practices.

2.4.4 The Role of Technology in Formative Assessment

Formative assessment is an approach to teaching and learning that seeks to enhance the skills of the student and improve their learning outcomes (Sadler, 1989). In the formative assessment approach, teachers ideally follow a five-step model where the (a) assessment is planned and sets clear objectives, (b) activities are devised to meet the objectives, (c) the activities are carried out in the classroom, (d) informal assessments are used to provide feedback, and (e) the outcomes are used in subsequent teaching (Black & Wiliam, 2009). There is much contingency in this process as it is meant to allow the student room to process the feedback and move at their own learning pace and level of skill development (Gikandi et al., 2011; Vásquez et al., 2017). Formative assessment establishes a feedback loop between the teacher and student as they pursue the learning objectives almost symbiotically (Roskos & Neuman, 2012). Despite its advantages, formative assessment is not widely used because it requires the regular, close analysis of what the student is doing in each task (Ruiz-Primo, 2011; Shute & Kim, 2014). Formative assessment requires that teachers radically change how they interact with their students (Black, 2006). This is difficult to implement in practice because of class size in many schools, for example, or the way that subjects are taught in short periods. As Rusman et al. (2013) noted, the assessment system in many countries is still focused mainly on summative assessment of results and static forms of knowledge. There is relatively little instruction that helps the student with acquiring learning competencies and study skills, for example.

Faber and Visscher (2018) carried out a study with a randomised experimental design in the Netherlands to assess the effects of the digital formative assessment tool (Snappet) on third-grade students' spelling achievement (eight nine-year-olds). The findings showed that the tool had no effect on the spelling proficiency of this group of students. However, Snappet log files data showed that students who utilised the digital tool more effectively performed better on the post-tests. In this respect, it is vital to notice that the researchers were not able to decide whether greater use was a cause for higher achievement, due to the possible endogeneity as better-performing students may enjoy completing the exercises. Contrary to these results, Faber et al. (2017) carried out a study using the Snappet tool in mathematics classrooms and concluded that the students' academic achievement was improved. They suggested that the differences in the results can be explained by the fact that students may not have liked the spelling interface, or they concentrated more on the adaptive mathematics assignments. The authors compare their findings to those of other studies, for example, in their meta-analysis on the use of mobile devices in educational settings, Sung et al. (2016) did not find statistically significant differences in achievement effects between different subjects. In addition, Slavin (2013) found no significant differences between mathematics and reading as a result of technological advancements in education. Faber and Visscher’s (2018) findings, therefore, seem to contradict other research, and they attribute this to perhaps the teacher not integrating the tool well with the lesson plan or some other anomaly dealing more with implementation than the product or assessment process itself.

Sheard and Chambers (2014) carried out a study in North Wales and England to test the effectiveness of technology-enhanced FA on the grammar learning of students in primary school classrooms' hand-held learner response devices (LRD) and how the technology contributes to a formative assessment pedagogy using interviews and surveys among the teachers. The handheld devices were used with a classroom response system called Questions for Learning (QfL), and the researchers found the programme improved the students' grammar skills in several ways. Teachers noted the increase in student knowledge and the use of associated terminology. The teachers also reported the improved adjective and noun use in the way students structured their sentences. However, the researchers also found that some little connections were made between QfL outcomes and subsequent writing tasks or the anticipated development of students' writing. Any links were limited to short writing assignments aimed at practising an immediate grammar rule that had been assigned in QfL, such as using the past tense when writing a paragraph (Sheard & Chambers, 2014). In responses to the survey, 91% of teachers reported improvements in student writing because of QfL and, in a survey of the student users, 65% stated QfL had improved their writing very much or quite a lot.

In Chile, Vasquez et al. (2017) carried out a study on the impact of technologies and the formative assessment on students' spelling in primary schools. The researchers carried out the study in two phases. The first phase developed the formative assessment strategy that teachers would follow in order to teach spelling to the class. In the second phase, the researchers assessed how different technologies (tablet or computer) impacted the strategy. The researchers found that the tablet was more effective with the same strategy than the computer was (Vásquez et al., 2017). The software the researchers designed assisted formative assessment to the extent it generated a progress report for each student that was provided to the teacher after each session. The report contained information about the level each student achieved and whether the answers they provided were correct or incorrect (Vasquez et al., 2017). The system the researchers developed also provided the teachers with a global overview of the whole class so they could identify the main areas of difficulty for all students and prepare the next session accordingly to ensure concentration on the areas that needed the most instruction. Vasquez et al. (2017) noted that this approach is taking instructional advantage of the “moments of contingency” that is part of the formative feedback framework (Black & Wiliam, 2009).

It is widely believed that technology can provide easily the type of feedback needed in the formative assessment. For example, in a study that compared the use of tablets and interpersonal computers to provide feedback to students on spelling, Vasquez et al. (2017) found that tablets are more effective for providing the self-paced feedback. Technology can provide activities that are almost engineered for cognition that is complex and dynamic. In the past, students performed routine tasks instead of igniting the cognitive conflict. Technology makes it easier to share information by creating an interactive environment (Aldon & Dempsey, 2016). In a study on primary schools in the north of England and Wales, Sheard et al. (2012) observed the use of a formative assessment technique that was enhanced by technology where students used electronic handsets to help reinforce their knowledge of grammar, which allowed them to move through the material at their own pace. Feedback was provided immediately, and teachers could identify problems. The researchers found that students who used the Questions for Learning feedback performed better on grammar tests, and with average and low performing students improving the most (Sheard et al., 2012). There were positive responses from teachers and students on the use of this handset.

These studies show that the introduction of technological advances is not neutral towards the practice of formative assessment. However, the relationship between the phenomena demands more extensive examination that focuses on the process and perceptions of students and teachers rather than on the particular technological solution employed to reveal deeper mechanisms involved.

2.4.5 Feedback and Technology

This section provides an overview of the current state of research on the technology-assisted feedback and its effects. As has already been discussed, feedback is crucially important for formative assessment, and therefore significant research attention was devoted to studying it. The growth of technologies for instruction in the classroom has facilitated the provision of individualised feedback by the teachers. Technology makes it more convenient and feasible to collect data about student understanding and to organise and share it in novel ways. Technology is also affecting the methods of instruction in the classroom because online and computer-based teaching tools help create a student-centred teaching platform, where the students take more responsibility for their learning process than in the traditional classroom (Caulfield, 2012; Faber & Visscher, 2018). There is emerging research that tries to assess the kinds of feedback that can help students to get the most from instructional technologies and improve learning. Technology can aid in this endeavour because it can be designed to capture significant moments of learning (Miyazaki et al., 2017).

The use of digital formative assessment tools is increasing in many educational systems around the world. For example, for high school students studying history in Portugal, Rodrigues and Olivera (2014) designed a system called AssiStudy that uses several modules to provide extensive feedback and to create practice exams for students based on previously administered tests. The researchers compared scores of students at specific high schools before and after the system was implemented and found that success rates improved from 45% to 73% to 78% (Rodriguez & Olivera, 2014, p. 39). Teachers in the study claimed that the AssiStudy system reduced their workload. The system also automatically graded the responses and provided immediate feedback, which the students found useful. The findings among a sample of students studying for history exams showed that it increased student confidence and led students to study earlier for tests, although the teachers expressed concern that students use the system to take shortcuts in how they study and spend less time reviewing the materials assigned (Rodrigues & Oliveira, 2014).

Panero and Aldon (2016) in France explored how students use tablets in the classroom with a case study involving students in the FaSMEd programme (Formative Assessment in Science and Mathematics Education). The researchers carried out observations of a grade nine mathematics classroom that used tablets as a part of the classroom milieu. The authors argued that both parties took advantage of the interpretation of data: the teacher made changes to their teaching method because of students’ responses, and the students were able to improve their learning after receiving the teacher’s feedback. Panero and Aldon (2016) noted there is much research on mathematics education and technologies, which is often tied to the development of specific educational software, like the Group Scribble project (Chen et al., 2009). Further and relatedly, other researchers have carried out studies about the contribution of technology to the teaching and learning of mathematics, especially in terms of the cognitive dimensions and building a better knowledge of the subject (Bereiter & Scardamalia, 2006) or to approaches to pedagogy, specifically in mathematics (Aldon et al., 2008). By following the teacher's implementation of the technology in the classroom, Panero and Aldon (2016) found that sometimes the use of formative assessment was only partial and that technologies helped the teacher to adopt more stages of the formative assessment process. This result is aligned with other research that showed teachers' adoption of classroom technologies takes time as it is a process (e.g., Clark-Wilson, 2010; Stroup et al., 2002; Walling, 2014). The process nature of the technology adoption in the classroom is not fully covered by the existing research and remains somewhat understudied, which is of utmost importance to the rationale and significance of my study.

Narciss and Huth (2006) use five dimensions of feedback to understand the effectiveness of instruction used in their study that examined the effects of feedback on maths students’ performance and motivation. Their study involved students using an Intelligent Tutor System (ITS) for mathematics in the fourth grade in ten German schools. The authors explained that there are five dimensions of feedback, namely:

1) Knowledge of result (telling the learner if their response is correct or if they made a mistake).
2) Knowledge of the correct response (KCR indicates not just if the learner’s response is wrong, it also shows which response is correct).
3) Answer until correct (the student has multiple opportunities to get the right response).

4) Elaborated feedback (provides additional instructions or explanation in addition to the correct response).
5) Bug-related feedback (learners are provided with the correct response, but errors are signalled out in the process and explanations are offered for the errors as well (Schimmel, 1988).

The authors focused on providing feedback at the explanation level so that the system provides more than just the correction of errors (Narciss & Huth, 2006).

In their study, Narciss and Huth (2006) demonstrated that a bug-related feedback design combines feedback tutoring and mastery strategies. With bug-related feedback, response attempts are analysed and assisted, so the student learns about what choices to make or what steps to follow before the knowledge of correct response (KCR) was revealed to them. It is useful to give students multiple feedback types to encourage achievement and increase motivation. Narciss and Huth (2006) pointed out that the kind of feedback provided to the students in this study was procedural information, not just correct response feedback. The results of the study indicated that withholding the correct answer is more effective than showing the KCR with the information. This can be explained by the observation that once given the KCR learners can ignore the extra information (Kulhavy et al., 1985).

In a study that explores the potential learning power of feedback and technology, Wang (2011) assessed the Graduated Prompting Assessment Module of the WATA (Web-based Assessment and Test Analyses) system (GPAM-WATA) and applied it to a population of junior high school mathematics students who needed remedial studies. The GPAM-WATA was developed with the idea of providing a ‘graduated prompt approach’ (Campione & Brown, 1985, 1987). This approach uses instructional prompts that are gradually presented to the student. The author conducted a quasi-experimental design dividing the students into three groups: one using the system, one using N.WBT (non-web based), and then a PPT (pen and paper test) group. The results indicated that the GPAM-WATA group that was provided with the graduated prompts was the most effective. The GPAM-WATA system helped the students who most needed remedial help, but it also helped improve the outputs for all the other students in that experimental group.

Similar positive outcomes were found among geometry students in a study by Miyazaki et al. (2017), who evaluated a system that helps in enabling students to study mathematical proofs, which is one of the challenging topics for many students in lower secondary schools. The system automatically identified four different mistakes the students were making with proof attempts and the computer programme provided feedback on-screen. The researchers found that the technological features of the programme provided systematic feedback that supported student understanding of geometrical proofs. Finally, the authors found some limitations in the programme, such as difficulties in the flow-charge format that was utilised. They recommended making changes in future iterations by adopting a more systematic learning progression for the web-based programme they piloted. In another study of the same web-based geometrical proof program, Fujita et al. (2018) investigated five learners in their use of the system and analysed the errors they made. The researchers found the learners started considering other options with the computer feedback and in some cases with intervention from their teacher. This raised important questions about how students perceive the feedback and when teachers should intervene. This sort of research is a step towards what Stylianides et al. (2016) called for in instruction about proof structures. An instructor should find “productive ways for assessing students’ capacities to engage not only in producing proof but also to engage in processes that are ‘on the road’ to proof” (Styliandes et al., p. 344, quoted in Fujita et al., 2018). Fujita et al. (2018) used their research as an example of how students can be supported in their learning of proof structure with computer-based feedback. There are ways that technologies can be used to help to teach staff to provide more feedback to students and to improve the overall student experience and their learning outcomes.

In a study among middle school students, Gaskins et al. (1994) discuss a science programme that also emphasised reading and writing skills. It is generally assumed that students will use what they learn in one domain across various subjects. However, there is little evidence available to support the notion that students recognise opportunities to use these thinking processes unless they receive explicit instructions to transfer skills between classes (Gaskins et al., 1994; Padilla et al., 1991). Science teachers are no longer just “dispensers of knowledge,” they have to work with students and help them to become problem solvers and people who can think for themselves (Loucks-Horsley, 1990). Using science class as a platform to also engage in writing is a means to encourage using various skills across different subject domains like argumentative writing and science.

Most of the empirical studies that have tested and experimented with digital formative assessment tools have been undertaken in the realm of language learning and STEM subjects, especially mathematics. For example, in Shute and Rahimi’s (2017) review article titled "Review of computer-based assessment for learning in elementary and secondary education," all but one of the studies reviewed in depth was a non-STEM subject. Another area where there is research in non-STEM subjects is with the application of ePortfolios, although most of the empirical research on ePortfolio implementation has been at the university level. Chang et al. (2013) explored how goal-setting through the use of a web-based portfolio assessment system (WBPAS) helped students to develop better self-regulated learning (SRL) skills. The participants were two classes of 11th graders who were taking a website design class in a vocational high school in the United States. There were 40 students assigned to the experimental group and a control group of 40 students who used a conventional paper portfolio. The study results suggested that students who set learning goals via the Web-based portfolio assessment system showed higher levels of self-regulated learning skills (Chang et al., 2013).

As it is evident from this discussion, technology-assisted feedback can be a powerful tool of the formative assessment process. Therefore, it is essential to understand what technological mechanisms are employed to facilitate formative feedback, which the next section will now review.

2.4.6 Technology-aided Formative Feedback Mechanisms

Formative feedback mechanisms are an important part of the formative assessment. Moreover, there is much potential in technology to provide feedback mechanisms that are cheaper, faster, and less of a burden on teachers. Feedback should be directed to how the student performs, and it should use the language that explains what the student can do to improve, rather than criticising or evaluating the student (Saulnier et al., 2008). As Spector et al. (2016) discussed, formative feedback can be conceptualised as a form of "scaffolding for learners." The most straightforward frameworks or scaffolds provide comments and explanations of where the student might have gone wrong on a specific learning task, as was done earlier in intelligent tutoring systems, which were some of the first technology-assisted feedback mechanisms to emerge (Spector et al., 2016). This mechanism uses a database with information on the subject to be learned and also a set of responses for common problems that students run into when completing the tasks. Then there are usually also remediation prompts added to this kind of database providing the student with a fast but helpful and information-filled response. Spector et al. (2016) also discussed another simple feedback mechanism in formative assessment applications. This is an automatic direction to a question-and-answer database based on a learner response. Although these simple mechanisms still have appropriate uses, they are primarily used in very straightforward domains.

More advanced mechanisms require additional information, and they review more than just student performance on a particular learning task. Spector et al. (2016) described an effort at formative assessment implemented at the Hong Kong Institute of Education where individual differences in student learning processes were identified, and formative feedback was provided to students in very personalised ways (Yang et al., 2014). Yang et al. (2014) incorporated a system to assess students' goal orientations, and this helped them gain a deeper understanding of the impact of the formative feedback on student learning. There was a difference between those students who were more focused on performance, and those students focused on a learning orientation. The students that felt more accountable to implement the feedback were more likely to find the feedback of use to them, whereas students who were focused on performance were more interested in the grade they earned.

The assessment systems being developed are becoming more dynamic. Designers are also finding ways to include learner profile information in their assessment analysis and outputs so that student interests and preferences can be embedded in the feedback output, thereby increasing the relevance to the learner and providing them with many different layers of feedback (Spector et al., 2016).That detailed feedback can be transmitted either by the teachers themselves or by a smart learning engine that takes the interests and profiles information and preferences into account in suggesting next steps for the students (Spector et al., 2016).

2.4.7 Benefits and Challenges of Assessment and Feedback in a Technology-rich Context

Using technology in the classroom has long been a concern in education theory, as there are some benefits and challenges associated with it. Pelgrum (2001) analysed the data from a worldwide survey conducted in 1997 called the Second Information Technology in Education Study (SITES), carried out by the International Association for the Evaluation of Educational Achievement (IEA). The author focused on the significant impediments to adopting ICT objectives in schools that were revealed in the survey results. The major barriers for adoption identified in the study were the lack of equipment and a lack of competence in computer use among the teachers. Pelgrum (2001) also made some conclusions by comparing the results between the countries. Some countries do promote teaching ICT skills in primary education (for example, Canada, New Zealand, and Singapore), whereas there was much less emphasis on ICT skills for primary school-aged children in other countries (for instance, China, Hong Kong, Iceland, Japan, and Norway).

Further, it was found that the emphasis on the acquisition of technology skills was higher for high school students. Besides, Pelgrum's (2001) article provides an early indication of applying pedagogical approaches that emphasised student-controlled learning, an essential part of formative assessment. From the data in the late 1990s, there was considerable variation among countries on this point. There appeared to be a trend that student-centred learning was used more frequently in primary than in secondary education (Pelgrum, 2001).

Gil-flores et al.’s (2017) study showed that schools in Spain had a good level of information and communication technology, but there were surprisingly low levels of classroom ICT use given the availability of technology. The researchers assessed the influence of ICT infrastructure and teacher characteristics using data from the Spanish sample in the 2013 Teaching and Learning International Study (TALIS). The sample included 3,339 teachers from 192 secondary education schools. The results indicated that support was necessary in the form of training materials and practices, as well as collaboration and fomenting a sense of self-efficacy. The infrastructure and hardware available were not as significant to the teachers in the study as were their need for training.

Aldon and Dempsey's (2016) paper shared the results of two case studies that were a part of the EU project Formative Assessment in Science and Mathematics Education (FaSMEd). One case study was made in France, the other in Ireland. Aldon and Dempsey focused on the role of technology in supporting formative assessment practices in the field of science teaching and learning. They planned professional development sessions to work with the teachers; the teachers would then subsequently implement the strategies in the classroom and review the results at later meetings. The researchers used a complex set of research methodology to collect results on the lessons, including semi-structured interviews with all teachers before and after the implementation of a lesson and analysis of video data and questionnaires administered to the students (Aldon & Dempsey, 2016). Both case studies showed that technology is not a necessity for implementing formative assessment strategies; however, students were very positive about using the technology since learning seemed more spontaneous and accelerated with the use of technology. As a result, the teaching intentions became clear to students as teachers clarified their teaching intentions and the criteria for success as well as to have students act as instructional resources for one another. Finally, technology helped teachers to commit to a complete formative assessment process instead of picking and choosing aspects, and thus they enhanced their understanding of the process. The research questions and model for this study focused on the role of the teacher in formative assessment but also examined the role of peers and the learner. The authors noted that several of the class activities gave more ownership and agency to the students as they assumed some responsibility for their learning. Aldon and Dempsey emphasised that the technology provided useful data, but that the skills of the teacher were essential for discussion and the selection of topics.

In contrast to the numerous positive results from studies discussed so far, there have also been some negative outcomes reported in the literature. Chu (2014) found that many educational programmes are moving towards using wireless technologies as tools in their learning environments, but there has been little research investigating whether e-learning scenarios are effective or if they are beneficial to students. Chu's study examined activity in an original culture course for an elementary school that used a formative assessment-based learning strategy with wireless technology to perform the activity in the field. The research analysed the students' cognitive load and learning achievement. Chu (2014) found that the performance of students was disappointing and even negative without proper treatment because of the heavy cognitive load of an improper learning design.

Other scholars list more general negative characteristics. Spritzer (2014), for instance, explained that the use of computers and wireless technologies has risks and side effects for students that are often not considered in the literature on ICT adoption in classrooms. The author argued that keyboard use and typing impairs maintenance of reading and writing skills, as research has shown particularly in the case of the Chinese language, which is not based on phonetics like Western languages. Each symbol in Chinese has a meaning and using the computer makes students type phonetically in a Westernised alphabet and then choose from a list of symbols (Tan et al., 2005, 2013). In two separate studies, Diemand-Yauman et al. (2011) discovered that students adopt a more deliberate way to process information when the font is difficult to read, for example. They performed much better on remembering syllogisms than students who were shown the syllogisms in an easy-to-read font (Diemand-Yauman et al., 2011). According to Spitzer (2014) and other authors, there is research to support the suggestion that ICT use and what an individual reads on screen leads to shallow processing of information. Less is learned through the use of Google, for example, as compared to books (Sparrow et al., 2011).

2.4.8 Technology-aided Formative Feedback in the Context of Problem-based Learning and Inquiry Learning

Formative assessment also needs to be able to adapt to different forms of learning and, therefore, technology is an aid in that endeavour. As Crogman and Crogman (2018) explained, preoccupation with technology and keeping up with innovations leads to the decrease in the practical use of some of the more classic teaching methods due to the current preference for technology and complex teaching pedagogies. The authors have argued that some of the basic principles in education and learning have been lost as a result. For example, inquiry-based learning begins with questions or challenges rather than known facts (Duch et al., 2001; Oguz-Unver & Arabacioglu, 2014). The teacher's role in this form of inquiry is to pose questions initially and then assist the students in finding answers. The students should then start making their inquiries. This learning technique is used often in science subjects. This process teaches students about trial and error.

Problem-based learning (PBL) is a technique used in teaching where real-world problems are used to promote student learning as opposed to the current direct transfer of knowledge from teacher to a student as in traditional approaches (Duch et al., 2001). PBL is valued because it encourages the development of critical thinking skills, problem-solving abilities, and communication skills. PBL can be proposed as group work or evaluating sources or putting together multi-media projects, for example, Duch et al. (2001). The approach is often carried out over several months or even the whole semester in university. The essence of PBL is a real-world problem focus.

By studying problem-solving as a learning tool, Bhagat and Spector (2017) have noted the lack of formative assessment. Recently, however, there has been the development of technologies that are meant to bridge this gap, although the authors note the tools have yet to be used in instructional settings. The authors explain the assessment tools developed can help to implement formative assessment in ways that may be conducive to problem-based projects or inquiry learning. These tools include High-Level Mobility Assessment tool (HIMATT) (Pirnay-Dummer et al., 2010), AssiStudy (Rodrigues & Oliveira, 2014), and iSMILE (Bhagat et al., 2016), for example. The authors describe how HIMATT has two platforms: HIMATT Research Engine, which helps students to carry out experiments and perform the subsequent analysis, and the HIMATT Subject Environment, that assigns experiments to individual learners dynamically. With HIMATT, students can perform science-related tasks including states and changes, analyses, and comparisons.

The use of all elements of formative assessment in science education, especially the use of the students' ideas to guide future lesson plans, is still rare (Ruiz-Primo & Furtak, 2007). However, using evidence from embedded assessments to guide instructional customisation, Gerard et al. (2010) showed that it can improve student engagement in science class and enhance the understanding of the introduced concepts by students. In their study, Gerard et al. (2010) investigated how teachers use evidence from the classroom and student performance to customise the curriculum and enhance it with technological tools. This approach improved inquiry science teaching and student knowledge integration in earth science for three sixth-grade teachers whom the researchers followed for three years. Teachers used feedback from their students' work to rework their lesson plans and strategies about their teaching. The results suggested that teachers customised their classroom activities because of the student assessments, and this led to higher learning for both the teachers and students (Gerard et al., 2010). The researchers found that student performance improved with each year of instructional customisation. Thus, these studies have demonstrated that using evidence from student performance and activities for curriculum development can improve science learning.

2.4.9 Technology-aided Formative Feedback to Improve Motivation

As was discussed previously, the use of formative assessment practices is conducive to the motivation of students and teachers alike. With the introduction of intelligent agents (Greer & Mark, 2015; Harley et al., 2015), smart devices (Spector, 2015, 2016a), and cloud-based resources, the capacity of new technologies to enable formative assessment has increased significantly in recent years (Armstrong & Llorin, 2015).

2.4.9.1 Motivation Among Teachers. An important motivating factor for teachers is ample professional development opportunities to comprehend the role of formative assessments and evaluations in learning and feel supported as they implement these tasks in the classroom (Spector et al., 2016). Providing the most relevant frameworks and using clear and compelling examples will help teachers and decision-makers to implement formative assessments effectively. Significant learning advancements have resulted from the capacity to deliver rapid, meaningful feedback in many countries around the world (Spector et al., 2016). Nonetheless, extensive training and mentorship of instructors with a focus on change management is required for the method to become universal (Dona & Gregory, 2016; Spector et al., 2016). Research has shown that with adequate training, teachers increasingly use electronic feedback methods because they make it more timely to communicate with students.

Another motivating factor is that teachers can provide support to the pupils who need it the most if they have a good level of formative assessment data. The teachers will have an opportunity to prioritise and focus on their teaching. Technologies are a tool that teachers can use to help them assure that no learning needs are being overlooked. Sheard et al. (2012) tested the use of handsets to teach grammar called Questions for Learning where pupils work through questions at their own pace. The QfL handsets give formative feedback on accuracy to the teacher immediately so they can identify any problems.

Another kind of technology that can make it easier for teachers is the Online FEdback System (OFES), a web-based tool that enables teachers to construct templates for feedback and provide comments and grades for each student (Hatziapostolou & Paraskakis, 2010). The hosting intranet also contains tools for online asynchronous discussion forums and self-assessment (quizzes), as well as announcements and areas to post documents and lecture notes.

2.4.9.2 Motivation Among Students. Motivation and engagement are essential areas of formative feedback because learning outcomes are highly dependent on the student being motivated and engaged (Köller, 2001). It is a challenge for programmes in developing countries, for example, to find access to systems that support feedback because of limited resources. Further, even when access is secured, there are adoption issues and associated challenges as was earlier discussed in the section on the technology acceptance models.

Several studies have examined the relationship between students' motivation and the use of technology. For example, a group of scholars at the Sri Lanka Institute of Advanced Technological Education (SLIATE) have tested new teaching and assessing methodologies, which combine team-based learning and guided inquiry learning in ways that make use of free resources so that students there can have classes with a formative assessment framework (Dona et al., 2016). The assessments are designed by established pedagogical principles (e.g., providing scaffolding according to each learner's needs) to identify a pedagogical strategy and a suitable technology for successful implementation (Dona & Gregory, 2016). This approach has allowed the staff at SLIATE to develop their own engaging learning experience and collaborate with the resources they have at their disposal, representing real-world contexts where digital assessments can help address shortcomings in the system (Dona & Gregory, 2016). Likewise, in Singapore, there have been experiments carried out with large lecture classes to provide blended formats which can use techniques like gamification to help bring the best feedback to even large size lectures and motivate students in large lectures, so they receive genuine individualised feedback (Murugan, 2015).

Another way that technologies can help to motivate students according to Sheard et al. (2012) is to have user-friendly appeal. Their handset technology used for the QfL lets students focus and experience "flow" (Csikszentmihalyi & Csikzentmihaly, 1990), which is the sense of being entirely absorbed by a task so that time passes quickly, and the student has an intrinsic interest in performing or completing the task. Pupils in their mathematics study were highly motivated to use the QfL devices at their own pace. Moreover, an earlier study by Van Dijk and Kluger (2001) confirmed the finding that positive feedback increases pupil motivation for a task. Setting challenging goals while having students perform a task of low complexity will provide more motivation and enhance achievement in grammar.

2.4.10 Technology-aided Formative Feedback to Improve Engagement Self-regulation

Self-regulation involves those processes where students are actively engaged with their learning environment, and they are aware of how to set goals for themselves. It is a capacity that is positively associated with student performance, and it includes processes like establishing goals, self-monitoring, controlling attention, asking for assistance when needed, as well as self-monitoring and self-evaluation (Ryan et al., 2001; Zimmerman, 1998). As students grow older, their learning behaviour should be less regulated by their family and their teachers. They should take the initiative on their own as they mature and become increasingly self-regulated (Edens, 2008; McCaslin & Good, 1996). Several studies addressed the relationship between the use of technology and the development of self-regulation skills.

For example, Edens (2008) compared two different ways of using an electronic student response system (SRS) (more colloquially known as "clickers"). Using a quasi-experimental design, the researcher gave the students in two different sections of an educational psychology class a pre-test, a series of quizzes, a course achievement post-test and a survey. In one class the researcher implemented a behaviourist-oriented or operant approach where attendance was kept and the quizzes counted towards the final grade and the other section of the course that used a metacognitive-oriented approach where attendance was not tracked through the SRS, and the quizzes were just a study aid. The main results of the study were a) there was no difference in terms of academic performance between the two groups. The pedagogy used had little effect; b) in the metacognitive group, the highly self-regulated students did better academically than the students in the metacognitive group who had low self-regulatory skills. Highly self-regulated students in the metacognitive group also scored better than highly self-regulated students in the operant conditioning group; c) specific characteristics of the study participants, such as gender, level of self-regulation, and goal orientation also affected the impact that SRS had on achievement. For example, low male self-regulators who had extrinsic goals in the operant group were outscored by males and females who were high self-regulators. Also, the operant group performed better in terms of attendance, but also suffered more anxiety.

Lin and Tsai (2011) observed that university students who seemed enthusiastic about learning in an online environment more than the traditional face-to-face classroom were more self-regulated learners. The study carried out by Lee and Tsai surveyed students who had experiences with both Internet-based and face-to-face learning. The results showed that students at this institution of higher education perceived higher levels of collaboration, self-regulated learning, and information seeking in Internet-based learning as opposed to the traditional classroom. In the literature on self-regulated learning, researchers have argued that SRL is vital in online learning and an essential key to student success in that realm (e.g., Williams & Hellman, 2004; Yukselturk & Bulut, 2007) although researchers also pointed out that SRL is understudied and has not received enough emphasis or analysis in educational research (Barnard et al., 2009; Winters et al., 2008).

Zhao et al. (2012) presented a framework of self-regulated learning (SRL) based on Web-based technologies (WBT). The authors described how SRL is a cycle that involves moving through the following processes: 1) task comprehension, 2) planning, 3) formation of strategies and 4) evaluating strategy effectiveness. With this schema, the authors suggested that SRL depends on developing the right characteristics in the learner and using digital technologies to deliver the appropriate learning strategies. Self-regulated learners are characterised by self-efficacy, experience, goal orientation, and motivation. The authors argued that WBTs help support SRL by providing teachers and students with accurate, meaningful and accessible information. Zhao et al. (2012) proposed that in order to enhance self-regulated learning there needs to be better understanding of how the learner's attributes interrelate with the digital environment and what can be done to increase the benefits to the learner in this regard.

2.4.11 Technology-aided Formative Feedback to Enhance Peer-Assessment

Notably, most research on peer assessment has primarily focused on the context of higher education (Topping, 1998; Falchikov, 2005). However, the outcomes are also likely to be applicable to the students of formal education schools, which is the population that my study has focussed on. Peer-assessment is considered a valuable learning tool because it assists students in developing critical professional skills, such as critical thinking and reflecting on the work completed (Mello, 1993; Somervell, 1993). Other research has shown that the use of self- and peer-assessment also motivates students to submit better quality drafts of written work, initially because they know it will be reviewed by their peers (Hanrahan & Isaacs, 2001). Willey and Freeman (2006) reported that the use of self-assessment and peer-assessment produces a kind of formative feedback that adds another dimension to the learning cycle and encourages the ongoing development of skills among learners. Moreover, in their discussion, Boud and Falchikov (2007) explored the potential in peer-assessment for developing the motivation for lifelong learning. Therefore, there is ample evidence to show that the regular use of self- and peer-assessment offers opportunities for students to practise and receive feedback on their work. Through providing peer feedback, students can also develop their judgement and evaluation skills, which are essential attributes for lifelong learning (Boud & Falchikov, 2007b).

Wilson et al. (2015) reported on results from their study of a peer assessment review tool implemented at an Australian university, which the researchers call the Workshop Tool. It was a function within their new university learning management system called Moodle. The researchers found that in order for students to benefit from the collaborative potential of the Workshop Tool, there were changes that needed to be made to the university culture to establish a more collegiate and cooperative relationship between the students, rather than the competitive, individualistic atmosphere that existed at the time of the study.

In another study, Willey and Gardner (2010) have long been testing, developing, and using an online tool called SPARK and SPARKPLUS as tools for self and peer assessments. Willey and Gardner (2010) used this tool in large engineering classes. Students noted that the use of self- and peer-assessment, together with criteria that measured collaborative procedures, had fostered team cooperation, commitment, and boosted student involvement. SPARKPLUS was developed from earlier research as an improvement over the original tool because it provides more options for exercises and reports (Willey & Gardner, 2010a). The results of their tests of the SPARKPLUS tool show that multiple uses of self- and peer-assessment opportunities within a single subject were successful in assisting students in achieving the desired learning outcomes. In general, students reported that the feedback they received increased engagement and successfully supported them to learn. The researchers did note, however, that some effort was required to break down some student reluctance to participate fully. The success of the SPARKPLUS programme was dependent on the teacher correcting the students' perception that peer assessment was for little more than making group work fair and was designed for the teacher to single out those who contributed less or made less of an effort. The researchers intended to develop the tool further to improve the capability to assess the feedback itself at the end and, therefore, to complete the learning cycle (Donnelly et al., 2011; Willey & Gardner, 2010).

2.4.12 Latest Accomplishments and Breakthroughs in Technology-aided Formative Assessment

There is a very eclectic set of empirical studies in the literature that have each examined small project efforts in different subjects and different age groups of students where formative assessment-based teaching using technologies were put in use. Donnelly et al.'s (2011) study looked at virtual experimentation and the potential to use a Virtual Chemistry Laboratory (VCL) at the high school level in Ireland. The authors note that the use of simulation-based software is becoming more common within K-12 science education (Dalgarno et al., 2009; Su, 2008). Virtual experimentation has many benefits because it provides more independence in terms of time and space and it shifts learning from the teacher-centred to the student-centred approach. Virtual experimentation also has a low-cost relative to conventional science labs and equipment (Georgiou et al., 2007). According to Donnelly et al. (2011), there are definite advantages to integrating ICT into science education, which include assessing practical work; however, integration of ICT is a change process that involves many different dynamics that can be hard to adapt into existing curricula and conventional instruction.

For technology and formative assessment to be adopted, aspects in conventional school curricula still need to move from relying so heavily on just summative tests (Phelps, 2005). In another example using a case study, Pimentel (2010) conducted a study applying a mixed methods approach in a single case study involving 198 teachers regarding the use of ePortfolios at high schools in the state of Rhode Island in the United States. The ePortfolios were used as a performance assessment measure meant to help value student effort in formats that are not just conventional testing. Pimentel (2010) notes that in order to use this tool, teachers must alter their classroom practice. During the data collection, teachers spoke of the power the ePortfolios programme had to shape instructional decisions and re-formulate assessments to meet existing standards using evaluation instruments, meanwhile also making the material intellectually interesting to students so they can find value in it (Pimentel, 2010).

Recent research has also emerged about the use of formative assessment and wireless technologies. These studies have found that the use of Wireless Networked Classroom Technology (WNCT) has improved levels of achievement in K-12 schools and for maths and science courses at college, because teachers can more easily gather data about student performance and understanding (Roschelle et al., 2004). However, as Roble (2015) notes, there are challenges associated with incorporating formative assessment into instruction, such as integrating Wireless Networked Classroom Technology and other tools. Roble (2015) has examined the formative assessment processes employed by three teachers who integrated WNCT into their mathematics classrooms, specifically the TI-Nspire Navigator System. This study used qualitative data to provide detailed accounts of the processes that were carried out to assess student performance. Results indicated that each teacher had their patterns and preferences for using the TI-Nspire Navigator System. They used their own, unique process of formative assessment during instruction and used different system features, although each of the three teachers integrated vital parts of the strategies from Black and Wiliam's formative assessment framework, which was discussed earlier (Black & Wiliam, 2009). This shows that each teacher's approach is personal, yet is also informed by the same foundational framework for formative assessment. Each teacher also utilised different system features of the navigator system (Roble, 2015). The teachers used the programme to gather inputs from the students about the tasks they were assigned in maths class regarding their ability to complete computations for the day. The kind of feedback the teachers gave to each student was also unique. The researcher analysed the feedback the students received and noted 19 different categories were ranging from evaluative and normative, corrective or verification, to elaborative and facilitative feedback, to give examples (Roble, 2015).

Bennett (2010) explored a model for assessment that was cognitively-based in a study involving middle school students. There are four parts of the Cognitively-based Assessment of, for, and as Learning (CBAL): domain-specific competence models (or learning progressions), summative assessment, formative assessment, and professional support. Bennett also argued in his discussion that formative assessments like CBAL need a theory of action. Although theories of action are common in the programme evaluation literature because they explain the cause-effect relationships and intended outcomes (Wholey, 1979), the notion of the theory of action is rarely seen in how formative assessment plans are designed. That is because there is less theorisation regarding the final stages or post-assessment when a teacher should work the assessment information back into their lesson plan or decide how to proceed on to the next stage with a student. However, in programmes like No Child Left Behind in the United States, this educational accountability programme does have what could be classified as a plan of action because it applies sanctions for poor performance. Instead of being just punitive sanctions, however, Marion and Perie (2009) suggest that alternate assessments can be carried out for a programme like NCLB or they could use alternate achievement standards as part of an action plan. Therefore, the notion of an action plan would be used to help teachers incorporate assessment results into their future teaching with a concrete set of steps to follow.

The diverse nature of the existing body of literature on ICT adoption and formative assessment has brought to light some different facets about this approach to education. There are benefits to integration of ICT, including the lower cost of providing lessons in chemistry, for example, with the use of a virtual chemistry lab, and learning with ICT is an activity that centres attention on the student instead of the teacher (Donnelly et al., 2011). However, integrating ICT into learning and assessment is a complex change that requires undoing many decades of more traditional assessment processes, such as summative testing (Pimentel, 2010). Teachers are instrumental in applying formative assessment principles and for choosing to adopt such practices. Roble (2015) found that staff were implementing their own processes of formative assessment, so interventions should be flexible. Bennett (2010) found that staff development was also instrumental in having the teaching staff successfully implement formative assessment, while Brink et al. (2017) noted that teachers needed roadmaps and definite plans for making inroads with formative assessment and new ICT instruction tools.

2.4.13 The Role of Students in Developing Technology-enhanced Formative Assessment

Another new direction in terms of analysing the impact of ICT use in education has begun to explore the attitudes and mindsets of the students when it comes to using technologies. Rohatgi et al. (2016) conducted research that showed self-efficacy is one of the most highly motivational factors for ICT acceptance among students. The researchers used data they acquired from the International Computer and Information Literacy Study (ICILS) in 2013 in Norway. The researchers showed there was no significant correlation between the use of technologies in school and ICT self-efficacy for students, but the use of ICT during the students' leisure time was a stronger predictor of self-efficacy. Also, there are different results in how self-efficacy relates to basic and advanced ICT. In basic skills, such as creating and editing a document, there is a positive relation between Computer and Information Literacy (CIL) and self-efficacy, but in advanced ICT skills, such as building a webpage, the relationship to self-efficacy was negative due to lower scores on the CIL test for those who had high self-efficacy in advanced computer skills. The authors also noted there may be problems with the measurement of advanced CIL in their study and the instrument they chose because not many of the test components required problem-solving or high order thinking. Also, programming and similarly advanced skills are not taught in high school, so students who have these skills are self-taught or take extra-curricular sources of instruction.

This section provided an overview of the current research on the relationships between the formative assessment and technological means. It presented several studies evaluating the role of technology in the formative assessment process and the associated benefits, while it also identified challenges and concerns that have been raised. In particular, a great deal of research attention in the literature has been focused on the technology-assisted feedback and the ways feedback is related to specific questions of learning. However, it is evident that despite these efforts, the field remains quite fragmented. Although the research and discourse in the literature focuses on the outcomes of formative assessment practised with the aid of technology, a set of essential questions escapes scholarly attention. As has been discussed in this section, the adoption of technology is a process, and the process is on a continuum that will affect the eventual outcomes.

The utilisation of technology-aided formative assessment in the classroom has generated considerable debate and raised complex issues regarding the development of teachers' attitudes towards learning technologies (Scherer & Teo, 2019). However, more research is needed to examine the influence of technology and formative assessment in secondary school classrooms in the UK (Scherer et al., 2020). Therefore, there is a need to explore the available technological means teachers use in classrooms and understand how these tools are employed in daily practice (Scherer et al., 2020). Further questions need answers: What drives the adoption of technologies? To what extent will they be adopted? What are the perceptions of the teachers? My study intends to explore these questions in classrooms to help determine how to maximise the beneficial effect of technology on formative assessment through understanding the perceptions of teachers and students.

Consequently, it is essential to understand the factors affecting those teacher and student perceptions about ICT and formative assessment. Why do teachers perceive specific technological advances as affordances? What affects their perceptions of usefulness and ease of use? Is it possible to affect these factors to benefit from the use of technologies in education? Obtaining a nuanced understanding of the teachers' views on these issues can inform the research and practice alike by, on the one hand, advancing the theory of technology acceptance and factors behind it and, on the other hand, suggesting possible improvements for the use of technology in the classrooms. I hold similar expectations concerning the students' perceptions. However, I expect these perceptions to manifest through different mechanisms. For example, if teachers perceive technological advances as useful and easy-to-use affordances to facilitate the formative assessment process, but students do not share these views, they may sabotage the use of the technology. In the opposite scenario, is it possible that the pressure from the side of the students will eventually pave the way for technology in the classrooms?

These questions centre around the interplay between the perceptions of the teachers and students in the process of adoption of technological means; however, none of the theories considered so far enables explicitly theorising the technology adoption process in relation to education and incorporating the perceptions of the two main stakeholders, teachers and students. The next section describes the theoretical framework that I have applied in this study. The building power of the theory of affordances (Gibson, 1977) is significant in learning; it incorporates the insights from the technology acceptance model and the grand learning theory of constructivism that allow conceptualising the role of perceptions. In the next section, I argue that this suite of frameworks suits the processual nature of my study and merges the theoretical constructs essential for closing the identified research gaps.

2.5 Theoretical Framework

This study intends to contribute to the streams of literature about the use of technology in the formative assessment in general and feedback in particular, as reviewed in the previous subsections. In order to do so, I have applied the theoretical framework that merges learning and assessment theories with the insights from the technology acceptance model and the affordance theory. This section will present the proposed framework in greater detail.

The research field dealing with the use of technology in education is actively developing and at present characterised by a multitude of competing approaches (Driscoll, 1995). As with the majority of the new rapidly developing fields of study, technology has been criticised for being subject to fragmentation and not evolving cumulatively (Hoadley & Pea, 2002) as well as lacking consistent empirical validation (Romiszowski & Mason, 2003). Honey et al (2000) reviewed the literature from the 1970s to 2000s and concluded that the research approaches evolved from studying the effect of the use of specific technological developments on students' learning to the broader range of research interests and questions. Research topics in the literature have dealt with a wide variety of topics, such as the integration of technology in the educational setting, the role of users' perceptions, as well as the role technological advances play in assessment, monitoring and curriculum development (Honey et al., 2000). These developments call for the new theoretical perspective that allows theorising the role of technology in education and particularly in the assessment process. However, the difficulties associated with developing the theoretical framework, within which the role of technology in the educational setting can be analysed, stem both from the high sensitivity of the topic due to its importance and from the multitude of factors present in the real-life setting and crucial for the actual outcome in terms of assessment and, ultimately, learning. The dual nature of the technology is that it is both a material object and a social phenomenon. Thus, the differences in the levels of cognitive development and varying perceptions of students and teachers alike, as well as the implications related to technology acceptance, complicate the analysis of the role of technology in assessment and education within a single theoretical perspective. Moreover, the interdisciplinary nature of the phenomena that involves learning, teaching, and the use of technology, calls for a multidisciplinary theoretical approach and, consequently, creative research design.

This section aims at developing a framework that allows theorising the role of the technology in education and provides a more fine-grained understanding of the phenomena. In the following parts, this thesis describes the theoretical framework that combines the theoretical lens of affordance theory with constructivism views on the learning process as well as the technology acceptance model borrowed from the field of information systems research. The combination of theoretical developments originating in different fields allows developing a theory that covers all aspects of the complex phenomena and enhancing the understanding of the role of technology in the formative assessment from the perspective of students and teachers on the individual and group levels.

As is evident from the review presented in the previous sections, the literature on assessment as well as the literature on technology are vast beyond estimation. Furthermore, assessment is an intrinsically social process which requires examining through a social theory lens, while technology can be studied from a multitude of perspectives, as already demonstrated by the research of others. Therefore, my research on the role of technology in education calls for a theoretical lens that includes insights from different theoretical perspectives. This section discusses such theories and is organised in the following way: first, the central insights from each of the theories to be used are presented, followed by the rationale for the new theoretical framework and ultimately the presentation of the research framework applied in my study.

2.5.1 The Theories of Learning

The history of scientific thought has seen numerous attempts to theorise the learning process, as evidenced by the large body of literature on learning, and several influential theories have been developed and become widely accepted. The views proposed in the early 20th century are known under the grand umbrella theory of behaviourism and centred around the ideas that learning occurs within behavioural reaction to external stimuli in the environment (Clark, 2018a). Behaviourism sees learning as a transition to the desired behaviour mainly due to external motivation and the system of rewards and punishment. While these represent an admittedly powerful and well-developed stream of research, they are generally ill-suited to explain the observed effects of formative assessment practice described in the literature. Another influential grand theory of learning, known as cognitivism, was proposed as an attempt to shift away from the dominating behaviourism views. Cognitivism centres around the ability of human cognition to acquire and absorb information (Clark, 2018b). While the learning process is no longer represented as a pure reaction to external stimuli, it is still seen as a passive process of knowledge transfer from the teacher to the student, which also does not explain the phenomena of formative assessment. In turn, constructivism sees the reality in general and learning in particular as created by the perceptions of people (Clark, 2018c). It sees the students as active participants and co-creators of their learning process. This theory focuses on learning as a process and admits the role of the students in it. Therefore, it offers a theoretical lens that allows theorising the interaction between formative assessment and technological advances and answers the questions how technology affects teaching and learning to offer a way of explicitly theorising the role of motivation and how technology affects it. The next subsection presents the most important postulates of constructivism as the learning theory.

2.5.2 Constructivism

From the standpoint of the philosophy of science, constructivism is the field of thought that sees the reality as constructed by people living in it (Charmaz, 2006). Constructivists decline any objective criteria of knowledge or the existence of objective knowledge “out there on the world” and proclaim and encourage all subjective experiences as the basis of knowledge (Poerksen, 2013). This perspective is represented by multiple theories and is widely used in various research fields; however, concerning learning it holds that learning is a process of constructing meaning (Merriam et al., 2007). Consequently, constructivism deals with epistemological questions of learning and is interested in how students obtain knowledge or, in other words, in the process of learning.

Constructivism can be defined by four features, namely, knowledge construction, cooperative learning, metacognition, and authentic learning task (Loyens et al., 2009). Knowledge construction refers to the idea that students themselves are constructing knowledge and the importance of the student’s background knowledge is greatly emphasised, as the new knowledge can only be constructed based on the previously constructed. The constructivism view on knowledge implies that knowledge is the understanding of the phenomena derived from experiencing it and reflecting on the experience. Cooperative learning implies that the interaction with others influences the process of knowledge construction by the learner. Metacognition is a concept of knowledge acquisition via self-regulated processes, including goal setting, self-regulation, self- and peer-assessment, while the responsibility for learning rests with the students rather than with the teachers (Boghossian, 2006). Finally, the authentic learning task means that students should solve real-life problems (Loyens et al., 2009). It is important to highlight that constructivism views knowledge not as an external reality to be comprehended, but rather as an internal process that is unique for every student (Schunk, 2012). Constructivists argue the human mind uniquely constructs the reality and therefore the notion of knowledge itself and therefore what constitutes knowledge is unique for every student.

Constructivism as a subject of philosophy of science as introduced in the domain of education was heavily influenced by the works of Piaget (1936) and Vygotsky (1978) and eventually evolved into two streams of research with learning – individual constructivism and social constructivism, with the more significant influence of Piaget and Vygotsky's ideas, respectively. The next section presents the former perspective followed by the discussion of the latter stream in greater detail.

2.5.3 Cognitive Constructivism

According to the ideas of Piaget (1936), knowledge as understanding is stored in the form of schemas constructed by the individual based on the background knowledge of the student (Yilmaz, 2011). Cognitive development is the process of knowledge equilibration that results in assimilation followed by accommodation of knowledge in the schema (Schunk, 2012). Essentially, the cognitive mechanism of knowledge construction, according to Piaget, is the internalisation of the experience (Schunk, 2012). This knowledge, in the view of Piaget, is constructed individually and as everyone’s experiences and cognitive processes are unique, there are numerous realities constructed by each person. Absolutising of individual constructivism views goes as far as claiming that all human beings and their experiences are unique and there is no objective reality. This idea suggests that knowledge cannot reflect that reality, sharing of knowledge is impossible, and the knowledge itself can be truly appreciated and understood only by its constructor (von Glasersfeld, 1998).

2.5.4 Social Constructivism

Social Constructivism is another stream of constructivism perspective heavily influenced by the works of Lev Vygotsky (1978). According to this view, understanding, meaning and essential knowledge are developed in the interaction with others, which makes the process of knowledge creation interpersonal rather than intrapersonal and social (Vygotsky & Cole, 1978). Social constructivism differs from individual constructivism in the following two assumptions: 1) individuals rationalise their experiences using a constructed model of the social world, and 2) the construction of reality is primarily made through language (Leeds-Hurwitz, 2009).

Further, different from the ideas of cognitive constructionism that presume the primacy of individual cognition and cognitive growth, social constructivism posits that cognitive growth initially happens on a social level and only after can it happen at the individual level (Vygotsky & Cole, 1978). Here it is important to notice the possible nature of the cognitive growth on the individual level. Knowledge construction on a social level allows individuals to relate to the environment and other humans and consequently all knowledge is rooted in the individual's interactions with the society that occurred before internalisation (McCormick & Paechter, 1999). Further, researchers argue that the environment and its features are collectively created by the members of the social group situated in that environment (Kukla, 2013). Therefore, culture and context are essential for understanding the reality in this environment (O'Donnell & King, 1999). In the view of social constructivism, knowledge is the product of human interactions and is socially and culturally constructed (Gredler

& Margaret, 2009). The social nature of knowledge implies that dialogue is the primary form of interaction conducive to knowledge (Freire, 1972). Dialogue facilitates working with others, fosters the sense of community, and builds social capital, thus forging the environment conducive to the creation of knowledge.

2.5.5 Zone of Proximal Development

To explain the effect learning has on the development, Vygotsky (1978) introduced the idea of two levels of child development. The first one, the zone of actual development, is the development level already achieved by the child. It is represented by the level of intellectual tasks the child is capable of solving without being helped by an adult. The level of actual development shows which mental processes have already been completed, that is, the actual development allows us to understand, and which developmental cycles have already been finished. The second level, known as the zone of proximal development (ZPD), is observed not in the process of independent task-solving, but rather in the process of solving tasks together with an adult or more knowledgeable person. The second level is always higher than the first one as the child is capable of solving more complex tasks with the help of an adult. Thus, the ZPD is the difference between the level of actual development (defined by the complexity of the tasks that the child can solve independently) and the level of potential development (the level that the child is capable of attaining by solving tasks under the supervision of an adult or together with peers). The ZPD defines the mental functions that are being developed at the moment and is the outcome of the development of higher-order mental functions being initially formed in the interaction with other humans and continuously turning into internalised mental processes of the child. Vygotsky (1978) concluded that:

1) learning creates the zone of proximal development that later becomes the zone of actual development,

2) learning facilitates development building not only on the already developed functions but also on those in the process of development.

Thus, learning should go ahead of development. Therefore, the main conclusion made by Vygotsky is that teaching should be guided not by past development, but by future development (i.e., the zone of proximal development) of the child. Consequently, teaching and upbringing are crucially important for the mental development of a child (Vygotsky, 1978). As learning occurs in the ZPD, it is essential to keep this in mind while analysing the effect of technology on formative assessment. For example, it is possible that no effect or even negative effect on learning is observed if the task under consideration is out of the ZPD of the student (being either too easy or too complex). Such an observation may be erroneously attributed to the role of technology. In general, the ZPD is a powerful insight that can explain why in some cases technological advances are conducive to learning, and in some of them, they are not. In addition, ZPD can help explain why in some cases technology-aided formative assessment may be efficient and inefficient in other instances. For example, if teachers who never used a computer are required to teach using an educational application without prior training on the use of computers and applications, they are likely to refuse it or fail in the attempt. However, had they first learned to use the computer and navigate different applications, mastering an educational application in the classroom would be “a small step” located in their ZPD, to which they would be agreeable and probably succeed. In a similar way, if some of the educational activities familiar to students would be technology-aided, such a change would likely be within their

ZPD and be successfully adopted with some scaffolding help from teachers. However, introducing a typing exercise for a child who does not know letters is clearly outside of the ZPD and is unlikely to lead to the development of knowledge.

2.5.6 Technology acceptance model

One of the most widely used models of technology acceptance is the technology acceptance model (Davis, 1989a) , which was developed within the field of information science and further diffused to different areas of knowledge, including education. The different theories so far discussed have focused on different aspects of technology use in learning; however, very few directly incorporate the role of perceptions, which is vital for the constructivism nature of learning. The technology acceptance model integrates the explicit role of perceptions, which makes it the most suitable framework for this study. Acceptance as a concept was initially introduced in psychological and cognitive behaviour studies and originally was related to accepting the situation without attempting to modify it (O'Donohue & Fisher, 2009). When the concept was diffused to other areas of psychological research, and beyond it to other fields of scientific knowledge, a multitude of definitions was developed.

Davis (1989) borrowed the TAM concept and introduced it in the technology-related domain of research as an attempt to explain and predict the acceptance of technological developments by end-users. He defined acceptance as the end user's decision to use the object of technology under consideration (Davis, 1989). The purpose of the original model was two-fold. First, it aimed at developing an understanding of the end user's acceptance process to inform the development of new technology. The second objective was to ground further practical testing methodology to inform practitioners theoretically (Davis, 1989). The model was extensively tested empirically, validated and supported by existing research (Venkatesh, 2000) and several meta-analysis studies quantitatively confirmed the strong support for the predictions of TAM, although with different correlation coefficients explained by contextual factors (King & He, 2006; Yousafzai et al., 2007).

Building on the theory of planned behaviour (TPB) and the theory of reasoned action (TRA), Davis (1989) suggested that the actual use of technology is determined by the intention to use, which is defined by the attitude towards using the technology. In turn, the attitude towards use is shaped by two external variables, namely the perceived usefulness and perceived ease of use (Davis, 1989). According to Davis (1989, p. 320), perceived usefulness is "...the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use is defined as "the degree to which a person believes that using an IT will be free of effort", and the latter can to some extent determine the former. On this note, it is important to mention that the model does not conceptualise the actual or objective characteristics of technology, but operationalises perceptions, very much in line with the constructivism ideas. Relatedly, the actual acceptance and use of the technology in the classroom for formative assessment purposes is likely to depend on how easy it is for teachers to use and how useful they perceive it to be in their practice, as well as on their prior knowledge and perceptions towards using technological tools. Further, it is important to notice the social complexity of the process and acknowledge that the perceptions of students also matter and are likely to have a similar effect on the actual use of technology in the classroom. The original TAM model is presented graphically in

Figure 2.2.

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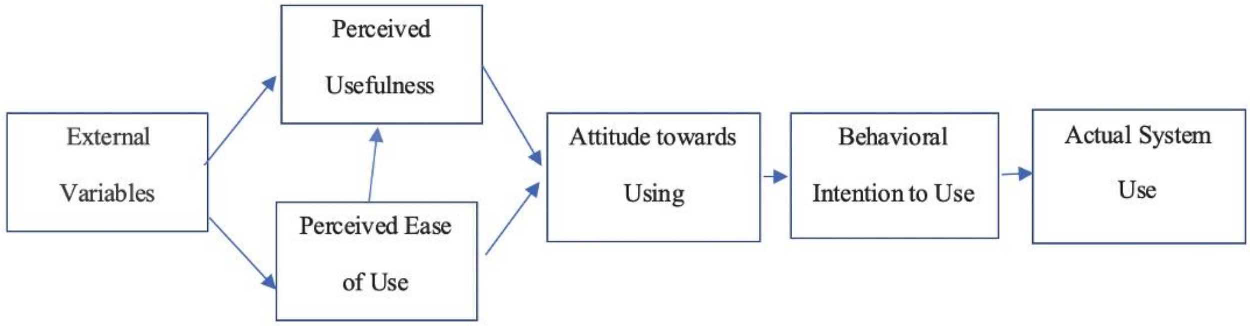
Figure 2.2.

Technology Acceptance Model (Davis, 1989)



Since its inception, TAM has formed the basis of numerous developments and updates. One example is the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003a), which was developed by introducing other factors relevant to the adoption of technology into the TAM model. While UTAUT is admittedly a powerful tool, the abundance of factors to some extent blurs the role of perceptions, which is of vital importance for my study. This is because it enables answering the questions about students' and teachers' beliefs concerning the role of technology in formative assessment, theorising the intrinsic motivation that is shaped by perceptions, and ultimately understanding the role of technology in education as a process rather than an outcome. Any model is a simplification of the reality that isolates the factors considered to be significant. Therefore, the argument for the use of the TAM model in my study is because of its implicit focus on the role of perceptions that is of utmost importance for the conduct of the research.

The technology acceptance model has also been applied in the research on higher education and acceptance and was shown to be of crucial importance for the understanding of effective e-learning in the higher education context (Martínez-Torres et al., 2008). Other studies have employed a modification of TAM in the mobile learning setting as the theoretical lens explaining the user behaviour (Huang et al., 2007). However, to date, no attempts have been made to examine the adoption of technological advances for assessment theoretically.

This model has also been further extended to include external variables, such as subjective norms in society and a person's self-efficacy (Schepers & Wetzels, 2007). Scherer et al. (2019) conducted a meta-analysis of 114 empirical studies using the TAM and combined it with a structural equation modelling approach. Although part of this study was to prove the utility of the model itself, the authors found that perceived usefulness of technology seems to be a critical factor of user intentions (Scherer et al., 2015). The authors suggested that the education and training that teachers receive should consider strengthening the focus on perceived usefulness next to perceived ease of use. Further, Scherer et al. found that the conditions that lead to easier technology adoption are multifaceted overall and relate to a diverse set of variables, including budget and materials, peer community, and faith in user skills. The adoption of information and communication technology (ICT), therefore, requires a multidimensional approach, and that does more than focus on strengthening the competencies of teachers (Straub, 2009).

Although praise is given to the TAM for its capacity to anticipate technological acceptance, the TAM is not perfect. It is crucial to investigate the nature and particular impacts of technical and usage-context elements that may modify the user's acceptance to strengthen the external validity of the TAM, according to Dishaw and Strong (1999). Legris et al. (2003) reviewed the TAM critically and highlighted the necessity to integrate other elements to provide a broader perspective and better explain technology adoption.

This study used the TAM because it has predictive validity in educational studies (Kiraz & Ozdemir, 2006; Ma et al, 2005; Teo, 2008) and it may impact technology affordances. I used six constructs: perceived usefulness, perceived ease of use, attitude, behavioural intentions, self-efficacy and facilitating conditions. Perceived usefulness (PU) is the extent to which an individual feels that using a particular technology would improve their work performance (Davis et al., 1989). Perceived ease of use (PEU) refers to the extent to which a person feels that a product is easy to use. PU and PEU are two essential belief constructs in the TAM that represent a significant portion of TAM and affect the attitude toward computer usage, influencing the behavioural desire to utilise technology (Cheung & Huang, 2005; Liaw & Huang, 2003). In addition, PEU impacts PU, and PU has a direct impact on technology usage attitudes (ATTU) as well as behavioural intent (BI) to utilise technology (Hasan, 2006).

At the same time, technology self-efficacy could impact teachers' and students' technology's ease of use and acceptance (Gong, Xu, & Yu, 2004). Self-efficacy relates to a person's perception of their capacity to plan and carry out the actions necessary to attain specified objectives. It is not concerned with the degree to which a person believes what they can accomplish with the skills had (Bandura, 1977). It influences the degree and method of technology employed in daily instructional practice, which is essential since the technology may shift teachers' responsibilities in the classroom from knowledge carriers to learning facilitators. On the other hand, facilitating conditions (FC) impact a person's motivation to complete an activity. FC is very influential in the usage of instructional technology in the classroom Groves and Zemel (2000).

2.5.7 Affordance Theory

James Gibson initially proposed affordance theory in the field of psychology. The author argued that the human perception of reality is based not on the actual objects and their physical characteristics, rather on the possibilities for actions offered by those objectives. Gibson (1977) coined the term *affordances* to describe these possibilities for action. Affordances are in essence a connecting chain between the perception and action. Affordances are perceived directly and are inherent to objects irrespective of whether the individuals are aware of them. For instance, a phone offers an opportunity of communication irrespective of whether the individual is aware of that.

On the other hand, affordances require an actor for the action to be executed. This constitutes the dual nature of affordances – on the one hand, they are represented by material objects, while on the other hand, their enactment is primarily a social process. The dual nature of affordances makes them perfectly suitable for theorising IT artefacts as the theory allows for explicit incorporation of them and is in line with the experiences of practitioners using IT (Volkoff & Strong, 2017).

The concept of affordances translated to the field of IT means that affordances are the outcome of the interaction of users with technology rather than the technology itself (Chemero & Turvey, 2007). However, this view is not indisputable. Norman (1988), for example, proposed that affordances are not “real”, not independent of the actor or their perception, and are not the outcome of the interaction between the actor and the object, but are instead the perceived and actual properties of the object irrespective of the actor. This view inspired a stream of human-computer interaction research (Volkoff & Strong, 2017). In essence, Norman’s view and the view of human-computer interaction stream of research is dealing with the usability of the object, while the original affordance theory conceived by Gibson relates to the usefulness of the object (McGrenere & Ho, 2000).

Affordance theory is promising in the technology-related research due to its socio-technical perspective that provides the possibility of direct incorporation of technology along with social and contextual features (Volkoff & Strong, 2017). While the main focus of affordance theory is the relationships between technology and its users, it maintains a clear distinction between them. Thus, the affordance theory allows the study of the role of technology directly and specifically, while also being able to incorporate the relationships with users (Volkoff & Strong, 2017).

Building on the original affordance theory, Osch and Mendelson (2011) proposed a typology of affordances in the information systems (IS) research represented by three types of affordances: designed, improvised, and new ones. Designed affordances are those planned by the developers of an IT artefact, and the activities that the developer conceived to be performed with the use of the artefact. Further, improvised affordances are the ones perceived by the users, which are not always the outcome of the original intent of the designer but instead are improvisations of a user's perception. Finally, the new affordances are those that were neither conceived by the designer, nor perceived by the user, but still emerge from the artefacts, often in the form of side-effects (Osch & Mendelson, 2011).

Another view of affordances was proposed by Leonardi (2011), who suggested a distinction between individualised affordances, collective affordances, and shared affordances. Individualised affordances are those enacted by individuals, while common ones are enacted by several individuals acting towards a shared goal, although their individual goals may be different (Leonardi, 2011). According to the author, shared affordances emerge from a group of individuals working towards a shared goal, which is aligned with their individual goals.

Bower (2008) used Gibson's theory of affordances to categorise them as functional affordances that enable the completion of work. They are media, spatial, temporal, navigation affordances, emphasis, synthesis, and access control affordances. Bower (2008) categorised each of the functional affordances to include particular conceivable actions or capabilities, as he termed them. For instance, navigation affordances include browsing, searching, creating links, and manipulating data. Moreover, Bower (2008) categorised affordances into individualistic activities, or "static" acts and collaborative actions. Bower (2008) defined *static affordances* as affordances "that provide fixed representations and unidirectional information transfer" (p. 7). Conversely, collaborative affordances "permit flexible, editable, and shareable representations" (Bower, 2008, p. 7). The relationship between collaborative and social affordances, such as social browsing and sharing, is vital. Social affordances include connections, comments, ratings/votes, sharing material, social browsing, social search, interaction, and collaboration (Hartson & Pyla, 2012).

In addition to Bower's functional affordances, Hartson and Pyla (2012) broadly classified affordances as: cognitive, physical, sensory, and emotional, to further define behaviours that activate the functional affordances of technology. Cognitive affordances, according to Hartson and Pyla (2012), facilitate cognitive actions such as "thinking, determining, learning, remembering, and knowing about things" (p. 644). Physical affordances facilitate behaviours such as "clicking, touching, pointing, gesturing, and moving objects" (Hartson & Pyla, 2012, p. 644). While the sensory affordances facilitate sensory acts such as "seeing, hearing, and touching (as well as taste and smelling) objects" (Hartson & Pyla, 2012, p. 644). They defined *emotional affordance* as life events influencing the user's emotions (Hartson & Pyla, 2012). In this study, I used Bower's and Hartson and Pyla's categorisation of affordances in analysing the technology-aided formative assessment and feedback affordances.

Classic affordance theory was also used as the basis of technology affordance and constraint theory (TACT), according to which affordance is the action potential or what can be done using the IT artefact, while constraints refer to what actions are impeded by the IT artefact (Majchrzak & Markus, 2012). Both affordances and constraints, according to TACT, are relational and are derived from the interactions between the users and technology rather than being the features of either people or technology. They should be distinguished from the functions of technology purposefully or unintentionally employed in the technology as well as from the attributes of individuals and groups, such as needs, wants, or goals. Further, affordances should not be confused with what was afforded by the technology, as affordances constitute only potential actions, while what was actually afforded by technology is no longer potential but concluded events given particular users, context, and goals (Majchrzak & Markus, 2012). The relational nature of affordances and constraints allows elucidating why different users in different settings achieve different results using the same information systems and why the outcomes of using the same technological solutions may vary considerably. However, the differences in contexts and backgrounds tell only a part of the story, while the other part is determined by the nature and specifics of the technology (Majchrzak & Markus, 2012). The TACT allows researchers to approach the analysis of practices involving technology from the aspect of the users as well as from the aspect of the objects of technology. However, the theoretical lens offered by TACT allows analysing not only of the specifics and features of users and objects but also the interactions among them with the specific focus on what actions those IT artefacts afford or hinder (Majchrzak & Markus, 2012).

Several researchers have used the affordance theory as the theoretical lens for studying the role of technology in the educational setting. For example, Kennewell (2001) used affordance theory to theorise the role of technology as supporting students in the transition through the ZPD. However, his work lacks clarification of the perception of affordances by teachers and, consequently, presents only a part of the story. Another notable attempt at using affordances in theorising technology in education was undertaken within an Economic and Social Research Council (ESRC) project in the UK (John & Sutherland, 2004); however, this study generally revealed only the tendency towards Norman's (1988) understanding of affordances and therefore did not elucidate the role of direct perception.

Norman's (1988) view of affordances inspired a stream of research on learning design with the normative focus on how educational technology tools should be designed and perceived in order to be conducive to learning. One of the early interests in this area was expressed by Pea (1993), who, although citing Gibson's original theory, expressed interest in the features of environment and context, rather than in perception of affordances. Therefore, Pea's (1993) study focused on the usability of educational technology tools and not on usefulness. Other researchers have investigated the role of multimedia CD-ROMs in facilitating learning and concluded that the students were more interested in the technological specifics of the tool rather than in reflecting on the learning material (Laurillard et al., 2000). Still, they attributed the observed effects to the design of the educational tool rather than to the perception the students had of it. Relatedly, Webb (2005) was interested in investigating what features of affordances are conducive to learning in science education, for example, in the learning opportunities offered by technology. Neither of these studies allowed for the direct perception of affordance, despite that aspect being highlighted in the original theory of affordances. On this note, it is important to mention that Norman (1988) not only acknowledged the deviation in interpretation of affordances from the ideas of Gibson but also later openly regretted it, stating that this led to a stream of misleading interpretations and hindered the original value of direct perception (Volkoff & Strong, 2018).

Another line of research applying affordance theory in the field of education was related to investigating the phenomena of interactive whiteboards. Unlike the studies cited in the previous section, this stream of research allows for the integration of direct perception. For example, Armstrong et al. (2005) were explicitly interested in the choices made by teachers using interactive whiteboards rather than in the tools themselves and focussed their investigation on how those tools were perceived. They concluded that the use of the similar technologies in the past could elucidate the process of using them in the present, thus arguing for the importance of historical context and probable path dependence (Armstrong et al., 2005). Relatedly, John (2005) argued for the importance of the context as well as the psychological profile of the user. A later study, also using interactive whiteboards as the technological context, showed that technological tools could be both affordances and constraints for the teachers and confirmed that employing technology changes the actual classroom practices in primary schools (Mercer, 2007).

Admittedly, attempts were made to integrate affordance theory with sociological perspectives. For example, Fayard and Weeks (2014) proposed complementing Gibson's theory (Gibson, 1977) with the works of Bourdieu and using the concept of habitus (Bourdieu & Chartier, 2015; Costa & Murphy, 2015) to theorise technological and social affordances simultaneously. Although this is an obvious step forward in terms of acknowledging the social dimension of affordances, this perspective still hinders the original value of direct perception and the role it plays.

Despite these efforts, much remains to be clarified regarding the role of technology in education. First and foremost, the role of technology in assessment, and particularly, formative assessment is still understudied. While the studies described in this section were mainly focused on particular technological advances, such as multimedia CD-roms (Laurillard et al., 2000) or interactive whiteboards (e.g., Armstrong et al., 2005), little is known about how the introduction of technology in the classrooms changed the process of formative assessment, what are the views of students and teachers on it, and what effects it had on instruction and motivation. Prior research has mainly sought to advance the effectiveness of the technology. Although it is true that the role of particular technological methods in education requires that their designs and features are effective, the beliefs, views, and ultimately perceptions of the teachers and students are not less important and represent the other part of the "puzzle". This duality forms an interesting relationship, in which, on the one hand, there is a technological solution, which is an affordance, and on the other hand, there is a whole set of perceptions of the actors. The interaction in itself and its effect has escaped the deserved attention of the existing research in the literature. For example, an assessment software can be introduced in the educational process. Teachers may use this software to conduct either or both summative and formative assessment, depending on whether they perceive it as a way to evaluate and compare students to each other or the way to facilitate learning. Alternatively, they may perceive it not in line with the intent of the designers and use it as a communication rather than an educational tool. This setting is complicated by its nature and therefore calls for a multitude of theoretical approaches to be thoroughly examined. The approach to the theoretical framework suitable for this purpose is presented in the next section.

2.5.8 The Rationale for a New Theoretical Framework

As already discussed, the role of technology in assessment practices remains somewhat understudied. While technological developments offer the opportunity for technology-aided assessment in general, and provision of feedback, in particular, the intrinsic social nature of these processes makes it impossible to be conceptually evaluated within a single theoretical domain. Further, the assessment and feedback are likely to be significantly affected by perceptions of teachers and students, as well as the groups. More, formative assessment practices have been shown to be conducive to the construction of knowledge (Black & Wiliam, 2009), which can be viewed through the lens of constructivism.

Consequently, it is not prudent enough to theorise the technology-aided assessment simply as an affordance of the technology, as the perceptions are likely to interfere and play an essential role in the process. Further, the constructive nature of the learning process is likely to lead to different perceptions and, consequently, differences in the use of technology-aided assessment practices. Relatedly, the process of adopting technology is also crucial in this setting, as non-adoption will ultimately lead to non-use of the technological affordance. As adoption was shown to be related to the perceptions (namely, perceived usefulness and perceived ease of use), it should be accounted for as a general factor. Consequently, all the arguments presented in this chapter justify the need for a holistic theoretical framework acknowledging the importance of those considerations and integrating them in order to allow for a comprehensive analysis of the assessment process. The following section outlines the proposed theoretical framework that, by merging the insights from the theories presented in the chapter, provides theoretical grounds for examining the phenomena of technology-aided assessment.

2.5.9 Conceptual Framework

The reviewed literature suggests that there is ample evidence of the benefits of formative assessment for students' learning. In addition, it is clear that the technology has gradually been integrated into many classrooms. However, there is still no consensus regarding not only the effects of technology on educational process but also the extent to which it is utilised. Furthermore, surprisingly little research attention has been devoted to the underlying reasons and motivations of teachers and students alike to use or refrain from using technological tools in the learning process.

The primary goal of this section is the development of a comprehensive theoretical framework building on the insights from different fields to analyse the role technology plays in the educational setting, mainly, concerning assessment practice. In particular, I aim to address the following questions in the interviews support of answering the research questions:

1) What types of technological-aided FA resources are available to teachers and students? How much of the chosen system's capability is utilised? Why?

2) How do teachers plan for technology-aided formative assessment, and what are the common tactics and procedures?

3) What kind of data is collected by teachers using technology-aided formative assessment? How are these numbers interpreted?

4) What is the fundamental rationale behind their decisions?

5) How do students and teachers view the influence of technology-aied formative assessment on student learning?

The theoretical framework for my study, multidisciplinary in its essence, is building on the existing research in the fields of sociology, psychology and information systems fields by bringing the insights of pragmatism, social constructivism learning theory and the technology acceptance model into the affordance theory with the aim to conceptualise the formative assessment process through technology. As the phenomena involve interactions between the material and the social, this thesis adopts the understanding of affordances as relational and dispositional concepts, following the original ideas of Gibson (1977). On this note, it is essential to highlight the value of direct perception introduced in the original Affordance Theory. Relatedly, perception is representative in that each person observes the world through past experiences, according to the pragmatic viewpoint. These representations motivate people to act, hence offering opportunities for their reformulation

(Santana, 2018). These factors call for the need to incorporate the broader learning outlook presented by constructivism (Bruner, 1960, 1996).

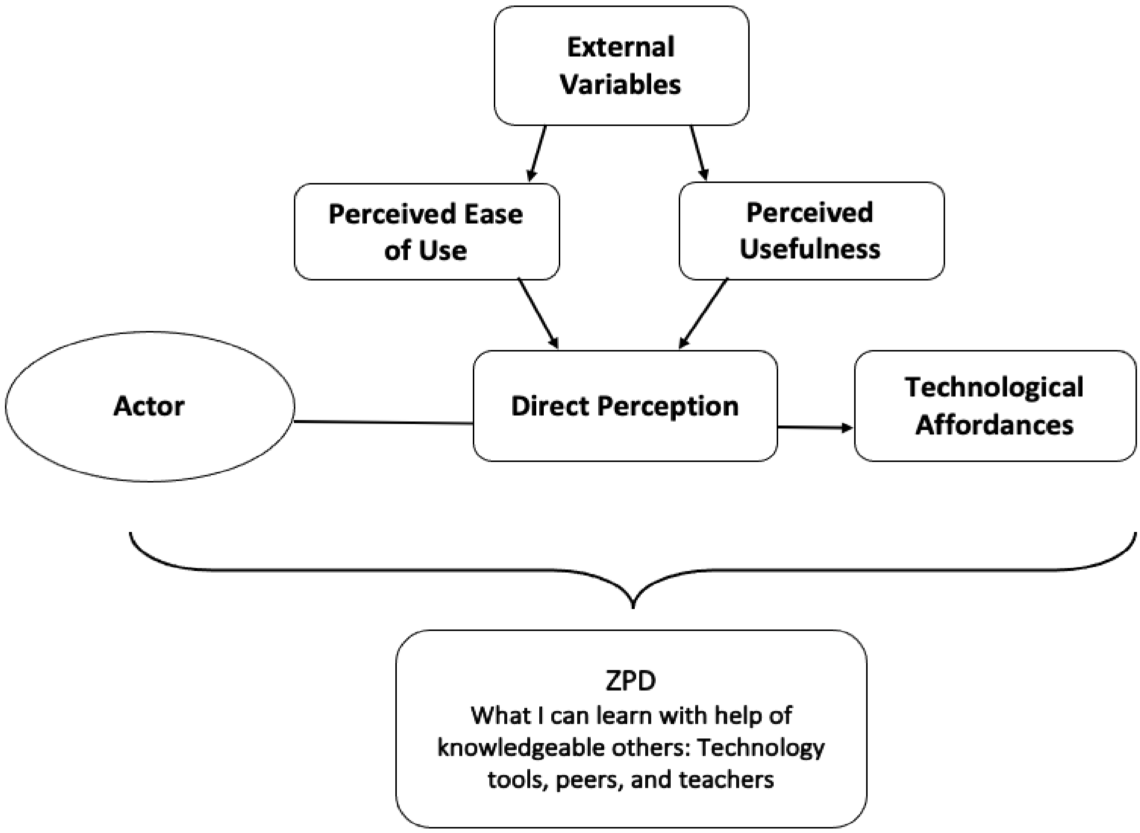
However, the best approach of integrating the social and material affordances, that are inevitably interconnected and interrelated in the educational setting, is not stretching the affordance theory to include a sociological perspective but complementing it with the constructivism views on learning. While the dual nature of affordances allows theorising actions as situated in the material world and filled by intent and meaning, it fails to explain the social construction of the use of technologies and how the technology affects what could affordances be in a particular context. Direct perception occurs in a social context and is enabled by actively establishing and maintaining a pragmatic relationship with the surrounding environment (Van Dijk & Kiverstein, 2021). Further, in order to theorise the direct perception in the learning context, how it is constructed, and what role it plays, it is necessary to bring in insights from other theories, and constructivism perfectly fits this requirement. As an actor, such as a student or teacher, ultimately constructs direct perception either individually or in a group, both cognitive and social constructivism help conceptualise this. As was discussed in the previous section, other authors' attempts at applying the affordance theory in the educational setting generally overlook the importance of direct perception and fail to accommodate it in their previous studies. Therefore, the theoretical framework I have applied in this study entails a high degree of novelty and allows theorising the role of technology from another viewpoint, at the same time acknowledging the role played by direct perception.

Affordances arise from the interaction between the teachers and the technology, as well as between the students and the technology, both individually and as a group. Whether they will be perceived would depend on the background and environmental context of students and teachers, while whether they will be accepted and used would be defined by the perceived ease of use of the technology as well as the perceived usefulness and what external variables influencing these perceptions such as perceptions of self-efficacy and facilitating conditions. Consequently, the educational setting in which technology is employed can be conceptualised as a multitude of actors, objects, and affordances arising from the interaction of actors with objects. Whether or not these affordances lead to action can be theorised using the technology acceptance model and will ultimately depend on whether these affordances are perceived as useful and easy to use by the actors. While complementing the affordance theory with the views of constructivism allows theorising the direct perception and its role in the actions made via affordances, the integration of the technology acceptance model provides a more fine-grained understanding of how this direct perception leads to acceptance and use of the technology through the concepts of perceived ease of use and perceived usefulness. This conceptual idea on the individual level is graphically presented in **Figure *2.2*** Conceptual Idea of Individual Level.

While the same concept applies to both students and teachers, I will further discuss the concept using teachers as actors. I argue that the teacher directly perceives the technological affordance, for example, new software for assessing performance, and makes judgements on its perceived usefulness and ease of use. At the same time, these perceptions may be influenced by external variables such as self-efficacy. This processing essentially defines whether the software will be actually used. At the same time, the process of direct perception is the process of learning or developing the knowledge about the software. Therefore, this knowledge affects the perception (i.e., whether the teacher will perceive the new software as strange, useless and difficult to master or as useful and easy to use) and the software is more likely to be judged as easy to use and useful and ultimately adopted if it is located within the ZPD of the teacher (for example, if the teacher used a similar software previously).

Figure 2.2

Conceptual Idea of Individual Level



On the group level, the concept is similar, aside from the multitude of agents and affordances involved, and indirect interactions are shaping direct perception along the lines proposed in the social constructivism literature. Further, and relatedly, the process of formative assessment aided by information technology in the educational setting can be theorised as an affordance. On this note, it is important to state that those affordances can be individualised, collective and shared, following the distinction proposed by Leonardi (2011). Individualised affordances emerge from the interaction of individuals, students, and teachers alike, with the technology. Important to notice also is that individualised affordances can be conducive to cognitive growth along the lines of cognitive constructivism. Collective affordances emerge from the group interaction with the technology, in class or otherwise, and can be conducive to learning in line with social constructivism, with the condition that the cognitive growth initially appears within the group and only after that on the individual level. Shared affordances, in turn, can emerge in a larger setting, such as classrooms, and during the course of group exercises. Consequently, these relationships can be conceptualised in this way, similar to the concept proposed on the individual level. However, theorising of direct perception, in this case, shall be based on the ideas of social constructivism. Further and relatedly, affordances are expected to be conducive to learning if they are situated in the ZPD of a student.

Finally, the dual nature of affordances and constraints, as well as their distinction from both actors and objects, enables gaining an understanding why a particular technological solution may be conducive to assessment and learning in one context and hinder it in another. Gaining insight into the perceptions of actors (teachers and students) allows examining the role of contextual factors as perceived by the students, teachers, or by these actors in groups.

To summarise, the theoretical framework for this research addresses the missing link of direct perception that has hindered the application of affordance theory in the educational context. However, the idea of direct perception is not only central to Gibson's (1977) original theory of affordances but is also crucially important to the understanding of the role of technology in education in general and assessment in particular, as it dramatically affects the actual use of technological tools and differences arising in the process. The interplay between the perception of the affordance and the actions carried out using it is intriguing and was not examined directly in the existing research. Consequently, complementing the affordance theory with ideas of constructivism and the technology acceptance model in my research has a great potential to enhance understanding of the role of technology in the formative assessment from the point of view of teachers, students, and classroom groups alike. The perception of affordance is expected to define the technological choices made by the teachers. Whether the teachers perceive the technology as an enabler and how they perceive it is likely to define the choice to use the technology or not, and if they decide to use it, which particular technological solutions they employ. In other words, if the teacher perceives a particular technology as facilitating and/or enhancing the formative assessment process, they are likely to adopt it.

However, the actual manifestation of this intent (i.e., the adoption itself) will depend on whether the teacher perceives it as useful for their particular purposes and easy to use. As already discussed, motivation is one of the keys to successful deep learning, and formative assessment helps support motivation. Therefore, it is critical to understand whether the teachers, as well as the students, see the technological advances as motivating. Is the use of technology in formative assessment intrinsically motivating for the students? Do students and teachers share the same views, or do they differ? Different combinations of students' and teachers' perceptions of the technology role in motivation are expected to lead to different outcomes. For example, if both teachers and students believe that the use of technology in formative assessment processes is motivating for the students, one is likely to witness a higher level of technology adoption. The opposite is also true; if the teachers and students see technology not as an affordance that supports motivation, but rather as a distraction, the resulting use of technology is expected to be lower. Of particular interest are the cases when students' and teachers' beliefs differ, for example, when students see the technological means as facilitating their motivation, while teachers regard them only as a distraction. Both the theory and practice would benefit from understanding the interplay and resulting outcomes in greater detail.

2.6 Summary

This chapter discussed the relevant research that has been done on the central topic, both theoretical and empirical. It thoroughly substantiated the role of technology in formative assessment and feedback and its impacts on learning. The review covered five main areas: educational assessment in general, formative assessment, feedback, technology in education, and the theoretical frameworks around which technology, formative assessment and feedback are revolving around. The chapter highlighted that the role of formative assessment and feedback in education is under-studied and under-appreciated. Understanding how students control their learning processes and make sense of the feedback and assessments they receive would bring assessment and learning together and help address the learning gap for many students.

This chapter also summarised research on formative assessment and technology. It evaluated the role of technology in formative assessment, its benefits, and challenges and concerns. Much research has focused on technology-aided feedback and how it relates to learning questions; the field remains fragmented despite these efforts. The literature focuses on the outcomes of formative assessment with technology, but essential questions still need to be explored. The adoption of technology is a process that is on a continuum that will affect the eventual outcomes. Little research has been devoted to analysing the technological means available to classroom teachers.

Further questions need answers: What drives the adoption of technologies? To what extent will they be adopted? What are the perceptions of the teachers? Can the perceptions of teachers and students be affected during the process of adoption of technology in education? Is it possible that the pressure exerted by the students eventually pave the way for technology integrations in the classrooms? The Theory of Affordances (Gibson, 1977) is significant in learning and, hence, this chapter incorporates insights from the affordance theory, the Technology Acceptance Model, and the grand learning theory of Constructivism.

A review of the relevant literature revealed an interconnected theoretical framework incorporating learning and assessment theories and technology adoption and affordances theories. The theoretical framework section addressed the missing link of direct perception that has hindered the educational context application of Affordance Theory. The relationship between the perception of affordance and the actions performed to take advantage of it is fascinating. It also emphasised the significance of incorporating a social and cognitive constructivist lens into adopting and integrating technology-aided formative assessment and feedback to maximise the affordances of technology in the teaching and learning process.

The current study would therefore inform stakeholders in education on how to improve schools, while enhancing teachers' and students' understanding of the role of technology in formative assessment. Thus, the theory and practice of pedagogy would benefit from a more thorough understanding of the interactions between teachers, students, and technology use described in this research.

Chapter 3. Methodology

3.1 Introduction

There is an evident gap between assessment and learning in the intersection between technology and formative assessment implemented in a school environment. Based on the pragmatic perspective of the study, the current study aimed to contribute to the existing knowledge by exploring and assessing how teachers and students perceive and use the technology-aided formative assessment. In particular, the study sought to determine how they adopt the use of technologies to facilitate the generation of feedback and how it affects teaching and learning. This study would build a theoretical and conceptual argument about harnessing the potential for improved learning in formative assessment and technologies in the school environment. Therefore, the pragmatic stance regarding how learning is constructed refuses to engage with disputed philosophical notions like truth and reality. Instead, it admits that single or many realities are accessible to scientific investigation (Creswell & Clark 2011) and could explain how technology facilitates the learning process, formative assessment, and feedback levels in an active, collaborative learning environment. The methodology I used to achieve the study aims was mixed, quantitative and qualitative data collection.

According to Creswell and Clark (2017), a study's choice of methodology is dictated by the nature of the research topic. The nature of the research problem in this study, as discussed in Chapter 1, is how some elements of traditional pedagogy, such as teacher-centred classrooms, are resisting and limiting the affordances of technology-aided formative assessment and feedback, which includes objects, attitudes, perceptions, usage and adoption. This necessitated the use of a mixed methods exploratory research design.

Table 3.1 demonstrates the connection between the research questions, objectives, methods, data analysis, and analysis tools. The study examined the perception and use of technology-assisted formative assessment and feedback in an IB secondary school in the United Kingdom using both quantitative and qualitative research approaches. The quantitative research section of this study involves a survey aimed to gain a background understanding of the case and its context, map the prospective areas for more detailed inquiry and explore teachers' and students' technology use and acceptance. While the qualitative research section consists of semi-structured interviews with teachers and students to ascertain their perspective on the use of technology-aided formative assessment and feedback, along with an observation of both classrooms and school environment. This chapter describes the precise research processes used to acquire survey, observation, and interview data as well as the analysis methods for making sense of the raw data. The chapter finishes with a discussion of the quality and ethical difficulties associated with the research.

This thesis followed Crotty's (1998) four research design aspects: epistemology, theoretical perspective, methodology, and methods. Crotty suggested research literature terminology is detached, with epistemologies, theoretical perspectives, methodologies, and methods "thrown together in grab-bag style as if they were all comparable terms" (Crotty, 1998, p. 3). These terms represent different hierarchical levels of decision making within the research design process. Creswell (2003) suggested these four decision-making factors lead to a quantitative, qualitative, or mixed research strategy, depending on the researcher's starting perspective on the nature of knowledge

Table 3.1

Research Questions in Regard to Research Objectives, Methods, Analysis, and Analysis Tools

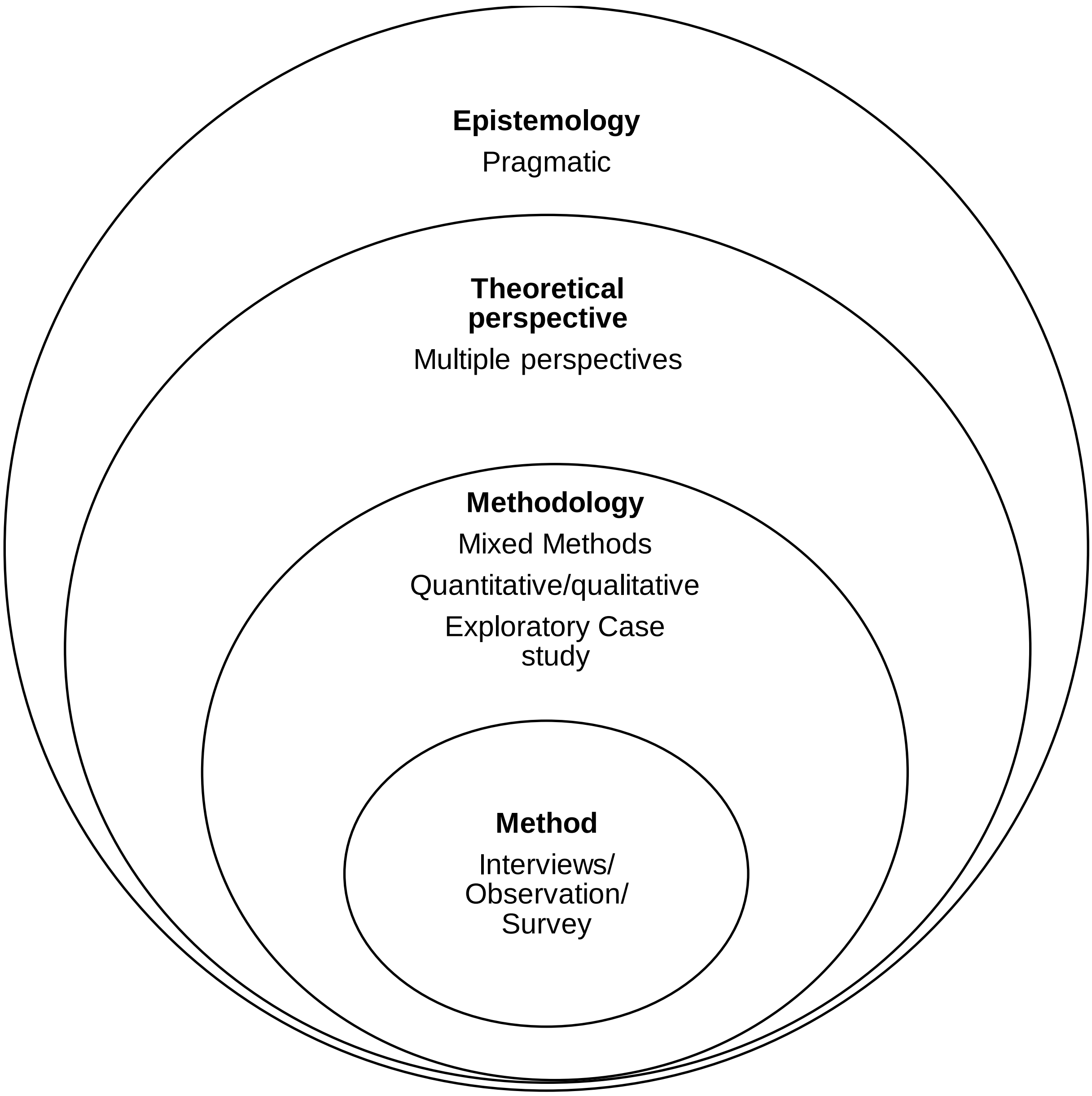
Research Question	Research Objectives	Method	Data Analysis	Analysis Tools
How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?	To critically assess how teachers and students are using formative assessment feedback in the teaching and learning they are using in the school environment.	Survey Observation Semi-structured interviews	Descriptive frequencies Thematic analysis	SPSS NVivo
How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?	To critically assess how teachers and students are adopting the use of technologies to facilitate the generation of feedback and how it is affecting the learning.	Survey Observation Semi-structured interviews	Descriptive frequencies Thematic analysis	SPSS NVivo

How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?	To build a theoretical and conceptual argument about how to harness the potential for improved learning in formative assessment and technologies in the school environment.	Survey Semi-structured interviews	Descriptive analysis Response distribution Mann-Whitney Test Thematic analysis	SPSS NVivo

Accordingly, in this study, the pragmatic philosophical framework and epistemology dictated the multiple theoretical perspective and a mixed methods study research methodology, and the methodological approaches, which, in this case, are survey, observation, and interviews, as they should fit within the epistemology's conceptual framework, as illustrated in Figure 3.1.

Figure 3.1

Research Design Aspects



3.2 Epistemology and Ontology

Pragmatism is the philosophical stance adopted in this study. Pragmatic exploration permitted me to investigate the role of technology-aided formative assessment and feedback to understand how teachers and students perceive and use the affordances and constraints of these technologies in the school environment. Moreover, pragmatic exploration enabled me to determine how their perceptions affect the technology affordances.

In the pragmatic ontology, individuals actively create reality by operating in the world. Therefore, the reality is constantly changing depending on people's experiences, similar to this study's case. Pragmatists view reality as continuously negotiated, disputed, and interpreted. Thus, the most effective strategy is what is practical and solves the problem. Often, pragmatists view reality as external to the learning process and relate to a social experience independent of our minds (Teddlie & Tashakkori, 2009).

Epistemologically, unlike positivists and constructivists, pragmatists believe in both one and multiple versions of the truth (Creswell et al., 2011; Kaushik & Walsh, 2019). This stance would take different orientations, such as subjective or objective, which prioritise value, suitability, and results in the research process (Hammersley, 2005). Moreover, pragmatism reaffirms the homogeneity of positivism and constructivism epistemologically or ontologically, as they view several comparable qualities in their investigation approach (Hanson, 2008). As a result, pragmatism has substantial acceptance in mixed methods research.

3.3 Theoretical Perspective

Mixed methods researchers such as Creswell (2015), Johnson and Onwuegbuzie (2004), Meixner and Hathcoat, (2019), and Morgan (2007) see positive value in both the quantitative and the qualitative views of human behaviour. They view the use of only quantitative or qualitative research as limiting and incomplete for many research problems. Mixed researchers use a combination of both concepts and approaches to understand the world more fully.

Learning in general, and formative assessment and feedback in particular, are intimately related to social constructivist perspectives. Through interaction, conversation and engagement, students can understand assessment needs and develop their learning (Black & Ammon, 2016; Dagar & Yadav, 2016). This enables students to engage and develop through feedback levels until reaching self-regulated assessment (Black & Wiliam, 2009). While learner involvement with technology facilitated by feedback is associated with their perception of its usefulness and ease of use (McGrenere & Ho, 2000). In this view, the reality could be subjective and objective since the perspectives of social participants influence it and technology as object is involved. Until recently, technology research in education has been strongly skewed towards quantitative studies (Sancho-Gil et al., 2020). There is a lack of exploratory and explanatory research designs as opposed to the positivist methodology, as technology is tied mainly to subjective reality. I studied subjective and objective reality in this study by surveying, interviewing, and observing teachers' and students' uses and acceptance of technology-aided formative assessment and feedback. I quantified and interpreted their usage, acceptance and experiences.

According to a variety of studies (e.g., Hesse-Biber & Johnson, 2015; Leavy, 2017; Mitchell & Education, 2018), it is crucial to comprehend the subjective reality of human, intersubjective (e.g., behaviour, dialogue, discursive, or cultural), and objective (e.g., material and causal) realities of our world. Although it is essential not to affect or skew what is being observed, it is also essential to comprehend the different meanings and perspectives of the range of participants in a sample of a population. For example, student participants in the current study were similar in age and technological abilities, while they also acquired similar technological tools and subjects studies. On the other hand, while the teacher population shared related tools and school support of technology-aided formative assessment, there was more variation among teachers in their age, teaching experience, and the level of technological knowledge they possessed. Therefore, the students were a more homologous cultural group to study than were the teachers. Comparing how these two groups contrasted or corresponded in their perspectives required mixed approaches to data gathering and analysis. In addition to quantitatively analysing data from surveys, collecting qualitative data through in-depth semi-structured interviews and careful observations was necessary to acquire better knowledge from the insiders' perspective of the school's and participants' assessment of technological culture. In conclusion, combining mixed approaches enabled highly relevant and complementing rich data to be acquired. Both quantitative and qualitative perspectives on human behaviour are viewed favourably by mixed-methods researchers. For many research challenges, they consider the use of only quantitative or qualitative approaches to be insufficient and limited. Mixed-methods researchers utilise a combination of both concepts and methods to gain a more comprehensive understanding of the world.

As Morgan (2007) recommended, I managed the study intersubjectively to capture the duality of subjective and objective perspectives, and moreover, to establish a proper mutual understanding with the participants who read and evaluated its outcomes. Intersubjectivity refers to the diversity of possible relationships among different perspectives (Gillespie & Cornish, 2010). Consequently, this component emphasises communication processes and shared meaning, which is fundamental to any pragmatic approach. Intersubjectivity is essential for understanding human social behaviour. To do that, I employed observation and integrated it with quantitative and qualitative analyses for a better and intersubjectively relevant understanding of participants in their natural school context.

3.3.1 Research Reasoning

The process of reasoning is a systematic movement of semantic information from a collection of assumptions to a conclusion. Semantic information is relative to several options that an assertion excludes and is therefore inversely relative to the prospect of an assertion (Johnson-Laird, 1983). To reach an increased understanding of the use of technology in the case school, abductive was used as the research reasoning to allow for flexibility in combining the theories' propositions and coming up with the implications that the empirical data may have in similar cases.

Abductive redescribes the observable everyday objects of social science, usually provided by interviewees or observational data, in an abstract and more general way to describe the sequence of causation that gives rise to observed regularities in the pattern of events (Edwards et al., 2014). Abductive serve several functions like rectifying discrepancies in the data. For example, due to the complexity of the role of educational technology in learning and feedback, discrepancies in the data arose, such as between the perceptions of students and teachers (see section 5.7) or between technologies as tools of formative assessment (see section 5.3).

Abductive combines observations, often in tandem with the theory identified in the literature review, to produce the most plausible explanation of the mechanisms that caused the events (Edwards, 2014). Essential concepts from identified theory will help understand the data from the studies to bring the processes and mechanisms at work into focus. With this reasoning, the empirical data allowed arriving at the operation of the mechanisms rather than the mechanisms themselves, as Edwards (2014) reported by developing a theoretical and conceptual framework aimed at theorising the role of technology in learning by developing a theoretical framework that combines affordance theory, TAM from information systems research and constructivism as a learning theory (see Figure 2.23, section 2.5.9 and section 6.2.1).

People construct their social world; however, their freedom will be constrained and limited by the structures in society (de Vaus, 2001). That will affect the possibility of reaching deterministic explanations, yet it is possible to reach probabilistic explanations, for example, to argue that certain factors increase the likelihood of a particular outcome (de Vaus, 2001). The explanation is rarely deterministic in social sciences. However, it can help researchers generate testable predictions, making those predictions more scientific than simple guesswork (Douglas, 2009). The particularities of the data collection and the specific methods involved are not relevant to the logic of the design (de Vaus, 2001; Rowley, 2002). However, the design related to the research questions is crucial for the outcome. Combining different data collection methods properly not only improves the validity of the research; the approach also makes it possible for me as a researcher to reach different insights (Rowley, 2002).

Further, the current study aims to reach analytical generalisation or, in other words, to generalise to theory rather than to the more significant population. On the one hand, an analytical generalisation involves a theory-grounded claim based on the empirics of a particular case. On the other hand, it tries to explain why similar things happen (Yin, 2013), which is similar to the logic behind abductive reasoning. If the research was done well, this means that the research results can be used to explain things that happen in similar situations, which improves the generalisability of the findings (Rowley, 2002).

3.4 Methodology

For decades, evidence-based education research has been pursued (Pring, 2000, 2004). This has led to dualistic thinking about the differences between qualitative and quantitative research in education. What Pring (2000) advocated for is more attention to the everyday context in which teaching and learning occur without appealing to dualism between the different ontologies of positivist and interpretive research. Adhering too closely to the claim that all ways of knowing are constructed and there is no absolute truth in the constructivist ontology obscures the reality that there are stable or enduring dimensions of human lives that can be known and described objectively and thoroughly. Thinking in terms of strict dichotomies between the qualitative and quantitative is therefore limiting. Consequently, in this study I used a quantitative and qualitative data method to complement a process orientation to the research (Maxwell, 2008, 2012), since quantitative data may indicate differences to be investigated in a more interpretive manner (Pring, 2000).

This study employed a mixed methods methodology using quantitative and qualitative approaches through the lens of the pragmatic stance. This methodology aided in a clear understanding of the overarching aims of the study to identify and understand how technology-aided formative assessment influences teachers and students teaching and learning in the context of an IB school in the UK. The related questions sought to answer whether technologies are making it easier for teachers to provide more detailed formative assessments and feedback and if these are benefiting student learning. This methodology is supported by various researchers (e.g., Creswell et al., 2011; Feilzer, 2010; Kaushik & Walsh, 2019; Teddlie & Tashakkori, 2009), who acknowledged that a mixed methods design delivers richer qualitative and quantitative data insights and triangulated understandings. This supports the academic stringency and depth of the current study. It also aided in compensating for the shortcomings of one method with the advantages of another, and in amending or verifying the analytical conclusions when the outcomes of each approach complement, confirm or contradict one another.

Mixed methods are not a data collection method; instead, it is a methodological strategy and study design employed in social science (Creswell, 2007; Creswell et al., 2011). In this study, I used a qualitative method case study approach since it allowed for in-depth exploration of a specific case in its natural setting (Yin, 2003, 2009a, 2015). It offers the opportunity to make detailed, empirical descriptions over time, use a variety of data sources, and gives insights that might not be achieved by other methods (Yin, 2015). I followed the definition Gerring (2004) proposed, that a case study is “an intensive study of a single unit with an aim to generalise across a larger set of units” (p. 341). I want to deeply understand how technology is used in teachers' and students' learning and teaching processes to see a broad contextual and vibrant picture of real-life technology use.

A mixed methods approach allowed me to bridge the gap between formative assessment practices of the teachers and the learning on the part of the students. Functions in the software or hardware that teachers and students are not using, for example, sharing or live tracking, were captured with the idea of determining what affordances in the technology make it possible to do and know. The research also has a descriptive dimension (Yin, 2003) because it seeks to elaborate on how teachers and students are using formative assessment in its real-life context. The purpose of analysis in this case is not just about the frequency of something occurring; as Easton (2010) and Yin (2003, 2009) argued, case research affords the researcher the ability to isolate and unravel a complicated set of elements and relationships, in a case or limited number of cases.

The qualitative method can be used to build an analysis based on three essential forms of data: what people say, how they act, and the things or artefacts they use (Grauer, 2012; Gustafsson, 2017; Yin, 2009a, 2015). This helped to develop understanding from the daily life routines through which students and teachers interacted in a given context and the interpretations they shared with me in their interviews. Using the qualitative methodology, I examined what teachers and students did in terms of technology-aided formative assessments, and through participant observation, I tracked their practices at school and collected data as elements of their uses and practices.

I used a quantitative method by surveying 11 teachers, and 25 students aged from 16-18 years old in Middle Years Programme (MYP) and International Baccalaureate Diploma Programme (IB). In this study, I used quantitative research to answer research questions related to teachers' and students' technology-aided formative assessment perceptions on the impact of such assessment on teaching and learning practices, to gather preliminary data about the kind of technology available and used it to explore the responses of teachers' and students' adoption of technology. Accordingly, Miles et al. (2014) reported that humans need both words and numbers to comprehend the world more thoroughly. In addition, they argued that rigorous statistical methods of quantitative studies are valuable assets, particularly when combined with an in-depth understanding of complicated real-world circumstances to create a potent mix. Furthermore, they emphasise that implementing a mixed methods design should not be motivated by a desire to cope with research trends, rather it should be determined by the requirements of the study (Miles et al., 2014).

I also used the qualitative method as it allowed me to ask how, what, and why questions, such as those that I have used to frame my research design. This methodology also allows a researcher to consider how context influences the phenomenon being studied (Baxter & Jack, 2008; Gustafsson, 2017). While there are different approaches to qualitative case study methods, this study has an exploratory dimension and a descriptive dimension, as Algozzine and Hancock, (2017) and Yin (2015) described. It is exploratory because I wanted to understand how the students and teachers adopt and adapt to formative assessment technologies while I also wanted to reflect on how teachers' and students' beliefs guided their choices of formative assessment and feedback technologies. I interviewed 17 teachers and 15 students and observed 12 classrooms in a UK middle class, international school during two periods of study from 10/02/2020 to 23/12/2020 and 01/03/2021 to 25/09/2021. This type of study assists in the understanding of a subject from exploring and analysing real-life situations. In the case of complex practices with multiple influencers, it is productive to build an understanding by reviewing various sources of information on the case.

Teddlie and Tashakkori (2009) reported five groups of mixed methods research designs: parallel mixed designs, sequential mixed designs, conversion mixed designs, multilevel mixed designs, and fully integrated mixed designs. I used the convergent design for its straightforwardness. It allowed me to collect the qualitative and quantitative concurrently and not simultaneously. The timing is concurrent with qualitative and quantitative strands that are typically combined at the level of interpretation and have equal weight (Creswell, 2015; Plano Clark, 2019). For example, I started with a survey instrument and, at the same time, conducted observations. I also used some results from the quantitative analysis in the qualitative (themes). Both quantitative and qualitative approaches are considered independent and, therefore, were combined after I collected and processed each data set independently. Moreover, I have compared them later in the discussion chapter. I chose this design because it provides a deeper understanding of the phenomenon by collecting qualitative and quantitative data that are unique yet complementary (Kukla et al., 2015).

A systematic and iterative approach was adopted to ensure concurrent data collection and analysis. The survey questionnaires, observation guidelines and interview protocols were designed and refined based on emerging insights throughout the data collection process (Bernard, 2017; Malmqvist et al., 2019). This concurrent approach allowed for the seamless integration of multiple data collection methods.

The data collection process began with distributing surveys to teachers and students via email. Clear instructions and deadlines were provided to ensure timely completion and real-time monitoring of survey responses allowed for immediate insights. While participants completed the surveys, observations were conducted concurrently within the school environment. Detailed notes were taken on participant behaviours, interactions, and relevant aspects. Audio recordings captured during the observations served as additional data sources for later analysis.

Simultaneously, interviews were conducted alongside surveys and observations, leveraging the real-time data obtained from survey responses and observational notes. These interviews provided deeper qualitative insights into the research topic. The recorded interviews were transcribed, adding to the data pool for analysis.

The collected data, including survey responses, observational notes, and interview transcriptions, were compiled for real-time analysis. Through an iterative process, findings from surveys, observations, and interviews were compared and integrated, allowing for a comprehensive understanding of the research topic. The concurrent analysis of multiple data sources facilitated cross-validation and triangulation of the findings (Creswell & Plano Clark, 2017).

By conducting surveys, observations, and interviews concurrently and analysing the data in real-time, I ensured a dynamic and iterative process that seamlessly integrates different data collection methods and timely insights generation. particularly in light of the time constraints imposed by the COVID-19 pandemic. The decision to utilise concurrent data collection methods was grounded in established research methodologies (Creswell & Plano Clark, 2017; Guest, MacQueen, & Namey, 2012; Hesse-Biber, 2010; Hesse-Biber & Johnson, 2015).

3.5 Data Collection Methods

Within the overall mixed study methodology framework, there are various data collection methods that researchers typically employ. In this study, a survey conducted at the beginning of the research was designed to collect participant demographic information, and to get an overview of the formative assessment and technology use climate in the classrooms and at the school. I also used a validated survey instrument to assess technology use based on the technology acceptance model (TAM). In addition, I selected semi-structured interviews and observation.

Along with the use of interviews and survey tools, this study included observations. Observation is justified as a method to collect data because the method helps the education researcher become immersed in the school environment and observe how technology-aided formative assessment and feedback transpire in the same surroundings and among the teachers and students themselves. To look for interrelations in this research context, I analysed each interview and set of fieldnotes to find which barriers prevented further adoption of technology-aided formative assessment and feedback, or which technologies were being used well, were found to be helpful, and why the particular technology was selected. Furthermore, the pragmatic ontology and epistemology allowed me to lend concreteness to the classroom technology affordances. I wanted to understand the full potential of the technologies that were being applied or used, and why lack of use was occurring. From the pragmatic perspective, the affordances are more concretely part of the learning reality, and recommendations could be made about how to use more of the technology’s potential. These data were gathered using participant observation, and extensive field interviews which I focused on the behaviours, practices, and beliefs emerging from within the classroom.

Before starting the data collection, I contacted the school administration requesting permission to conduct the study on their premises and provided all the requirements. I filled out two forms: the vetting checklist and the screening form (see Appendix 7-32: Case School Study Approval and Appendix 7.33: Candidate Vetting Checklist). Accordingly, the school's compliance manager permitted me to conduct the study. The requirements included personal details such as disclosure and barring service check (DPS), national insurance number (NINO) and references. Afterwards, I exchanged some emails to discuss arrangements such as schools' privacy and safeguarding requirement. We agreed on the school assigning a coordinator to aid and facilitate my study, such as orientation sessions and sending emails to the school population.

In the next section, the data collection methods utilised (survey, observation, and semi-structured interviews), the research design employed, and the research phases are discussed.

3.5.1 Survey

In the current study, the survey aimed to gain a background understanding of the case and its context, and to map the prospective areas for more detailed inquiry. From a pragmatic perspective, I focused on both quantitative and qualitative use of surveys to determine the diversity of the topic along with determining frequencies, means, and parameters. In other words, the analysis primarily aims to calculate the number of participants who exhibit the similar or variable characteristics, yet the survey can confirm the significant variation of relevant dimensions and values in a population (Boyatzis, 1998; Fink, 2003; Jansen, 2010). Moreover, Maxwell (2010) advised that research would favourably benefit from the use of quantitative data “when it is used as a complement to an overall process orientation to the research” (p. 480). Quantising in research has led to “allow analysts to discern and to show regularities or peculiarities in qualitative data they might not otherwise see or be able simply to communicate, or to determine that a pattern or idiosyncrasy they thought was there is not” (Sandelowski et al., 2009, p. 210). In this case, the quantitative data aided to reveal some variation in the participants’ responses, as described in Chapter 4. Findings (section 4.2.5).

3.5.2 Semi-structured Interviews

Semi-structured interviews were used as the method for eliciting participants' thoughts and experience. The interview questions covered several topics, such as the role of technology in aiding formative assessment and feedback, different use, perception towards it (affordances, usefulness, ease of use, constraints), and challenges and concerns (see Appendix 7.5). Interviews provide critical information on lived experience and its meaning, as well as generating situated understandings based on distinct interactional experiences (Denzin, 2008; Denzin & Lincoln, 2008, 2011), making them a valuable source of data (Yin, 2009b). As a result, interviews were crucial in eliciting teachers' and students' viewpoints for this study, as the goal was to obtain access to each participant's distinct voice and meaning. The uniqueness of each participating teacher's experience (Huberman & Miles, 2002; Miles et al., 2018), as well as the progression of their understanding and ideas (Ezzy, 2013; Hyde, 2000; Trochim, 2006) concerning formative assessment and feedback processes were studied and captured through semi-structured interviews.

Unlike structured interviews which are an impassive record of participants’ thoughts and opinions (Schober & Conrad, 2008), semi-structured interviews enable greater input by “leaving space for participants to offer new meaning to the study focus” (Galletta, 2013, p. 24), while at the same time allowing the researcher to focus on the main topics. Wahyuni (2012) stated “The main feature of an interview is to facilitate the interviewees to share their perspectives, stories and experience regarding a particular social phenomenon being observed by the interviewer” (p. 73). Thus, qualitative research relies heavily on respondents’ stories of events and views which are educed through semi-structured interviews (Smith, 1995).

Therefore, interviews were used in eliciting information from research participants at every stage of the project. For example, interviews were completed during the pilot study stage with two teachers and two students to assess the general effectiveness of the interview questions and the survey questions. The survey and the interview questions were then adjusted based on the pilot study results before they were implemented in the full study. Semi-structured interviews were carried out with 33 participants, 18 students out of 42, and 15 teachers out of 38 teachers in the International Baccalaureate Academy. Some research participants were interviewed more than once to follow up and to build more detail about their technology-aided formative assessment and feedback practices. More details will be found in section 3.5.4.

3.5.3 Observation

Observation of technology use was a method employed to better understand the school's environment and ethos, and participants’ behaviour. The observation method in research allows the semi-structured interviews and survey data to be validated (Jamshed, 2014). In this study, the observation enabled additional triangulation of the data gathered by survey and individual interviews, boosting their validity, as Lewis et al. (2003) and Ritchie (2003) reported. Creswell et al. (2011) view integration as the connection between data collecting and analysis methods. In mixed methods research, integration might occur by linking, constructing, merging, or embedding (Fetters et al., 2013). In this study, integration happened through merging, as I reviewed the quantitative and qualitative data concurrently to compare and analyse. I integrated the data by merging them in the final stage. I used the observation to compare the survey and interviews and to aid the interview analysis. I planned to collect both datasets in the design phase to easily combine the quantitative and qualitative databases, as Castro et al. (2010) recommended. I merged the observation data after conducting the quantitative and preliminary interview analysis.

By creating reliable records or even analysing participants' behaviours as they occur, the observation approach provides a more comprehensive understanding of participants' behaviour and interactions in real, living circumstances (Ritchie, 2003; Ritchie et al., 2013). This contextual and holistic approach was established using the observation method in conjunction with a survey and individual semi-structured interviews, which aided a comparison of teachers' and students’ perspectives and experiences with technology use in formative assessment practice.

Within the scope of my thesis, non-participant observation was employed using a structured observation approach. As the researcher, I conducted careful and unbiased observations, documenting specific behaviours or events of interest without interfering (Bernard, 2011). To record the observed behaviours, a pre-determined coding scheme or checklist was utilized (Babbie, 2016). The structured observation tool proved advantageous for capturing quantitative data, making it well-suited for research settings where the target behaviours or events are already known (Vogt, 2011). This systematic approach ensured that the behaviours of interest were systematically observed and recorded while guaranteeing consistency and impartiality in the data recording process.

The method of non-participant observation was chosen for this study to avoid any potential influence on teachers' existing practices with technology and their processes of formative assessment (Denzin & Lincoln, 2011; Liu & Maitlis, 2010). The objective was to directly observe and understand teachers' natural formative assessment processes when utilizing technology in the classroom (Liu & Maitlis, 2010). It is important to note that no treatment or intervention was provided to the teachers regarding using technology or formative assessment. As a researcher, I positioned myself at the back of the classroom and employed audio recording, a notebook for field notes (see APPENDIX 7-14 & APPENDIX 7-15), as well as an observation checklist and Guide Sheet (Appendix 7-13) during the observation process. I observed the interactions of students and teachers with technology, watched how students interacted with tablets or mobile phones, and utilised educational applications, while also noting carefully how teachers used interactive whiteboards, and determining whether technology was or was not used in the teaching process and formative assessment.

3.5.4 Sampling Procedures

The research was conducted at an International Baccalaureate (IB) school where students expressed a keen interest in studying Arabic as a means to enhance their religious and cultural knowledge. The case school featured a diverse student population, with individuals from various ethnic and linguistic backgrounds, including British, Arab, Malawi, and Somali. Although most students were English speakers, not all were fully bilingual in English and Arabic. Approximately 60% of the students were bilingual. At the same time, the other parents chose the school to align with their Islamic values and ensure their children could read and comprehend the Holy Quran, which is written in Arabic. While the direct correlation between the students' ethnic and linguistic backgrounds and the specific focus of this study may not be irrelevant, this contextual information provides valuable insights into the case study school. It contributes to a more comprehensive understanding of the distinct perspectives held by its students.

I employed convenience sampling of school and participants, which numerous scholars recommend for its ease of data collecting (Cohen et al., 2011; Etikan, 2016). According to Patton (2002, 2005, 2014), convenience sampling is advantageous for detecting problems, establishing alternative solutions, and collecting more non-inferential statistical data. Based on Mills et al.’s (2013) recommendation and considering the exploratory nature of the study, I selected the case school that best lends itself to identifying the targeted phenomena's conditions and qualities. Considering my role as a professional in the education sector with a long experience in schools as a teacher, deputy head, headteacher and school governor, I was familiar with the case school, its curriculum, technological environment (see section 1.4), and challenges. The school was also known for welcoming researchers.

Before data collection, I conducted an orientation session to the teachers’ and students’ population separately. At the end of the teachers’ session, 21 teachers had volunteered for the interviews and provided their emails for further arrangement; however, due to COVID and lockdown situations I only had an opportunity to interview 16 teachers, and one decided to withdraw after the interview. Regarding the survey participants, it was agreed that the school administration would send the survey to the school’s teachers’ and students’ population from MYP and IBDP. I was allowed to interview students in school but without taking any personal information from them. Therefore, I arranged the interviews on-spot depending on students volunteering and being committed to the time, date, and place agreed upon. Each student was assigned a unique research number that the school administration shared and, thus, their names or other details were undisclosed. For any further communication or withdrawal, the student could approach the research coordinator assigned by the school or me. I interviewed 18 students, all of whom were extremely cooperative and enthusiastic. All participants were told about the research, its goal, and methodology, as well as being advised they were not compelled in any way to be involved and that their identity would remain confidential. During orientation events held at the school, each person volunteered to participate in the research.

Frey (2018) argued that although convenience sampling contains methodological flaws, there are steps to overcome these flaws. To overcome these flaws, I followed the steps Frey recommended, which are: 1) explaining the demographic and other features of the sample in detail and, if feasible, 2) comparing them to those of the relevant population so that readers of the study may assess its representativeness; 3) making attempts to recruit all intended participants to avoid response bias or selection bias and to ensure that self-selecting does not exacerbate unrepresentativeness; and 4) guaranteeing that the recruited individuals are theoretically relevant to the study so that selection is not dependent on convenience alone.

The survey sample size was 36 individuals (25 students and 11 teachers). The interviews sample size was 33 (18 students and 15 teachers). Participant demographics are 38 teachers and 42 students, as shown in **Table**

3.2*-Table *3.5. According to their survey responses, the majority of teachers taught just one subject; however, two of the teachers taught two or more subjects. It is worth noting that the 18 students who participated in the interview were also included in the survey sample. Therefore, the same 18 students provided data for the study's interview and survey components.

Table 3.2

Demographic Information of Teachers

Teacher Population	Grade	Subjects	Survey Sample	Interviews Sample	Classroom observation
38	MYP/ IB1/ IB2	11	11	15	15

Twenty-five of 42 students who were taking a range of subjects in the current school semester were administered a survey. See Tables 3.2 and 3.3 for student demographic breakdown.

Table 3.3

Demographic Information of Students

Students Population	Age	Grade	Interviews Sample	Survey Sample
15	16	Year 11/ MYP	6	11
20	17	Year 12/ IB1	8	8
7	18	Year 13/ IB2	4	6
Overall 42			18	25

Table 3.4

Information on Participants (Survey)

School	Variable	Frequency
N=42	Students	25 (59.5%)
N=36	Teachers	11 (30.6%)

Table 3.5

Information on Participants (Interviews)

Population	Variable	Frequency
N=42	Students	18 (42.9%)
N=36	Teachers	15 (41.7%)

3.5.5 Pilot Study

Due to the exploratory nature of this study and the need to gain a comprehensive, in-depth understanding of the role of technology in formative assessment, a pilot study was conducted. The pilot study aimed to ensure the reliability and consistency of the instruments (survey question items, interviews questions, observation notes), identify potential areas of concern that might hinder the successful use of the data collection design (Bassey, 1999; Malmqvist et al., 2019); and improve the study's credibility (Padgett, 2008) through modifying the design and instruments. Moreover, it helped me as a researcher to focus on narrowing the study's topic and obtain a better understanding of the study and observation focuses, as Arghode (2012), Denzin and Lincoln (2013), and Williams and Morrow (2009) recommended. The pilot study and survey results aided in focusing and designing the fieldnotes sheet and therefore in writing the classroom observation vignette (see Appendix 7-15).

The use of consistent and well-tested questionnaires promotes confidence in the reliability of data produced by studies conducting an in-depth investigation and knowledge gathering, rather than taking a more general perspective (Bassey, 1999). The survey questions were distributed for the pilot study before starting the main study and then an interview pilot was conducted. Two teachers and four students from the school participated in the pilot survey. The feedback received addressed improvement in the questionnaire's construction and interview questions, such as rectifying the lack of clarity of terms, improving the logical sequence of questions, and correcting typographical errors or missing words, such as adding more devices or applications to the used devices questions or repetition of some words, as seen in Figures 3.2 and 3.3 below.

Figure 3.2

Survey Feedback Sample 1

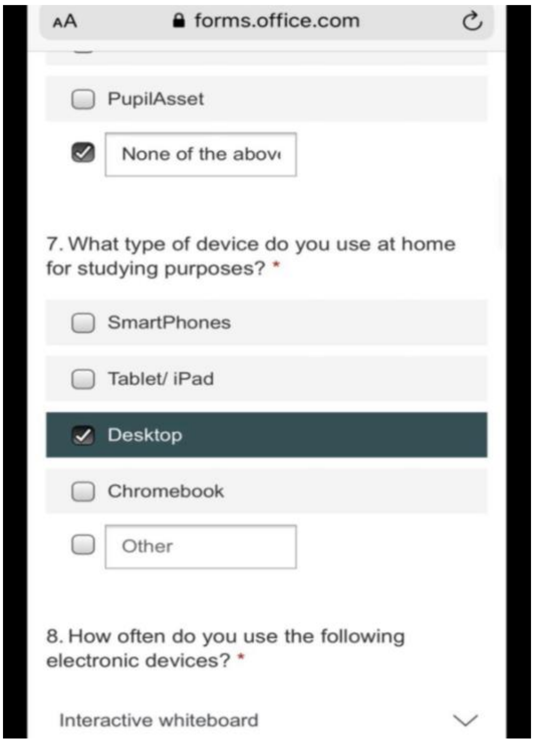
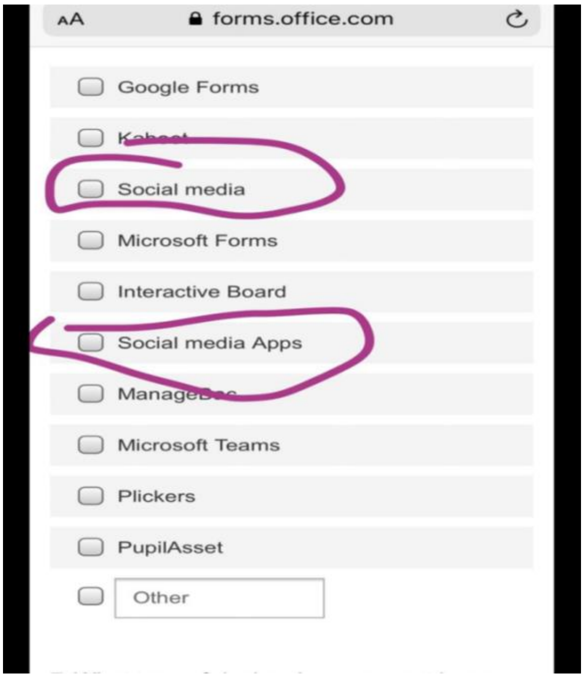


Figure 3.3

Survey Feedback Sample 2



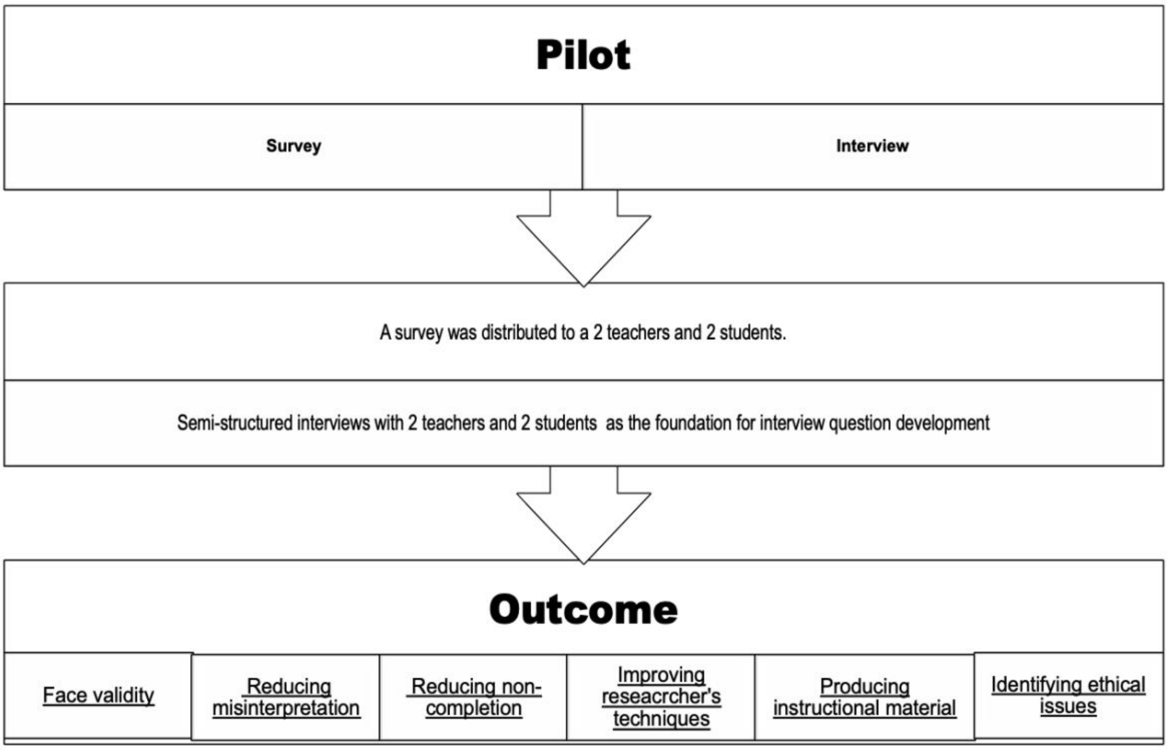
Pilot study feedback from school professionals identified several areas needing improvements in the survey's structure, including ambiguity of phrases and the questionnaire's structure. The pilot study involved sending the survey to a colleague who is specialised in educational technology (PhD). It is worth noting that the survey question items were also developed under the supervision of my supervisors to ascertain if items accurately represented the acceptance of technology-aided formative assessment and feedback constructs, while also determining if the number of items adequately covered each feature. Additionally, the pilot study was useful in detecting any bias resulting from an imbalance in the number of items addressing each attribute, content validity (Brod et al., 2009; Vakili & Jahangiri, 2018). Conversely, internal validity requires that the question items accurately reflect the research questions (Cohen et al., 2013), which was confirmed by the specialised participants involved in the pilot study and my supervisors.

The administration of the pilot study provided face validity of the instrument, reducing possible misinterpretation or non-completion by the participants, as Fink (2010), Galletta (2013), and Hamed and Lumpur (2016) recommended. The key element in primary data generation from interview questions in qualitative research is the researcher, because data are collected directly rather than depending on information gathered from previously done research (Lincoln, 1995; Merriam & Tisdell, 2015; Savin-Baden & Major, 2012). As a result, interview piloting is an essential part of the research since it highlights the variability in the main study. Malmqvist et al. (2019) reported that researchers would be better informed, prepared, and confident in the data collection instruments by conducting a pilot study in qualitative research. Two different teachers and two different students than those in the pilot survey participated in the semi-structured interviews pilot; they were asked for their feedback.

The participants' feedback indicated that some questions were redundant or led to the same result, that some others were ambiguous, and that more questions on the research themes needed to be asked. For example, in the pilot interviews, I learned that I am asking similar question in form, such as: “What other ways can technologies be used in the classroom?”, “What other ways can technologies be used to help you with your homework?”, and “How else could technologies be used to improve your learning?”. Or unclear questions, such as “In what ways do you use the feedback in your own learning processes?”. For more details see Appendix 7-4: Pilot Interviews Example. The pilot study of the interviews also aided in demonstrating the efficacy of my techniques for obtaining valuable responses. The interviews helped in producing instructional material for the participants to include in the information sheet, such as the amount of time each interview required or the type of expected questions, for example, “Will anyone know I am participating?” (see Appendix 7-5: Example for Interview Questions).

Figure 3.4

Pilot Study Flow Diagram of Process Leading to Outcomes



3.5.6 *Quantitative Methodology*

A survey was administered to participants who were conveniently selected from the case school population. I randomly distributed the survey to teachers and students through the Microsoft Forms (n.d.) link. I asked the school's coordinator's office to send the link to all schoolteachers and students related to the targeted years (MYP and IBDP) through their official school emails in February 2020. However, participation was contingent on the availability and willingness of the targeted demographic. Teacher participants took 13 minutes average to complete the survey while students took 20 minutes. The survey contained a confidentiality statement outlining the study's purpose, the researcher's obligation towards the obtained data, and the participant's right to withdraw the supplied data at any time. It also included definitions and explanations of some terms in the questions, such as formative assessment and feedback levels, for more clarity and precision and to avoid confusion, especially with student participants.

The survey was designed to provide preliminary data to support the investigation and answer the research questions:

1- How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?

2- How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?

3- How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?

One of the survey purposes was to obtain a general overview of the potential study population and how they use technologies and formative assessment practices as a part of their teaching or learning. This method follows Pring's (2000a, 2000b) suggestions that the preliminary survey is a standard method even in case study-based research and that it is used in order to get a scoping overview of a particular research context and the population which will participate in the study. From the pragmatic perspective, the survey served as a departure for more investigation, rather than being an end to any research practice or any specific research question. The survey was not used as a sole resource to answer a specific research question but rather as an aid to investigate and support answering the research questions. No conclusions were drawn from a single method in answering the research questions, as would happen in a realist or positivist approach.

As mentioned above, I used one of the models most widely used to understand technology acceptance, known as the technology acceptance model (TAM), which assists researchers to understand and explain user behaviour. This model was developed in information systems science and was adopted by researchers in fields of education, where technology use has become a prominent aspect of teaching and learning in many countries. A key dimension of the technology acceptance model is the idea that the fundamental determinants of people’s use of computers depends on how they perceive the ease of use and the usefulness of the technology devices (Davis, 1989). Using a validated survey instrument meant to assess the levels of technology acceptance in the population would help operationalise the students' and teachers' perceptions of technologies. Therefore, according to the TAM theory, the use of technologies in the classroom for formative assessment purposes may depend on the ease of use for teachers. It is also necessary to consider how useful teachers perceive the ease of use to be in teachers’ practice and students’ use, since their prior knowledge and experience using technological tools will affect their perceptions and acceptance.

Technology acceptance has mostly been studied quantitatively (Davis, 1989b; Davis et al., 1989; Segars & Grover, 1993; Venkatesh & Bala, 2008). The most notable contribution of these quantitative research efforts is that perceived ease of use, and the perceived usefulness are reliable predictors of technology acceptance. However, the use of TAM in this research goes beyond exploring predictors of use and usefulness, as in quantitative TAM studies. This is because the purpose of the research is to investigate the interconnection between teachers and students, and their use of technology from a pragmatist mixed methods perspective, and how to recognise unanticipated practices and differences (Beaudry & Pinsonneault, 2005). As Beaudry and Pinsonneault (2005) reported, users' perceptions of the anticipated technology benefits and concerns influence their selection and adaptation mechanisms. Therefore, in this research I used TAM to explore teachers' and students' perceptions of technology-aided formative assessment that might determine the technology affordances and constraints.

*3.5.6.1 Survey instrument.*To collect data from among a targeted research sample of students and teachers at the International Baccalaureate Academy in London, UK, teachers', and students' survey versions were conducted in early 2020. I used an online survey created in Microsoft Forms (n.d.) to collect primary data. I chose this method because it is less time-consuming than other methods, as Blank (2008) reported, and would be more convenient for the participants because it would allow them to complete the survey at their own convenience and pace.

The survey was divided, in addition to the background information section, into three sections corresponding to each research question: access and use of technology, assessment and feedback utilisation, and technology acceptance (see Appendix 7.2-7.3). The first section lists the technological devices that both the students and the teachers owned, or actually used in their learning or teaching and specifies what, how and in what context technological devices were used to support formative assessment. This section relates to the participants' use of technologies, and assists with answering the first research question: "How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way? ". It gathers the responses of participants to the use of technology, highlighting those who have not incorporated all the available technologies in the formative assessment. It is worth noting that there were two versions of the survey: one for the teachers and one for the students. The second section of the survey related to the participants' responses to the implemented technologies: kind of technologies providing feedback, feedback providers, and frequencies of receiving feedback with technology. It assists with answering the second research question: "How does technology provide formative assessment and feedback?".

The third section groups two categories of analysis linked to the technology keenness and acceptance in which adoption of technology depends on the perception teachers may have about whether technology motivates or distracts students from the learning process. It relates to the third research question: "How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?". In the final section, the research has captured the perceptions of both teachers and students on the impact of technology-aided formative assessment on teaching and learning practices. A pre-existing survey (Teo, 2019) was used to collect data, since this instrument has been extensively validated, and I adapted survey questions to the context of my study (Hendrickson & Collins, 1996; Karahanna & Straub, 1999; Szajna, 1996; Teo, 2011; Venkatesh et al., 2003b). Furthermore, I took an explorative approach by setting up and sharing the survey with potential participants as a method of creating reliability and validity, while also serving as a precautionary means of identifying any potential threats that might affect the quality of the survey (Hyman et al., 2006).

The TAM survey had 19 questions in six sections: 1) Perceived usefulness (PU), 2) Perceived ease of use (PEU), 3) Attitude to technology use (ATTU), 4) Perceived self-efficacy (TSE), 5) Behavioural intention to use (BI) and 6) Perceived technological facilitated condition (TFC). Each section has three question items except PU, which has four (see Appendix 7-2: Teachers' Survey and Appendix 7-3: Students' Survey). In the introductory part, I outlined the purpose of my study, entitled *Exploring the Role of Technology in Formative Assessment,* and explained the aim of the survey (see Appendix 7.1).

3.5.6.2 TAM Measurement Scale. All questions asked in this study were derived from relevant existing literature. The scale's wording was adapted to reflect the role of technology in the formative assessment context. These scales were chosen based on their proven psychometric properties in measuring attitudes and opinions about technology use as applied in numerous studies in the current body of research. I also tested the reliability of the scale using Cronbach's alpha (see 4.2.5.1). The constructs are measured using a five-point Likert scale (Likert, 1974), as shown in Table 3.6. which provides the questions and an overview of the scales employed in the questionnaire. In educational and social sciences research, the Likert scale is one of the essential and widely utilised psychometric instruments. I used a five-point Likert-type scale to enhance response rate and quality while decreasing participants' stress levels (Armstrong, 1987; Likert, 1974; Nemoto & Beglar, 2014; Verma, 2004). The number 1 response choice indicates strong disagreement, and the number 5 indicates total agreement. Thus, selecting 5 will display a highly positive acceptance toward technology-aided formative assessment and feedback, whereas selecting 1 will demonstrate a highly negative attitude of acceptance. With a five-point scale, it is easy for the participant to recite the entire list of scale descriptors ("1 equals strongly disagree, 2 equals disagree...") (Dawes, 2008). A list of possible schemes offered on our five-point scale ranges between strongly disagree and strongly agree.

Table 3.6

TAM Question Items

Section/ Construct	**Items/Questions (Strongly Agree =5 – Strongly Disagree =1)**
PU Perceived usefulness	Using technology will improve my learning.
	Using technology will help my learning to be more effective.
	I have a wider task option when I use technology.
	I find technology to be useful in my studies.
PEU Perceived ease of use.	I find it easy to get technology to do what I want it to do.
	Using technology does not require a lot of mental effort.
	I find technology easy to use.
ATTU Attitude to technology use	The technology makes learning more interesting.
	Learning with technology is fun.
	I look forward to those aspects of my learning that require me to use technologies.
TSE Perceived self-efficacy	I can complete a task using technology if I could call someone for help when I get stuck.

Section/ Construct	Items/Questions (Strongly Agree =5 – Strongly Disagree =1)
	I could complete a task using technology if I ONLY had a book to guide me.
	I can complete a task using technology if someone demonstrates how to use it first.
BI Behavioural intention to use	I will use the technology in future.
	I plan to use the technology often.
	Whenever possible, I intend to use computers for learning.
TFC Technological facilitated condition	Learning to use the computer takes up too much of my time.
	Using the computer involves too much time.
	It takes too long to learn how to use the computer.

3.5.7 Survey Procedure

The observation phase focused mostly on research questions one and two: "How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way? " and "How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?". Observation helped me to discern the structures, discourses, and perceptions that shaped the behaviours of the teachers and students in the UK International Baccalaureate Academy context. It allowed me to see, interact with, and obtain a comprehensive understanding of the natural environment of the participants. I collected data on the uses, utilisations and experiences of teachers and students, and how the technology-aided FA was impacting their teaching and learning practices. The focus was on how the students and teachers used formative assessment and the related technologies. I used descriptive fieldnotes as I recorded everything in my personal notebook and fieldnote guide sheet. When taking field notes, a researcher must pay attention to space, location, people, interactions, and what is not said. The researcher writes down the findings to gather context knowledge, identify trends, and remember what happened throughout each observational period (Tenzek, 2018). I designed a field note sheet based on the research aims and objectives to record my experience and observation of participants that took place in the school environment. I also used a notebook to record and draw the classroom and students' seating positions. In addition, I recorded audio notes to reflect on my experience. The field notes guide sheet covered the following main aspects (see Appendix 7.13):

- Organisation of students in the classroom.
- Conditions offered for the adoption of technologies.
- Technological devices used by teachers and students in the classroom.
- Technologies (devices, platforms, apps, web apps) used for interaction and engagement purposes.
- Formative assessments strategies and feedback levels (self, task, process, self-regulation) utilisation by technology.
- Overall school technological environment.

Semi-structured interviews of about 60 minutes duration with open-ended questions were utilised to obtain in-depth information that would not have been achievable with a questionnaire format. This technique enabled questions to be asked to elicit more extensive information and reveal participants' viewpoints

(Cohen et al., 2011). The interviews were designed to address all research questions regarding teachers' and students' perceptions and technological experience and use in relation to formative assessment and feedback. Appendix 7-5 lists the specific questions that I asked the teachers.

Interviews were conducted in the least formal settings possible to ensure the interviewees were comfortable talking and sharing their insights. For example, I conducted the interviews based on the participants' preferences, such as in classrooms, form rooms, laboratories and libraries while not occupied. As a result, I established an environment in which they could place their trust in me as a researcher, allowing me to interact and have a comprehensive understanding of participants' views. I used an audio recorder to record all interviews, which was supplemented by taking written notes for all interviews unless the participants did not agree to have their interviews audio recorded. In addition, I transcribed the interviews to conduct the text analysis.

An important question when dealing with oral interviews is how to determine what is being said is true. Human memory is malleable and constrained, which constitutes some difficulty in reconstructing past events, as human perception, interpretation, and memories are affected by social discourse, and shaped by thought and discussion (Bodnar, 1989). Further, when people speak about their experiences, they may exaggerate, hinder, forget things, lie, or misunderstand and get confused (Sangster, 1994). These forms of participants' responses can alter results of interviews and affect the process itself. To mitigate this issue, I confirmed the data collected with the participants on different occasions by email or a follow-up meeting to validate the information and ensure the trustworthiness of the data (Birt et al., 2016). I also asked for explanation, elaboration, and clarification whenever needed.

INTERVIEW QUESTION DESIGN

Specific interview questions were designed to assess teachers' motivation for using technologies and formative assessment approaches (see Appendix 7-5). In the interpretivist framework, it is important for the key researcher to first capture authentically the lived experiences of people (Denzin & Lincoln, 2005) so interviews are focused and iteratively develop material for analysis of the important concepts (Smith & Elger, 2014). In an interpretivist interviewing framework it is important to probe details and implications, raising queries about anything puzzling or inconsistent. The researcher needs to notice subtleties and already have a basic knowledge about the particular empirical and actual workplace situations, which allows more productive questioning of the interviewees. As Smith and Elger (2014) explained, "naive, stand alone or passive interviewing would not do this" (p. 129). Other interview questions were designed for students to explore their impressions of the technologies and to gather feedback. I also asked questions to elicit information about the kinds of data teachers collect with the technological tools and how the teachers interpret the data they collect. Given that the interviews were designed as semi-structured interviews, there were some concepts that emerged from the empirical research and from what research participants related about their own perceptions and impressions.

The following Figure 3.5, Figure 3.6, and Figure 3.7 show the links between the different research methodologies and the sub-questions of the main research question:

Figure 3.5

Linking Methods to Research Question One

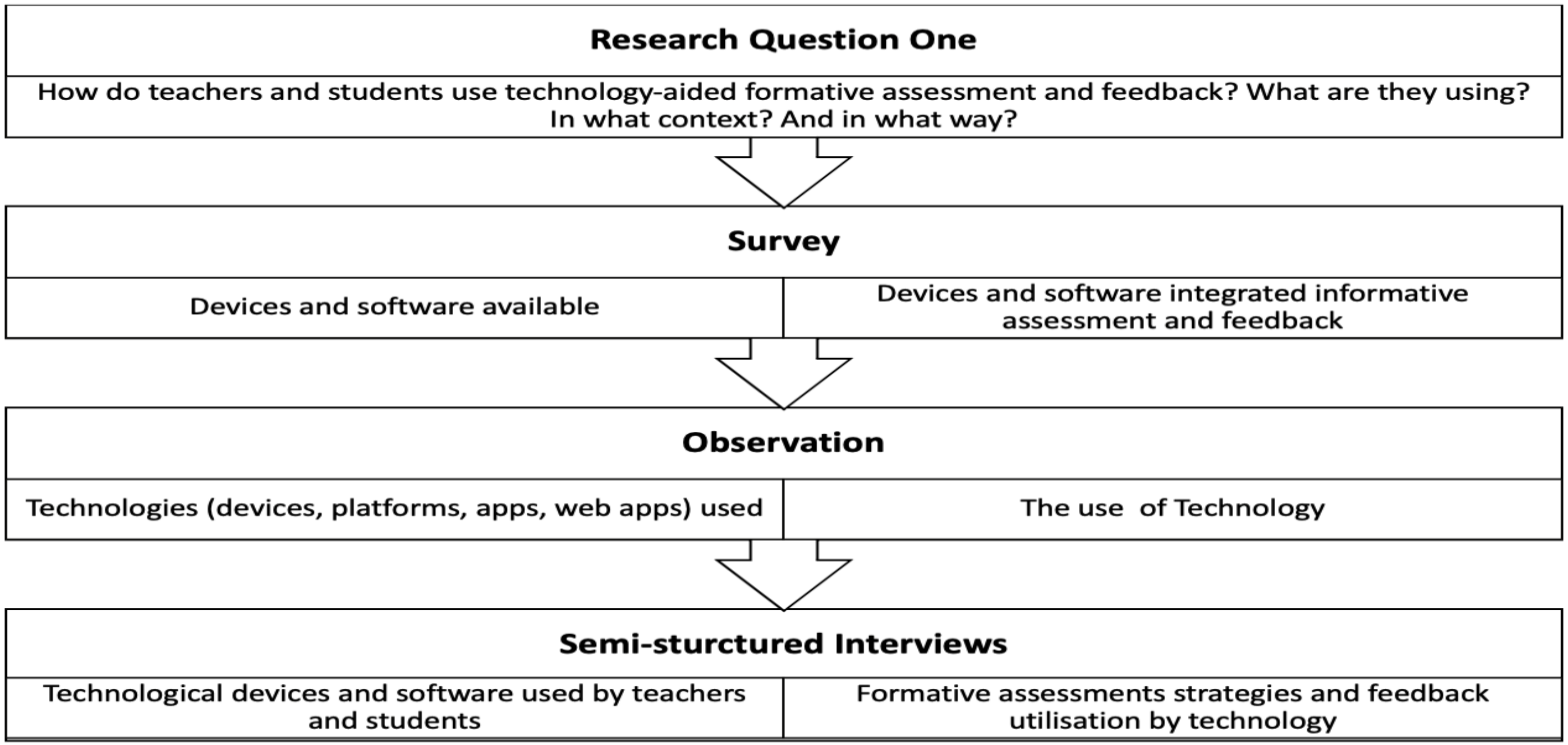


Figure 3.6

Linking Methods to Research Question Two

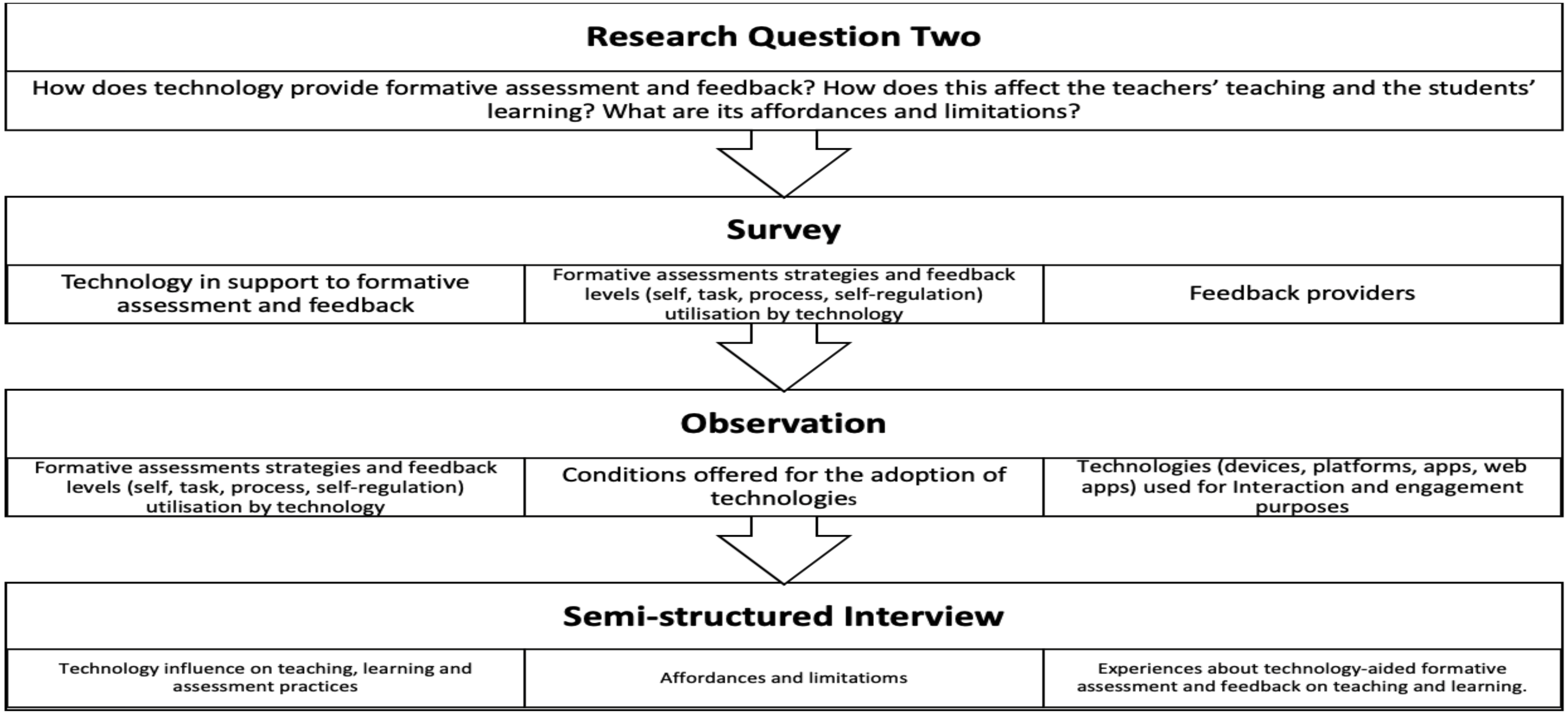
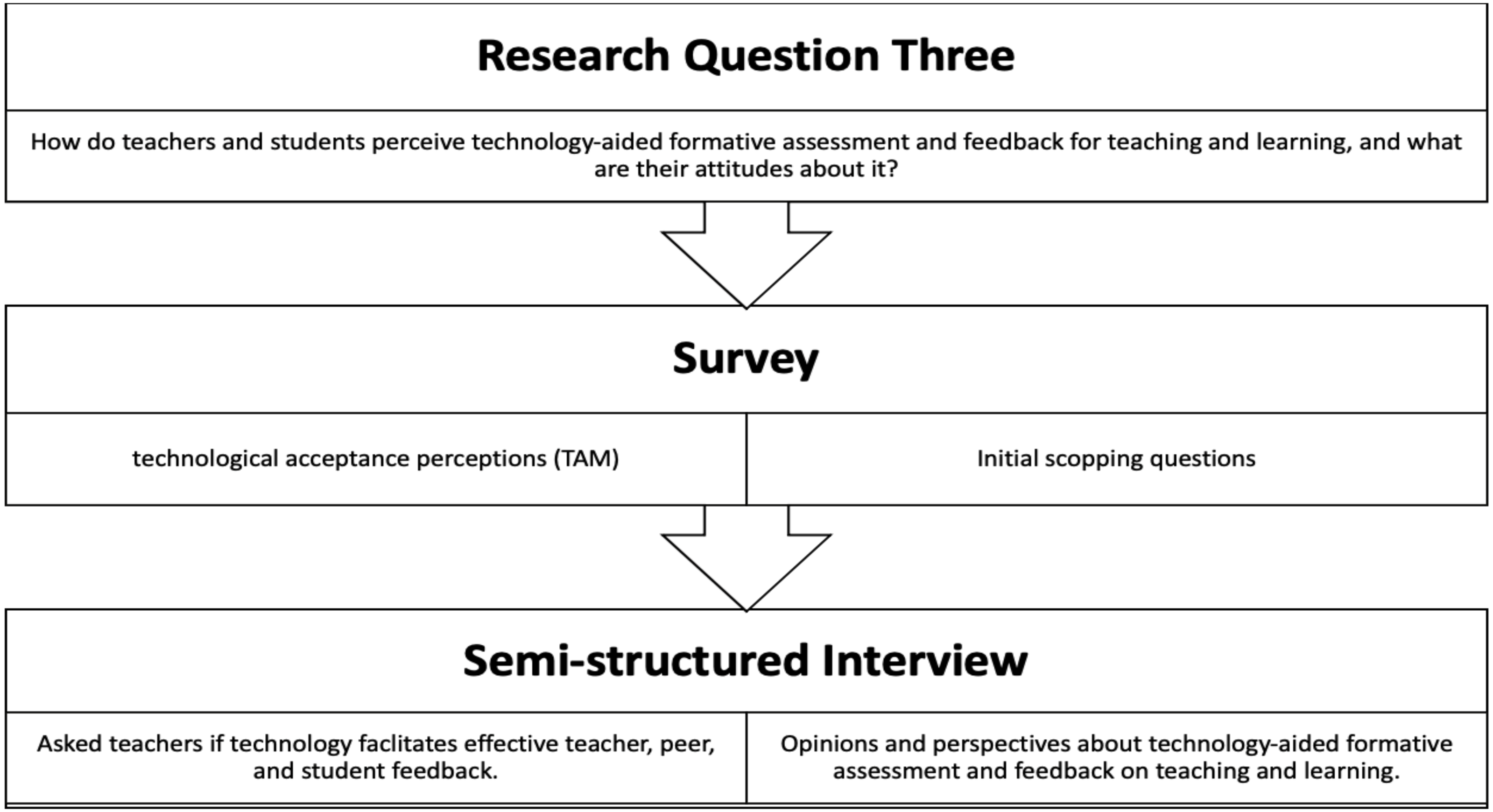


Figure 3.7

Linking Methods to Research Question Three



3.5.8 *Quantitative Data Analysis*

The current study utilised quantitative analysis for the survey. For quantitative analysis, I followed the three stages of data administration identified by Merriam and Tisdell (2015, p. 222), which are "data preparation, data identification, and data manipulation". This method of data analysis provides adequate support for the processes that were adopted for this study. In this study, data preparation entails entering the coded questionnaire responses into the most recent version of the Statistical Product and Service Solutions (SPSS) software programme, known as IBM SPSS Statistics 22 (SPSS Software, n.d.).

The SPSS platform was used to store and analyse the survey codes and data analysis (Babbie et al., 2022; Stehlik-Barry & Babinec, 2017). This section provides an account of the analytical techniques applied to the data collected from the survey procedures, with the aim of addressing the research questions. In particular, the data analysis is used to identify how teachers and students perceive technology-aided formative assessment for teaching and learning in a UK International Baccalaureate Academy context.

As I argued in the research method section above (see section 3.4), a mixed methods approach gives a more profound comprehension of research problems and complex phenomena than either strategy alone (Creswell & Clark, 2017). By triangulating one set of findings with another, one can get a deeper understanding and increase the validity of inferences. The survey data were analysed quantitatively using reliability coefficients and descriptive statistics to calculate the frequency, mean, and standard deviations of the data resulting from the study. Statistical analysis of the survey data was performed using SPSS 22 software that allowed me to investigate numerical data, as

Bryman and Cramer (2011) reported. The software provided fast and reliable statistical analysis for quantitative data in this current investigation, as Bird (2009) reported. The rationale for utilising descriptive statistics was to gain a descriptive statistical account of the technological environment of the case school and participants' perceptions and actual practices. Descriptive statistics may serve two purposes: providing essential information about variables and highlighting possible links between variables; they might be valuable (Creswell, 2002; Teo, 2014). This phase identified actual applications and perceptions that would influence the adoption of technology-aided formative assessment and feedback in a specific setting. Cronbach's alpha was used to determine the internal consistency reliability of the 19 TAM question items. In the study analysis, Cronbach's alpha rating of 0.736 for teachers and 0.732 for students indicated that the TAM survey had a satisfactory level of internal consistency reliability, which demonstrated that the questionnaire instrument measured what I wanted it to and was a suitable measure of the students' perceptions and practices. Although contestable, researchers in the sciences often state that acceptable reliability for each scale is regarded as alpha = 0.70 or above (Kennedy, 2022; Taber, 2018; Vaske et al., 2017).

I also conducted Mann-Whitney statistical tests to assess whether different demographic groups, i.e., the teachers and the students, had different attitudes toward the TAM constructs. Since the sample size was small, the non-parametric statistical technique best verifies whether significant differences existed between different demographic levels (Harwell, 1988). Non-parametric tests are tests that make no assumptions about the underlying population.

3.5.9 Qualitative Analysis

I followed the procedures and techniques for qualitative data analysis described by Miles and Huberman (2002) and Patton (2002), including preparing the data, coding the data, synthesising and making sense of what is learnt, and presenting the data. I first conducted a verbatim transcribing of the interviews and formed a comprehensive narrative for the field notes in the form of a vignette (see Appendix 7-15: Classroom Observation Vignette). I refined them by converting the cluttered, raw data into clear words, modifying, checking for accuracy, coding, and analysing. Coding is a type of indexing used to arrange the vast amounts of data generated by qualitative research (Locke et al., 2022). By utilising NVivo, I coded text with labels driven by the research questions to understand significant meanings and ideas (Bazeley, 2021). I started with basic descriptive coding and later progressed to more interpretative or pattern codes. As the analysis progressed, I worked on synthesising findings and making edits by creating memos and summaries. NVivo aided in retrieving documents, statements of concepts and certain phrases or terms along with combining the codes more quickly to build different themes (Creswell et al., 2007; Creswell & Clark, 2017). Table 3.7 presents an example of the coding process.

3.5.9.1 Data Thematic Analysis. After conducting the quantitative and qualitative analyses, I constructed an overall thematic impression of the data. I used the thematic analysis to identify meaningful patterns across a dataset (Braun et al., 2021). As proposed by Braun and Clarke, the thematic analysis consisted of six steps (2006). I thoroughly familiarised myself with the data by reading them multiple times and taking notes to document my initial thoughts. This allowed me to develop first codes by highlighting features of the interview responses and observation schedules that linked to the perceptions and experiences of the participants (Wiltshire & Ronkainen, 2021). Then, I conducted a search for themes by collecting all coded data associated with each probable theme. After reviewing the themes, I refined and renamed them before conducting an analysis of the resulting final themes. The last step comprised connecting the primary categories, evaluating the data, and crafting the story.

Table 3.7

Example of Coding Process (3 Teachers and 4 Students)

Transcript Examples	Participant	Descriptive Codes	Interpretive Codes	Overarching Themes
I feel like if it's online it's better and easy access. Sometimes I can lose my book, my book is not with me, or I forgot it somewhere. I can access the assessment anywhere from my phone from the laptop, desktop, tablet; I can access the assessment problems.	Student 12	Accessibility (usefulness)	Benefits	Technology is in every aspect of our lives.
The ability to peek in student work is an important part of formatively assessing students, figuring out where they are in making a decision about what they need to move forward.	Teacher 11			
I was able to achieve higher grades when I used the Kognity software online; it's interactive. I also find it is very entertaining it's a good way of learning that's also fun, and it's interactive so you can	Student 1	Better grades And Entertaining	Benefits	Extending classroom beyond school

do it with your friends, and you can do it whenever, especially with the teachers, it helps them to teach us. It helps us to be on track of all our work and I think just in general it has improved my grades.				
It has like video links which a student likes to interact with. There are exam questions as well. Students can have battles, like they compete and receive instant feedback. Ongoing feedback is very important because ongoing will have an impact on the outcome.	Teacher 1	Interactive and Competition		
For the scientific laboratories, I find it should be easier for us when needing answers, but unfortunately, it is still quite difficult to get an answer to a specific question or query we have from the Internet, and it is more helpful to ask a teacher being in a lab so that we may fully understand.	Student 3	Not for all subjects (Labs)	Concerns	One size does not fit all

It's always got new things coming on like in technology and apps, and when it's like everybody comes with his own policies.	Teacher 11	Overwhelm		
The biggest challenge was what happened to us when the school stopped paying for the Kognity Licence. So, I think the major problem was the cost of it because when they stopped paying, we went from being able to immediately get feedback for our work, to technically having nothing to work on.	Student 2	Cost	Concerns	Challenges
I think a lot of the time, sometimes technology can be a real distraction. And that is the problem with technology, especially with the existing technology where everything of their social media everything is integrated into. So, there is no clear distinction of educational use of technology and non-educational use of technology.	Teacher 13	Distraction		

3.6 Quality and Trustworthiness of Qualitative Data

Positivists often dispute the trustworthiness of qualitative data because they report that validity and reliability cannot be addressed adequately in qualitative research (Golafshani, 2003). However, several writers on research methodologies, notably Guba (1981) and Silverman (2015), have argued that the issue of validity, reliability, rigour, and quality in qualitative research can be addressed effectively by researchers adopting methodological strategies to ensure trustworthiness of their findings. For example, Silverman (2001) showed how qualitative researchers might incorporate validity and reliability criteria. Guba (1981) proposed four characteristics which qualitative researchers should examine for a reliable study that correlates to the positivist investigator's standards, namely credibility (instead of internal validity), transferability, dependability, and confirmability (in preference to objectivity). To explain how this study accords to each of these criteria for the trustworthiness of the findings, I divide the description into the following subsections: credibility, transferability, dependability and confirmability. I then discuss the reliability of the survey as well as the triangulation methodology used to combine the gathered data.

3.6.1 Credibility

Now, in terms of trustworthiness, qualitative research must have credibility as well as trustworthiness of its findings, as suggested in Patton (2015). To ensure the credibility of the analysis it is important to devote sufficient time to becoming familiar with the location and context, testing for misinformation, establishing trust, and getting to know the data (Lincoln & Guba, 1985; Sim & Sharp, 1989). Noble and Smith (2015) discussed techniques qualitative researchers might implement to assure the credibility of study results. Among these strategies, as I quote from Noble and Smith, p. 34-35, are:

1) “Accounting for personal biases which may have influenced findings.”
2) “Acknowledging biases in sampling and ongoing critical reflection of methods to ensure sufficient depth and relevance of data collection and analysis”.
3) “Meticulous record keeping, demonstrating a clear decision trail and ensuring interpretations of data are consistent and transparent”.
4) “Establishing a comparison case/seeking out similarities and differences across accounts to ensure different perspectives are represented.”
5) “Including rich and thick verbatim descriptions of participants’ accounts to support findings.”
6) “Demonstrating clarity in terms of thought processes during data analysis and subsequent interpretations.”
7) “Engaging with other researchers to reduce research bias”.
8) “Respondent validation: includes inviting participants to comment on the interview transcript and whether the final themes and concepts created adequately reflect the phenomena being investigated”.
9) “Data triangulation, whereby different methods and perspectives help produce a more comprehensive set of findings.”

To assure credibility, I conducted a prolonged engagement, persistent observation, triangulation, and member check, as Lincoln and Guba (1985) and Sim and Sharp (1989) recommended. Member check is a method for investigating the reliability of outcomes. After transcription, I provided teacher participants with outcome data to verify accuracy and congruence with their experiences. While with students, I conducted a member check after each interview. According to Lincoln and Guba, this is the most crucial method for gaining credibility. Prior to commencing the study, I conducted an orientation meeting with all school staff and students from MYP and IB academic years separately with the coordination with school management. It was managed in the school's assembly hall under the school management supervision. I introduced myself and presented a detailed overview of the study: definitions, topic, aims, objectives, research questions, methods, timeline, contacts, and ethical considerations (see Appendix 7-16). There was also time devoted to answering questions and socialising for prolonged engagement. Both teachers and students asked questions about the nature of data and who will know about it and if their names will be revealed. Both teachers and students were welcoming and cooperative. I also piloted the study where I tested the questionnaire and interview questions with two teachers and four students from the same school. The pre-data collection phase required almost two months; however, the results helped to ensure the reliability and the confirmability of the answers as well as the clarity of the questions asked in the survey.

Moreover, to ensure this principle, I also applied a triangulation procedure, based on the combination of three methods: the survey, the semi-structured interviews, and the observational data analysis. Then, I drew the research process grounded on the following four phases: 1) conducting the survey to obtain a general overview from the teachers, 2) conducting the survey to obtain a general overview from the students, 3) conducting a semi-structured interview with teachers and students, and 4) observation of the school's technological devices, digital tools, teaching aids and resources, and learning practices, along with teachers' and students' usage of technology inside and outside the classrooms. For persistent observation purposes, I investigated the observational data to identify the traits and aspects most pertinent to the role of technology-aided formative assessment and feedback, which helped me in designing a field note observation checklist (see Appendix 7-13).

Since the interviews were conducted in stages, they allowed me to cross check and verify the consistency of the answers provided in the surveys as well as their reliability, which improved the power of the qualitative inference. I conducted a member check (respondent validation) and received feedback from both teachers and students regarding their interview answers. Since the researcher and respondents approach the data from distinct perspectives, this approach improves the quality of the results (Lincoln & Guba, 1985; Sim & Sharp, 1989). On the other hand, the division in stages also respects the central idea of the interpretivist epistemological perspective of this study, highlighting how human-to-human interaction interplays with human-to-technology interaction (Bryman, 1984; James & Busher, 2009).

3.6.2 Transferability

Another principle about the trustworthiness and quality of the research that should be used to guide qualitative research is transferability, which is synonymous with generalisability and refers to the external validity of the results. According to this principle, there may be evidence that the research findings could be applicable to another context, situation, time, sample, or population being considered (Lincoln & Guba, 1985). Qualitative methodologies and interpretivist approaches often lack generalisability; however, it is not necessary or even possible for a researcher to prove generalisability. The qualitative researcher's responsibility is simply to provide a robust and detailed enough account of their methods and experiences in collecting the database that would allow other researchers to judge potential applications for transferability to other contexts. To ensure my research complied with transferability principles, I approached the investigation of interactions between the teacher and student participants with technology in a more general manner, respecting the teachers' and students' perspectives and listening to their expressions of thought about this process of human-technology interface. To provide a rich and full understanding of the research setting, I not only described the behaviour and experiences of the participants, but also provided a thick description (see Appendix 7-15) of the environment and made explicit connections to the social and cultural contexts that surrounded my data collection. This approach may assist others in evaluating the generalisability of the findings. Naturally, if other research applies the same methods and the same questions to another environment or different participants, the results could change. However, in keeping with the constructivist paradigm, the research is likely to be transferrable since the focus is on the qualitative use of the information rather than the statistical value of the mean or the variance of some parameter.

DEPENDABILITY AND CONFIRMABILITY

Dependability stresses the need for consistency of the findings as well as the ability of the research to document its evolution, allowing an audit trail. To ensure dependability, I made the research process as transparent as possible, as preconised by Hwang et al. (2009). From the beginning stage, when I explained the goals of the research to the participants, I documented each step of the research process, data collection and analysis as well as recording the interview questions and answers of the participants, and all data gathered from the survey, observation, and interviews.

Furthermore, for the purpose of establishing trustworthiness, it is important to consider confirmability, which concerns the degree of confidence that the findings are based on the narratives, experiences, and concepts of the informants rather than being influenced by researcher biases or distortions. The way I addressed this principle was using three different methods, including surveys, semi-structured interviews, and observational schooling data on the interaction of technology and formative assessment within the class environment.

Therefore, the process helped to attain research trustworthiness, since it allowed me to acknowledge biases and minimise any potential for my prejudice to affect the results through reflective commentary, while I was able to focus entirely on the answers provided in the questionnaires and the interviews. Although this analysis was dependent on my own sensitivity to the words and actions of the informants, since I was instrumental in interpreting the answers and observing the environment, the choice of those methods balanced this conduction, giving more weight to the words and the thoughts of the teachers and the students, as preconised by the interpretivist epistemological perspective.

3.6.3 Reflexivity

The final principle to be discussed is reflexivity, which is related to the role of the researcher, as highlighted by Lincoln and Guba (1986), Berger (2015), and Sim and Sharp (1998). Researchers contribute to qualitative research with inherent researcher biases, which must be acknowledged and addressed (Miles & Huberman, 1994). In acknowledging my own biases, I was consciously aware that my prior beliefs as an educator who worked in schools almost all of my adult life should neither embed a prejudice about the phenomenon nor influence the instruments of the analysis. However, I still benefited from my experience, mostly in designing the survey and interview questions. I realised that I should provide a fair analysis by respecting different experiences and gathering information through the maximum perspectives possible, while also actively preventing any biases I held from influencing any aspect of my research. To follow this principle, I kept a personal notebook to document my reflexive notes regarding the gathered data. Moreover, I recorded audio notes regarding the observation that would happen unexpectedly. I routinely reviewed and deliberated upon my notes and recordings while critically reflecting on my methods to ensure objectivity, accuracy, and sufficient depth and relevance of my data collection and analysis.

3.6.4 Quality of the Survey

Since one of the methods applied in this research was a survey, it is important to stress the internal consistency of this method and its reliability. I applied a Cronbach’s alpha method regarding the TAM items survey, where each answer was translated to a code and associated with a psychometric property. This method enabled me to classify the answers according to groups that were measured using a five-point Likert scale, and then analysed using SPSS statistics. I used Cronbach’s alpha method, a reliability coefficient, as a useful tool for quantifying the internal consistency of a set of items, which refers to how closely linked a group of statements are.

Before starting the main analysis, I examined the data sets for any errors and suspicious records in the survey. A series of preliminary procedures are taken to ensure the quality of data and follow appropriate practice (Feldt & Magazinius, 2010; Oppenheimer et al., 2009). Firstly, respondents failing to meet the completion time were removed from the data set. Secondly, all data sets were examined for evidence of straight lining, leading to all those indulging in the practice being discarded (Hair et al., 2014). Thirdly, incomplete questionnaires were also removed from the data set. Whilst being stringent evidently reduces the actual sample size used for analysis, such quality checks are applied for determining whether participants completed a survey attentively, which also increases the statistical power of the analysis (Oppenheimer et al., 2009). For example, I checked the time participants spent completing a survey to remove the ones who were overly fast to serve as a quality control measure.

Establishing the reliability and validity of the constructs is important in accounting for the measurement error. Measurement error is the difference between the true value of a variable and the value obtained by measurement (Hair et al., 2014). The researcher first discusses the approaches used to examine the reliability of the construct and establish the reliability of the measures. The researcher deems this necessary since reliability and validity are related in the sense that validity presumes reliability (Bryman & Bell, 2011). In other words, an unreliable measure can never be valid because systematic error cannot be distinguished from random error. Thus, reliability is a necessary condition for validity (Hair et al., 2014).

3.6.5 Triangulation

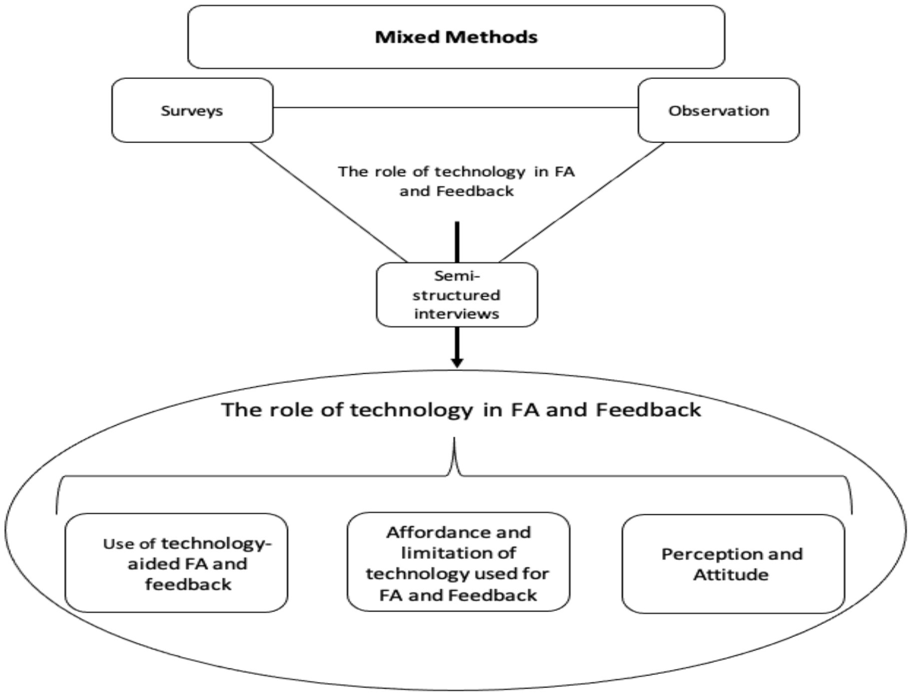
Triangulation was used to ensure data quality, enhanced validity and reliability, and ensured the consistency of the findings. This triangulation method allowed a comprehensive analysis, as preconised by Patton (1999), of the interplay between teachers, students, and technologies in the within-class environment, under different views and perspectives. Here, I applied the triangulation method since I combined the analysis through the conduction of three investigative methodologies: the survey, the semi-structural interview, and the observation. These multiple data sets were compared through triangulation to confirm the results, which increased the credibility and reliability of the research (Noble & Heale, 2019).

I used methodological triangulation to address the same research questions from multiple angles. I also combined qualitative and quantitative research methods within a single study, as Jick (1979) and Gobo (2016) considered merging methods the most prevalent sort of triangulation. I employed a survey, semi-structured interviews, and observation to understand how participants perceive and employ technology-assisted formative assessment and feedback in their teaching and learning. I administered a survey to collect preliminary information regarding the technology-assisted formative assessment and feedback setting, devices, practices, and acceptance of these technologies. I performed in-depth semi-structured interviews and observations to investigate the kind of affordances and constraints perceived of these technologies regarding formative assessment and feedback, as well as how they adapt to it. I overcame the disadvantages and study bias that rely on a single research strategy by utilising methodological triangulation. In addition, it enhanced my understanding of the phenomena under investigation.

Using data triangulation, I applied numerous data sources to address the research question. I varied my data collection throughout time (March 2020 to June 2020), space (classroom, form rooms, the school facilities), and individuals. To understand participants' perceptions and behaviours about technology-assisted formative assessment and feedback, I acquired and analysed data from a sample of 11 and 25 students and teachers in the survey, 15 teachers and 18 students in interviews, and 11 classroom observations. Figure 3.8 shows the triangulation of the survey, school and classroom observation and semi-structured interview methods with a magnification on the factor questions in relation to the role of technology and formative assessment.

Figure 3.8

Triangulation of Mixed Methods



3.7 Methodological Considerations (Ethics, Role of the Researcher)

This study took place in the social context of an educational institution and involved human subjects. Therefore, it was vital that all aspects of this study were conducted ethically, with absolute integrity, and followed best practice. The quest for knowledge is an important, justifiable, and legitimate activity, particularly where the results of research may offer benefits to society by enriching human knowledge while causing no risk or harm to those involved. As the responsible researcher in this endeavour, I adhered to legislation and regulations as well as moral and ethical standards, especially in relation to those directly involved in the study, according to the recommendations of Shamoo and Resnik (2009). My research was conducted in compliance with the guidelines of the British Educational Research Association (BERA) as set out in the *Ethical guidelines for educational research*, 4th edition (2018). Furthermore, I received ethical approval to carry out this research from the University of

Exeter, Faculty Research Ethics Committee, on two phases due to COVID lockdown: approval number D1920-034, (01/12/2019) and approval number D2021-116, (16/03/2021) (see Appendix 7-30).

First, from the beginning of the study, I regarded it as crucial to treat the respondents ethically and respectfully, to ensure they were fully informed of the purpose of the study, what the research entailed, that their participation in the study was voluntary, they could withdraw at any time, including after the study, and that their identities and information would be kept confidential (BERA, 2018). Consequently, their written consent for the participation was obtained and all records of the data from interviews and questionnaires remain anonymous (Hesse-Biber & Leavy, 2011).

Second, I avoided any possible conflicts of interest that would arise prior, during or after the study. I identified all social and personal interests that may impact how I conducted my research. I reviewed all institutional ties I had or have had in the past that could compromise my objectivity. I also disclosed on the information sheet to the school and participants all the institutions with which I was affiliated.

Third, I acknowledged that research misconduct, in particular, involving fabrication and manipulations of data, plagiarism and self-plagiarism, would be unacceptable and would not be tolerated (Blatt & Martin, 2013). In order to assure a high level of academic integrity, I used techniques such as member checks, audit trails, and NVivo software that keep the participants' words intact, and add to the trustworthiness and credibility of the findings. It is worth noting that the supervisors' oversight and frequent interactions aided me during the study as they monitored my methods and approaches.

Finally, a rather obvious ethical risk stemmed from my adopting such an observation approach, which involved me interacting so closely with the participants and being “inside” the case, where there was potential to blur the boundary between the researcher and the subjects of the study. My immersion in the study environment presented a challenge for me to maintain the balance between being the outsider and insider, observer and observed at the same time (Dwyer & Buckle, 2009). Therefore, to maintain a high degree of self-reflexivity I kept a notebook and audio records to document my thoughts and notes during each step. Furthermore, I sought guidance and support from other researchers and my supervisors whenever in doubt to ensure my objectivity, the ethical manner of my activities, and ultimately the reliability and validity of the research results (Creswell & Clark, 2017).

The research project followed closely BERA's (2018) ethical criteria, which places substantial responsibilities on participants, policymakers, general public, professionals, and the community of educational researchers. The first role is to avoid causing harm to research subjects (BERA, 2018). To ensure compliance with BERA standards, I made sure that the following activities and measures were implemented with regard to all participants: 1) official consent was obtained from participants to confirm their clear consent of their involvement in the research; 2) voluntary informed consent was sought from all participants (and their parents, if applicable; this was in case there would be underage student participants or students with special needs) to guarantee that the research was conducted ethically and that participants comprehend the goal and nature of the study as well as the secure storage and reporting of data; 3) all participants were explicitly informed of their right to withdraw from the research at any time (BERA, 2018). To protect the identity of the participants and ensure confidentiality, I stored the data in a password-secure digital format that only I could access. I will hold the data for five years beyond the study's conclusion, at which point I will permanently delete the data. I also gave pseudonyms to the participants to protect identity. Concerning the study's duties to the community of educational researchers, the study was done ethically, avoiding data distortions or misrepresentations, and avoiding the research being used for objectives other than those mentioned (BERA, 2018). Where necessary, the research was communicated to the public and other interested parties in plain, uncomplicated language (BERA, 2018).

In contrast to quantitative research, the researcher in qualitative study is the primary instrument for data collection, analysis, and interpretation (Blackman et al., 2002). As Lincoln and Guba (1985) argued, "naturalistic inquiry (qualitative study) in humans” is "the instrument of choice” (p. 236). To avoid any risk, I supplied the consent forms and information sheet (see Appendix 7-17 and Appendix 7-18:) describing all the risks and potential repercussions of participating in this research. Given the study's nature, there was low or no risk to the research subjects, teachers and students, as all students were over 16 years of age. Since notes and published data from this study employed aliases and pseudonyms, it is unlikely any individual or group could be identified. I conducted the interviews in private on the school grounds and ensured the questions were not sensitive, personal, or concerning confidential information.

There have been recommendations from research authorities for increased transparency and clarity of methods in qualitative research (Lune &

Berg, 2017). Therefore, I paid attention to the reporting of the methods to ensure those are neither oversimplified nor under described. To reach deep contextual understanding, I adopted the observation approach that implies that the researcher and the subject of the study are present in the same context (Alvesson, 2009). Observation roots of this method place emphasis on interpretation and development of the deep understanding of the case (Eriksson & Kovalainen, 2008).

3.8 Limitations/Potential Difficulties

All research faces an interchange between accuracy, simplicity, and generalisability when it comes to the choice of methods (Langley, 1999). By conducting a mixed methods study with a small sample size in the quantitative part, I recognised generalisability may be compromised in attempts to achieve higher accuracy. The purpose of this study was to develop an understanding of the role of technology in the case of a particular school, its teachers and its students. However, caution should be exercised in generalising the findings to other contexts or the broader population since each situation a researcher investigates will be unique in terms of time, place, and subjects. In effect, outside the experimental laboratory, no two studies can be truly replicated and, therefore, none can be expected to produce the same results (Collins, 1992). However, it would be interesting to compare the results of this study with another conducted at a different school, given that much can be learned by extending and refining applications of research abductively to expand on knowledge.

Critics of the qualitative methodology will point out there are some limitations too because it is seen as context-dependent knowledge rather than general and theoretical knowledge (Starman, 2013). Others feel there is a tendency that the qualitative methodology may confirm what the researcher already believes (Starman, 2013), which justifies the use of mixed methods to overcome the one method limitations. However, one of the main issues with the qualitative research relates to the number of cases. Yin (2003, 2009) stated that a single case has the ability, if it is unique and representative, to generate significant output as it allows the researcher to focus attention on a small group of subjects. A single case can be used to assess the theory-based propositions as well as to provide the ground for extending the theory and discussion of the implications that are likely to lead to similar outcomes in other cases, which can be done abductively.

I followed a convenience sampling technique, a widely established method for selecting participants in both quantitative and qualitative research. However, Mackey and Gass (2015) reported that convenience sampling is likely biased and advised researchers not to consider convenience sampling representative of the population. Therefore, I considered homogeneous convenience sampling a viable alternative to conventional or heterogeneous convenience sampling, as Jager et al. (2017a) recommended. I also tried to cover the homogeneous sampling with as much sample size as possible. In the study all the student participants share the same age, subjects, classrooms, technology access and financial status. Teacher participants also share the standard assessment and technology knowledge and skills, and Internet and technology access.

In terms of methodology, researchers must know that "what people say during an interview will be affected to some extent by the questions asked" (Hammersley & Gomm, 2008, p. 100). As a result, despite the efficacy of semi-structured interviews as a strategy for eliciting insights into participants' understandings, this research did not rely only on interviews for data gathering. Observation was used to supplement and confirm data from the interviews. Observation enabled the evaluation of exterior behaviours and interior perspectives, supplying significant data that will help to reinforce the research conclusions. Observations, on the other hand, might be time intensive. As a result, a highly structured observational approach was adopted, with a particular emphasis on using technology for formative assessment, to ensure the quick capture of genuine, significant data. Moreover, through establishing rigid outlines, researchers could reproduce the suggested study more readily (Cohen et al., 2011). I used a checklist to examine the existence, amount, and frequency of technology use in formative assessment, to minimise the approach's shortcomings.

3.9 Summary

The current study is an exploratory mixed-methods investigation that adopts a pragmatic philosophical position where the impacts of ideas and actions are essential components of meaning and reality. In this regard, pragmatism allows the concurrently using qualitative and quantitative inquiry techniques to provide evidence supporting best practices. In this sense, pragmatic exploration allows studying the role of technology-aided formative assessment and feedback to comprehend how teachers and students perceive and employ these tools. A survey, observation and semi-structured interviews were conducted and analysed quantitatively and qualitatively. Quality procedures were followed to ensure the research's reliability, credibility and transferability, along with methodological consideration.

Chapter 4. Findings

4.1 Introduction

As explained in Chapter 1. Introduction, this study explores the relationship between formative assessment (FA) and educational technologies implemented in a school environment. Educational technologies are often very complex because they involve several communities, including teachers, students, and school management, practices informed by pedagogies, and different technologies in the educational context (Scanlon et al., 2013), which are currently seeing rapid growth. This study aims to understand teachers' and students' perceptions and practices regarding the technologies and the formative assessment process in an International Baccalaureate school context. Specifically, it explores how teachers and students use formative assessment feedback in teaching and learning and how they adopt technologies to facilitate the generation of feedback and their perception of technology-aided assessments for learning.

This chapter is structured into three sections:

- Quantitative data analysis addressing research questions 1 and 3.
- Qualitative data analysis addressing the three research questions:

1- How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?

2- How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?

3- How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?

The chapter presents the identified themes related to each research question obtained and analysed from the survey, classroom observations and semi-structured interviews with teachers and students. At the end of this chapter, a summary of findings related to the research questions is presented. Moreover, the subjects in this thesis are presented into three subject groups: STEM, Humanities, and Languages. This is done because, based on the surveys and interviews, the teachers and students often use different technologies, and even when the same technologies are used, they are used to a different extent and their usefulness is also not the same for different subjects. Table 4.1

shows the distribution of the subject groups and the number of occurrences of each subject in the data collection. A comparison of the results of the survey, interviews, and observations allows for triangulation.

Table 4.1

Subject Groups Occurrence in Observation, Interview, and Survey

Subject Group	Subjects	Classroom Observation	Teacher Interview	Teachers' Survey	Students' Interview	Students' Survey
STEM	Chemistry	2	1	1	4	19
	Maths	2	1	1	7	25
	Biology	1	1	1	4	15
	Computer Science	1	1	1	3	2
Humanities	Humanities	1	1	0	2	4
	Geography	1	1	0	1	5

	History	1	1	0	2	5
	Arts	0	1	1	1	8
	Economics	0	1	1	2	5
	Physical Education (PE)	0	1	1	0	0
Languages	English	3	3	2	5	22
	French	0	0	1	1	2
	Arabic	0	0	1	1	24

1. The STEM subject group involves six different classroom observations: two chemistry, two maths, one biology and one computer science. Furthermore, five teachers (chemistry, biology, maths, computer Science) participated in the survey and interviews.
2. The humanities subject group comprises four different subjects and classroom observations: humanities, geography, and history. Five teachers participated in the interviews (humanities, business, arts, history, economics) and two in the survey (business and arts).
3. The languages group has three English language classroom observations, two interviews with teachers of the same subject, and five teachers participating in the survey (three English teachers and two Arabic).

Table 4.3 presents teacher participant numbers and occurrence in the three methods: survey, interviews, and observation. However, a similar table regarding the student participants could not be generated since collecting personal information about the students in the case school was not allowed. Table 4.2 shows the interviewed students' grades and the numbers I assigned to them.

Table 4.2

Interview Participants Table (Students)

Student Grade	Student Number
IB2 (Grade 12)	10, 2, 11, 3, 5
IB1 (Grade 11)	1, 6, 8, 9, 4
MYP (Grade 10)	15, 16, 14, 13, 12, 7

Table 4.3

Participants Table (Teachers)

Teachers	Subject	Survey	Interview	Observation
1	Chemistry	✓	✓	✓
2	Biology	✓	✓	✓
3	English HL	✓	✓	✓
4	English SL	✓	✓	✓
5	English SL	✓	✓	
6	Geography		✓	✓
7	History		✓	✓
8	Humanities		✓	✓
9	IT	✓	✓	✓
10	Economics		✓	✓
11	Business	✓	✓	✓

12	PE	✓	✓	
13	Art		✓	
14	Informal		✓	
15	Informal		✓	
16	Philosophy		✓	✓
17	Maths	✓	Informally	✓
18	Maths			✓

4.2 Quantitative Data Analysis (Survey)

The survey represents 11 teachers out of 38 (28.9%) and 25 students out of 42 students who are 16 years and older (59.5%). It should be noted that the survey, interview, and observation samples overlap. It should also be noted that the size of both samples is small, and a convenience sampling technique was applied. The survey results are divided into two parts. The first part (sections 4.2.1 - 4.2.4) is mainly related to the uses of technologies associated with Research Question Two. The second part (section 4.2.5) is related to the results of the technology acceptance model (TAM) survey with regard to the first research question.

This section presents the survey data analysis to demonstrate a range of technologies that teacher and student participants use in their assessment practices. Furthermore, this section explores the survey participants' acceptance towards the technology-aided formative assessment and feedback, along with the actual use and affordances of this technology. Finally, this section presents the survey's statistical results, including the descriptive statistics represented by the frequencies, mean, and standard deviation for each variable, along with offering an interpretation of the participants' responses. The following part touches on the first research question regarding how teachers and students use technology-aided formative assessment and feedback, what are they using, in what context and in what way.

4.2.1 Technological Devices and Software Used

Starting with the devices used at school, all participants (11 teachers and 25 students) reported using technology in their teaching, learning and assessment practices. Regarding the type of devices, most respondents indicated using more than one device, such as desktops, laptops, iPads, and smartphones (Figure 4.1

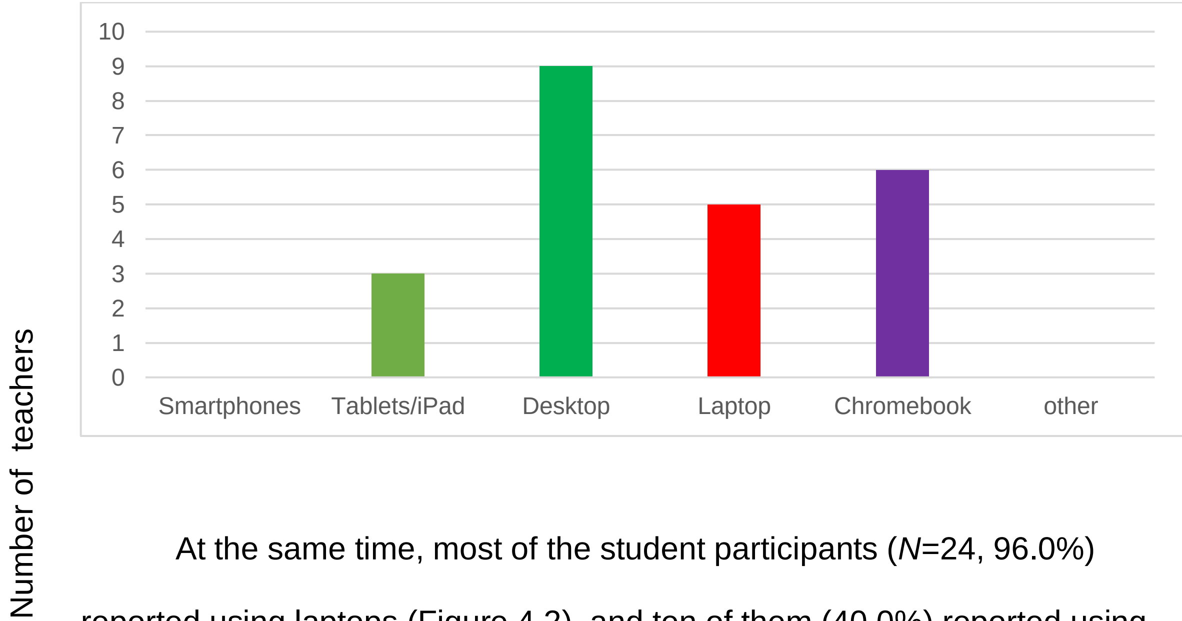
All teacher participants (*N*=11, 100%) reported using some type of computer: desktops, portables, or both. The use of desktop computers amongst teachers was high (*N*=9, 81.8%), as shown in the green bar in Figure 4.1. This result was expected since they are available in each classroom and teacher’s office. Chromebooks, as portable devices, are also used by some teachers (*N*=6, 55 %). Chromebooks are also provided by the school to all staff and students. In addition to the provided devices, many teachers (*N*=8, 72.7%) used their personally owned devices, such as iPad and laptops. In this study, tablets, laptops, smartphones, and Chromebooks are categorised as portable devices.

The data on used devices show the availability of a basic technological environment. The data also show that teachers tend to use provided devices such as laptops and desktops rather than personally owned ones such as smartphones. None of the teacher participants reported using smartphones

(*N*=0, 0%), and two only reported the use of personally owned tablets as additional to the desktops and laptops (*N*=2, 18.2%).

Figure 4.1

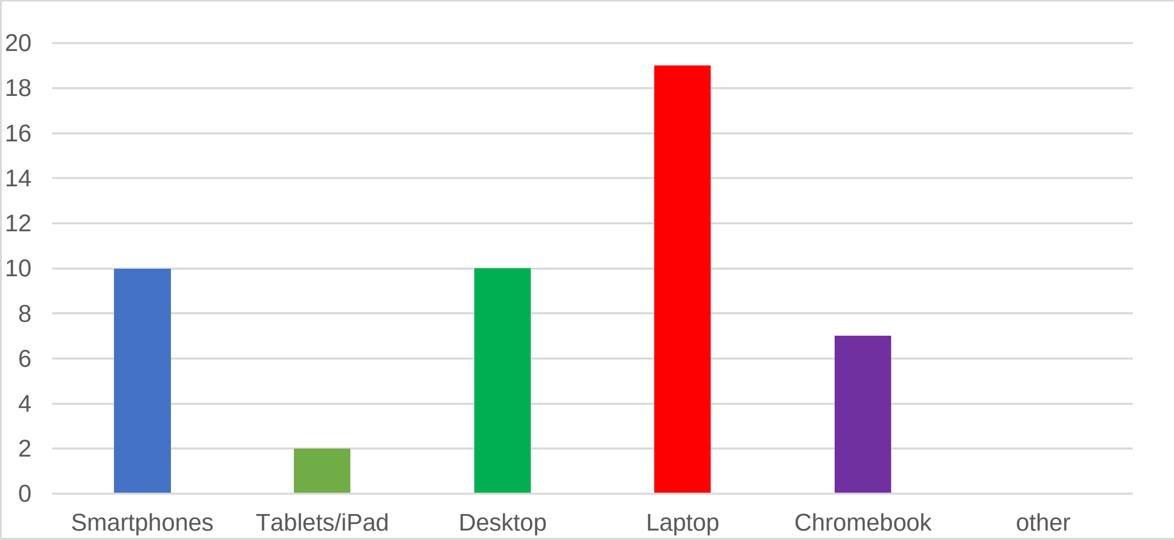
Devices Used by Teachers



At the same time, most of the student participants (*N*=24, 96.0%) reported using laptops (Figure 4.2), and ten of them (40.0%) reported using smartphones. While seven students (28.0%) reported using provided desktops, the data are indicative that student participants prefer to use portable devices over desktops. The reason behind teachers' and students' choices and the functionality used in these devices will be investigated later in the qualitative analysis (see section 4.3).

Figure 4.2

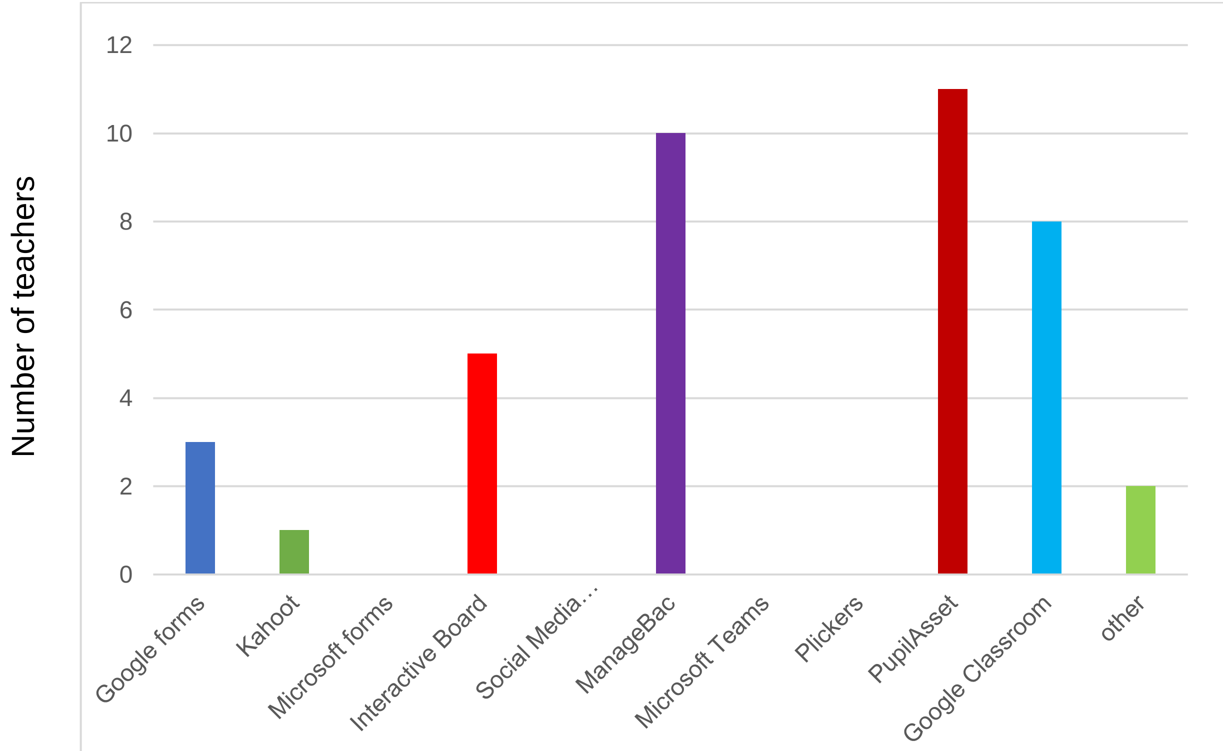
Devices Used by Students



Regarding the technology and software used for schoolwork, almost all teacher respondents reported using PupilAsset (*N*=11, 100.0%) and ManageBac (*N*=10, 90.9%) (see Figure 4.3). They are mandatory in the IB schools; ManageBac is used as a learning management system, and PupilAsset is a student's tracker. Google Classroom comes on top of the software that teachers use for teaching and learning (*N*=8, 72.7%). The Interactive White Boards (IWB) were mentioned by five teachers (*N*=5, 45.5%) as an information and communications technology (ICT) tool used.

Figure 4.3

Software Used by Teachers

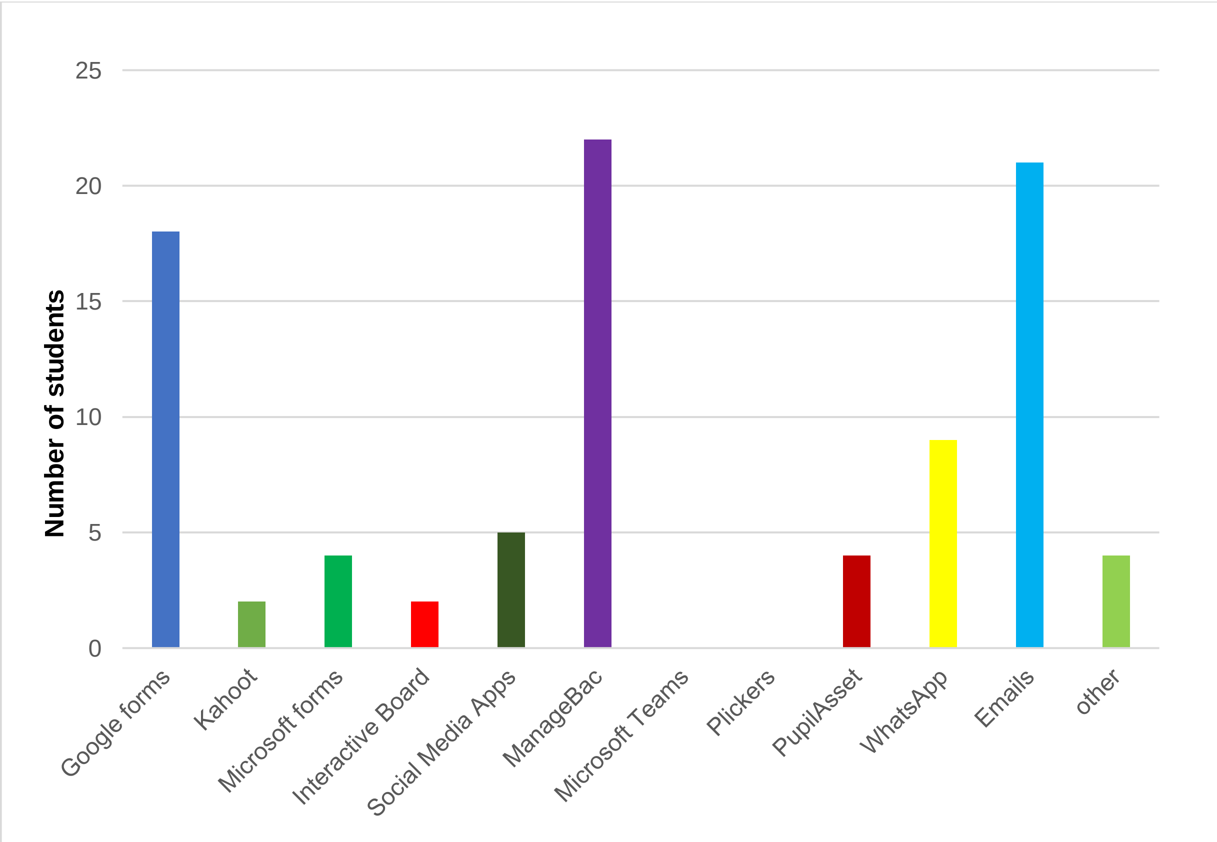


While most students reported using ManageBac (*N*=22, 88.0%), a mandatory platform used for assignments, test submissions, and grading and feedback in IB schools, Google Forms (*N*=18, 72.0%) and Emails (*N*=21, 84.0%) are other most used applications by the students. Notably, only 27.3% (*N*=3) of teacher participants reported using Google Forms. The students also reported using various informal applications for feedback, such as WhatsApp (*N*=9, 36.0%) and social media (*N*=5, 20.0%) (Figure 4.4).

Regarding learning and assessment software, only two programmes were named in the other apps: the chemistry teacher mentioned Kognity under “other”, and the maths teacher mentioned Kahoot (see Figure 4.3). At the same time, four student participants (16%) reported using Khan Academy and Quizlet with no mention of Kognity in the "other" bar (see Figure 4.4). These results can be compared with the interview results presented in the qualitative analysis section (section 4.3.1). This comparison would indicate that diverse software uses might be due to the discipline's nature, which is investigated in the Research Questions Two section (See 4.3.1).

Figure 4.4

Software Used by Students



4.2.2 Frequency of Technological Access and Usage

The frequency of technological access and usage also differed between the surveyed students and teachers. 64.0% of student participants (*N*=16) reported accessing the Internet from both school and home, as shown in Figure 4.5. Figure 4.6).

At the same time, 72.7% of teacher participants (*N*=8) reported accessing the Internet from both school and home (see Figure 4.6).

Figure 4.5

Students' Internet Access

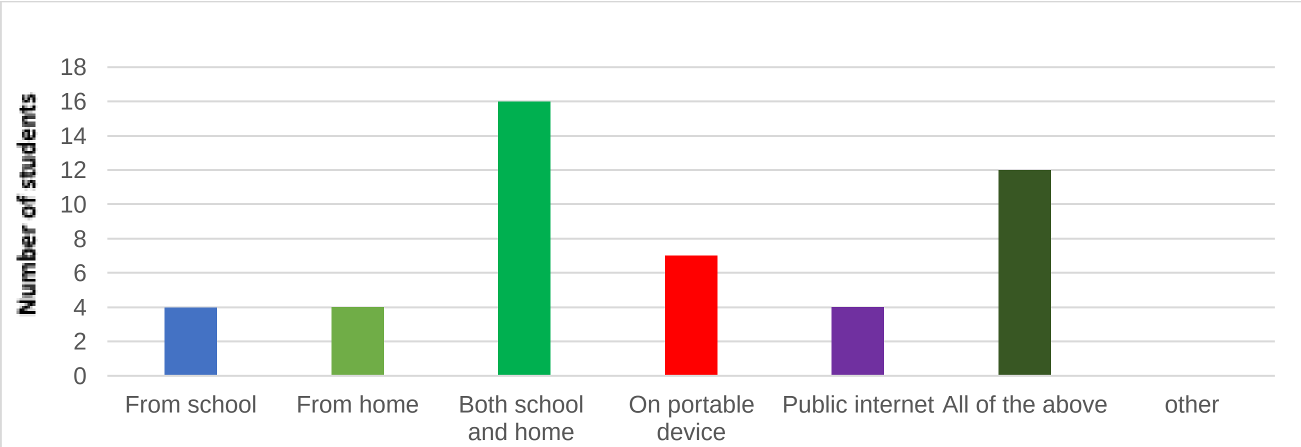
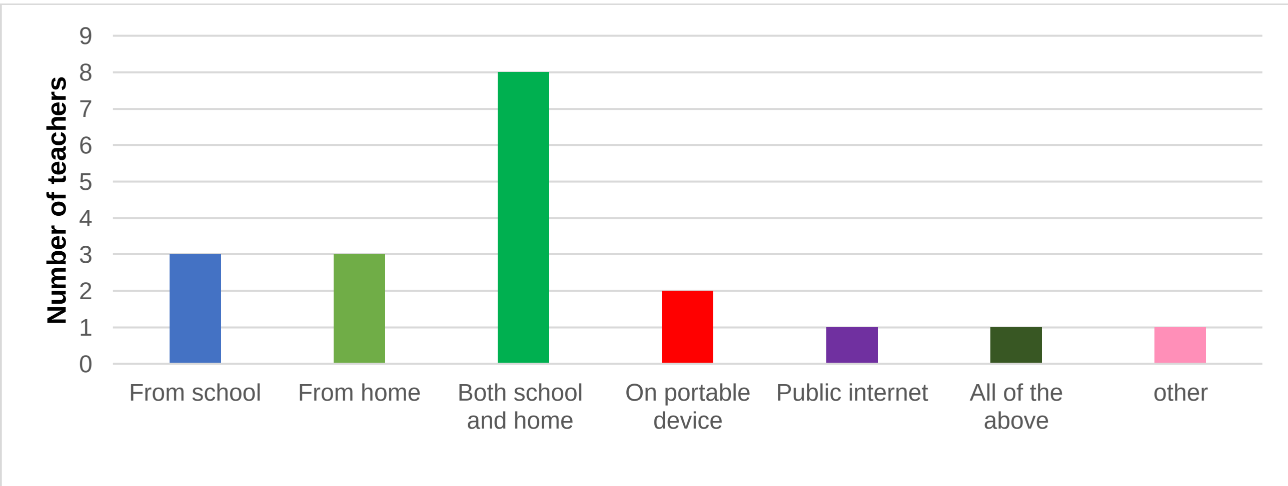


Figure 4.6

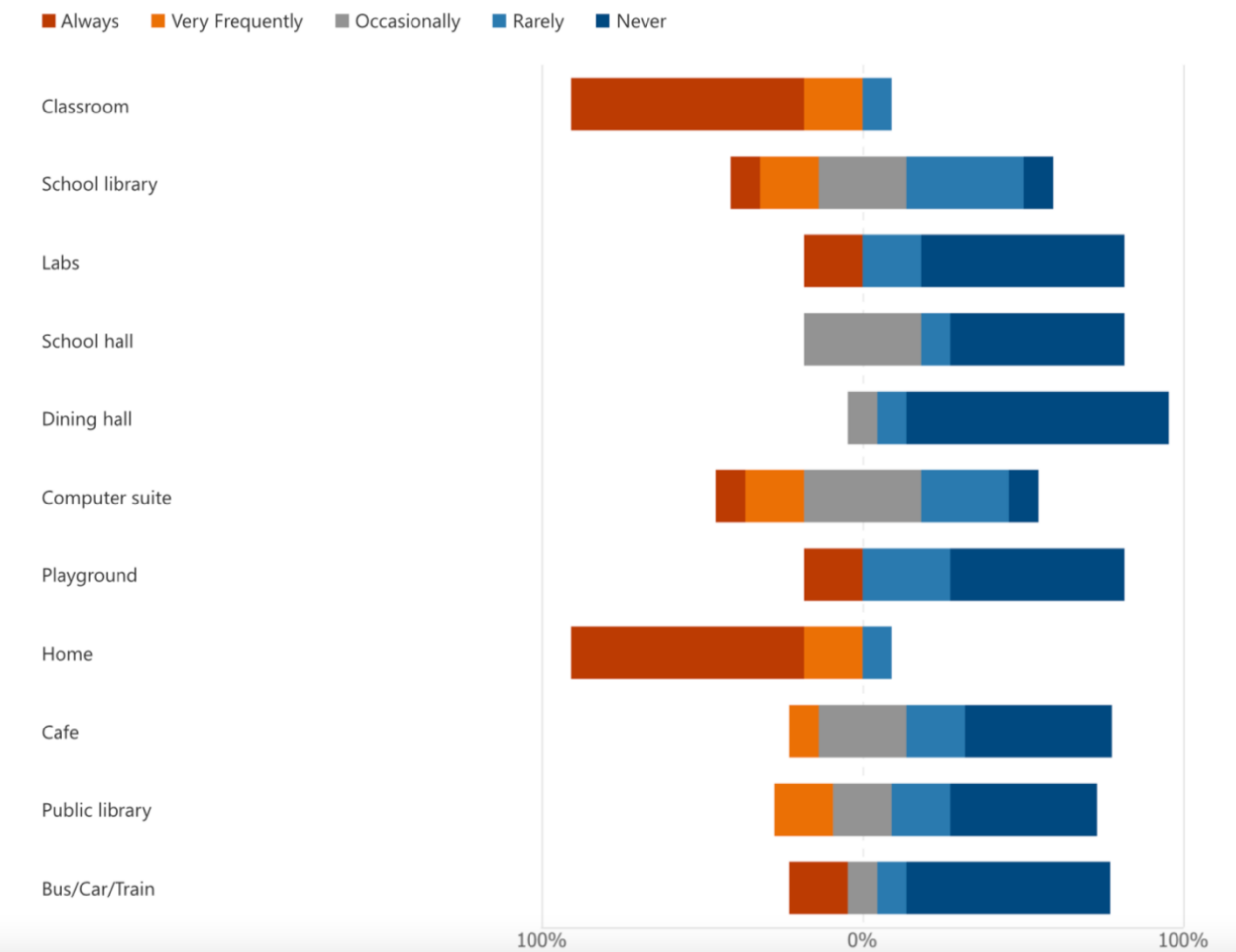
Teachers' Internet Access



Regarding the use of educational technologies in different locations, the survey results demonstrate that all teachers use educational technologies at home and in classrooms, although the English Language teacher does it 'rarely' unlike the rest of the teachers using them 'always' or 'very frequently'. The teachers reported not using the technology much while in public places or on transportation (Figure 4.7).

Figure 4.7

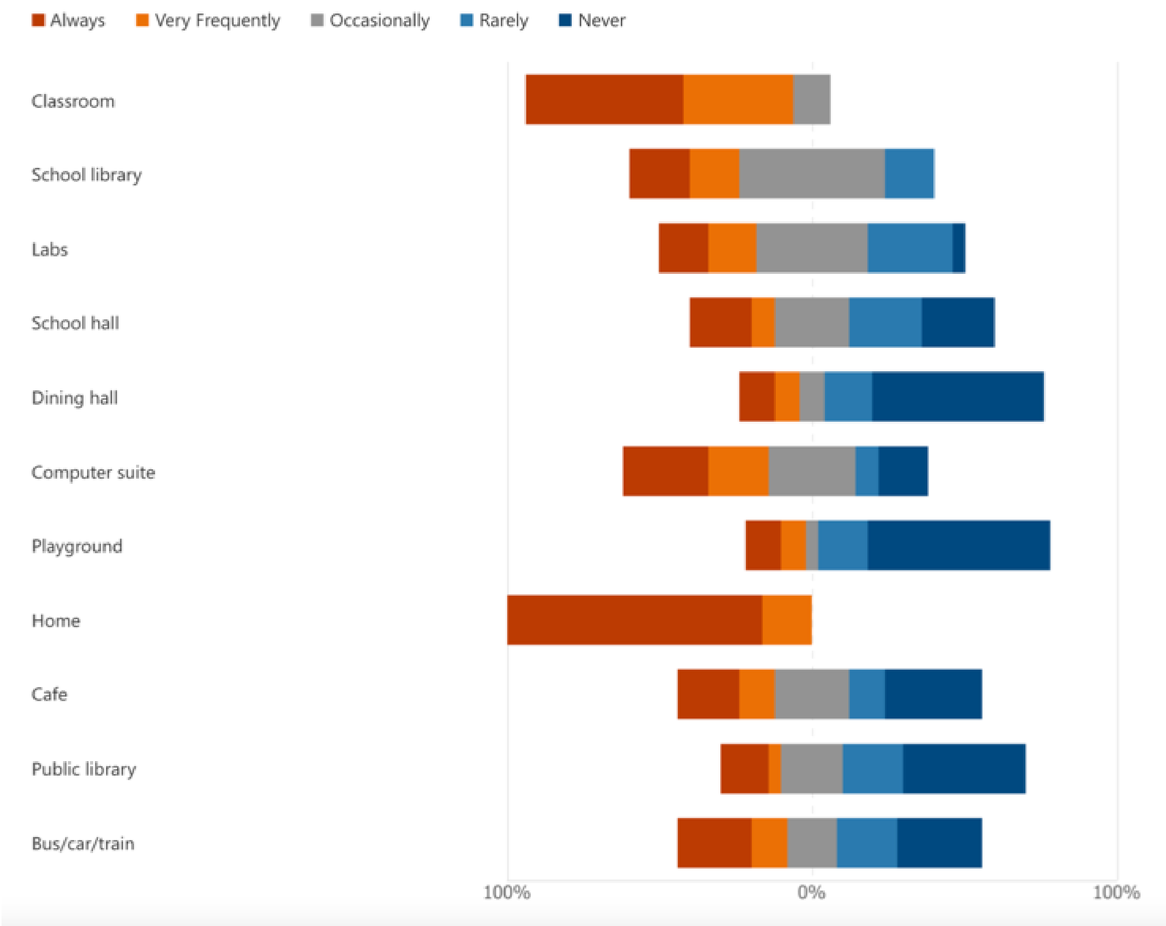
Frequency of Use of Technological Devices Inside and Outside School (Teachers)



The results also demonstrated that all students used technology for educational purposes in both school and home, as did their teachers, although three students used technologies in classrooms ‘occasionally’ while still using them at home. Some students seemed more flexible, as they reported using the technology in various places, such as computer suites (*N*=20, 80.0%), a school library (*N*=21, 84.0%), public libraries (*N*=10, 40.0%), cafes (*N*=14, 56.0%), and transportations (*N*=13, 52.0%) (Figure 4.8). Therefore, most surveyed students and teachers reported using technology for educational purposes in both school and home environments.

Figure 4.8

Frequency of Use of Technological Devices Inside and Outside School (Students)



The most regularly used electronic devices for educational purposes with formative assessment and feedback by teachers were IWB, desktop computers, and laptops (Figure 4.9). Whereas six out of 11 teachers indicated in the devices' selection section that they used Chromebooks, the usage chart showed that, in contradiction, they rarely used them. This finding is surprising because, as discussed earlier, more than half of the teachers (*N*=6) used

Chromebooks at some point, and these devices are provided by the school, meaning that they are intended to be used during the teaching process. Computer tablets, E-books, and digital cameras were the least used in the educational context. While laptops were the devices most used by all student participants (see Figure 4.10), the IWB comes next in line as used regularly, which appeared normal, as they were observed being used daily in classrooms. The least used devices by students were digital cameras and e-book readers.

Figure 4.9

Frequency of Electronic Devices Used (Teachers)

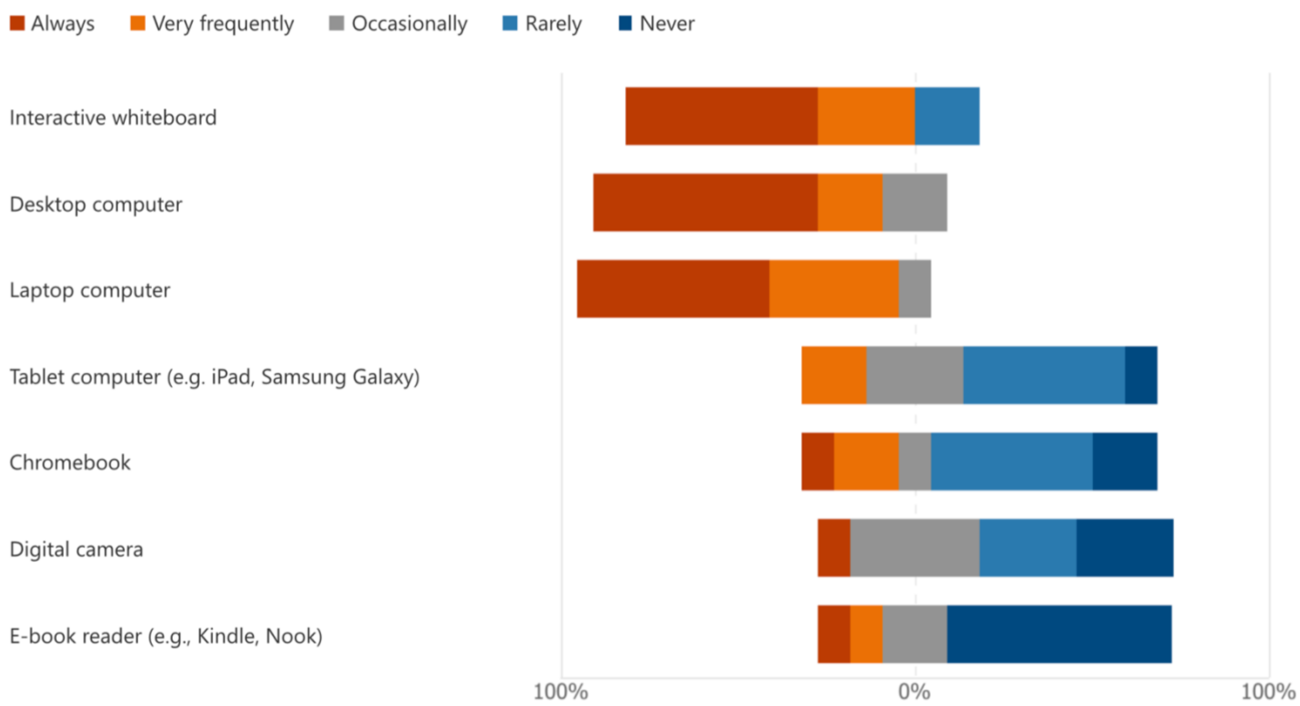
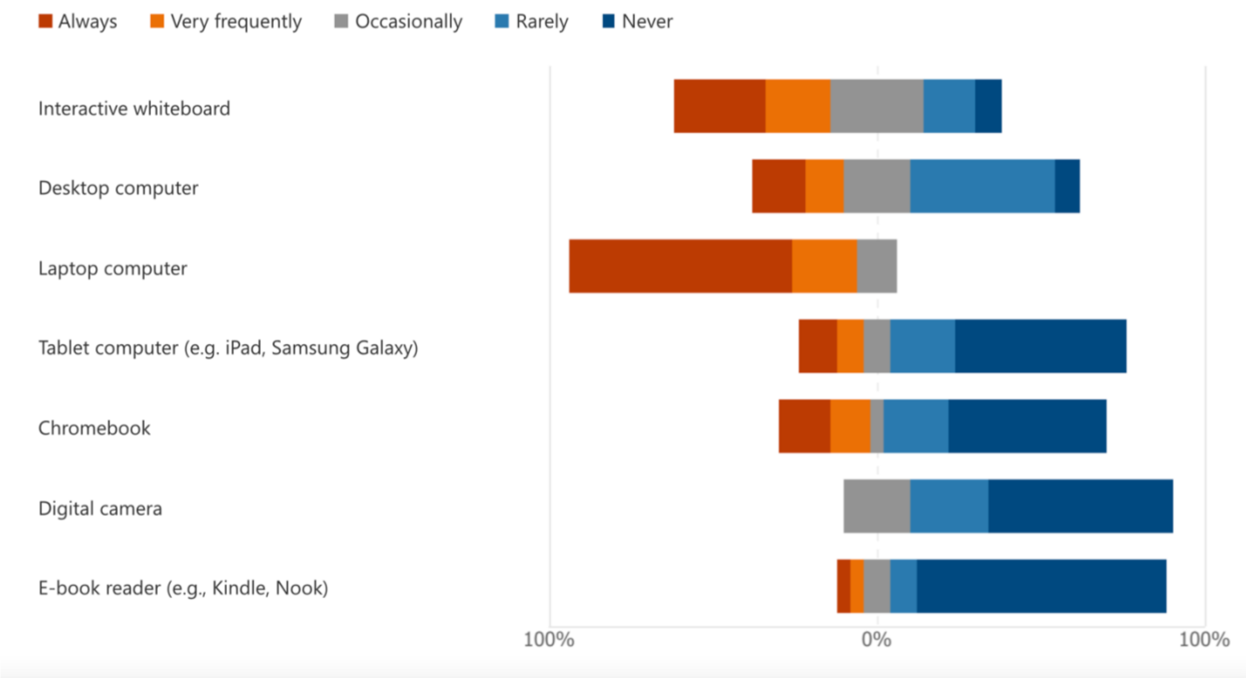


Figure 4.10

The Frequency of Electronic Devices Used (Students)



4.2.3 Feedback and Technology

The perspectives of the surveyed teachers and students differ concerning the used feedback technologies, feedback providers, and feedback levels. As shown in Figure 4.11, for providing feedback to students, teachers claimed to use four technological tools: ManageBac (*N*=8, 72.7%), Kognity (*N*=4, 36.4%), IWB (*N*=2, 18.2%), and Google applications (Google Forms, Google Classroom, and Google Docs; the last two were mentioned under the "Other" choice). Interestingly, although Kahoot (n.d.) offers formative assessment tools such as quizzes and class engagement evaluation, and is deemed to be feasible and practical to make learning fun and enjoyable (Tenau et al., 2019), and one maths teacher and two students stated using Kahoot for learning (see Figure 4.11, 4.13, section 4.2.1), it was not mentioned at all as a feedback provider tool. This indicates the need for more investigation into the benefits and affordance regarding the used software in assessment and feedback. In comparison, most student participants reported that they received feedback mainly through ManageBac, Google Forms and Microsoft Forms (Figure 4.11).

Figure 4.11

Technology for Feedback (Teachers)

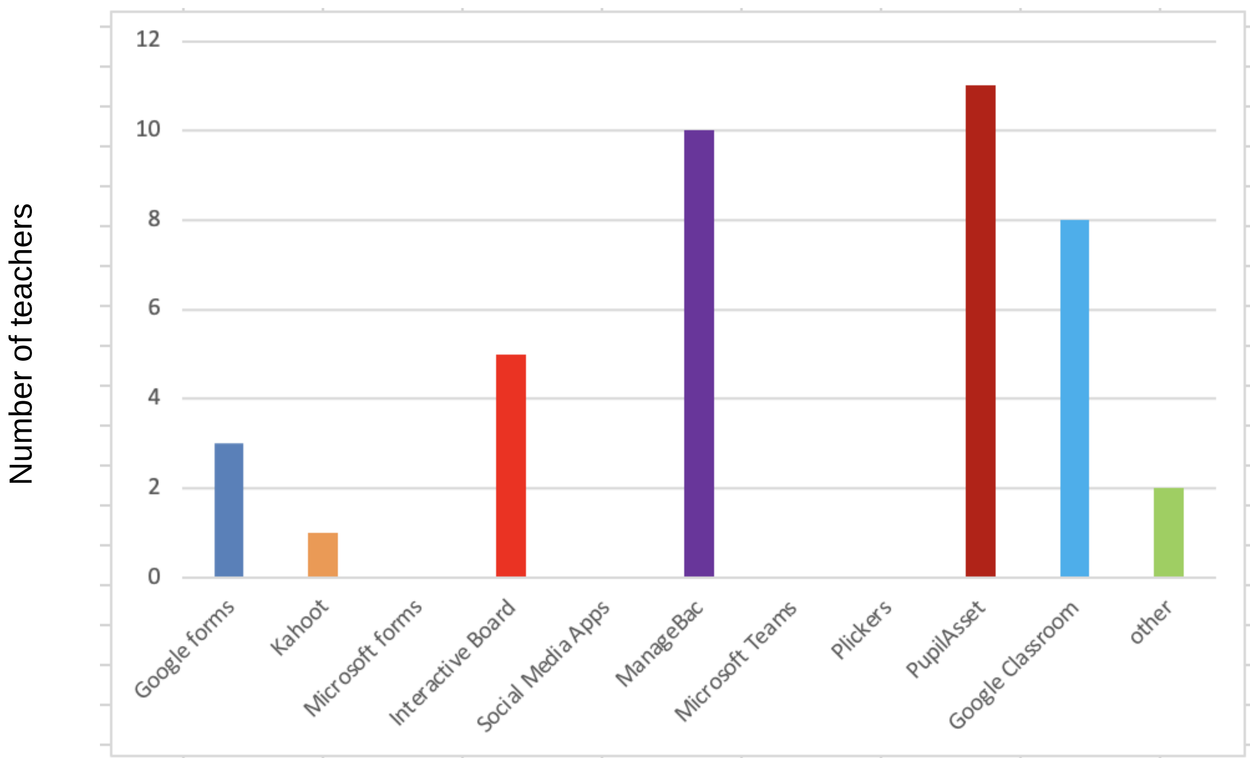
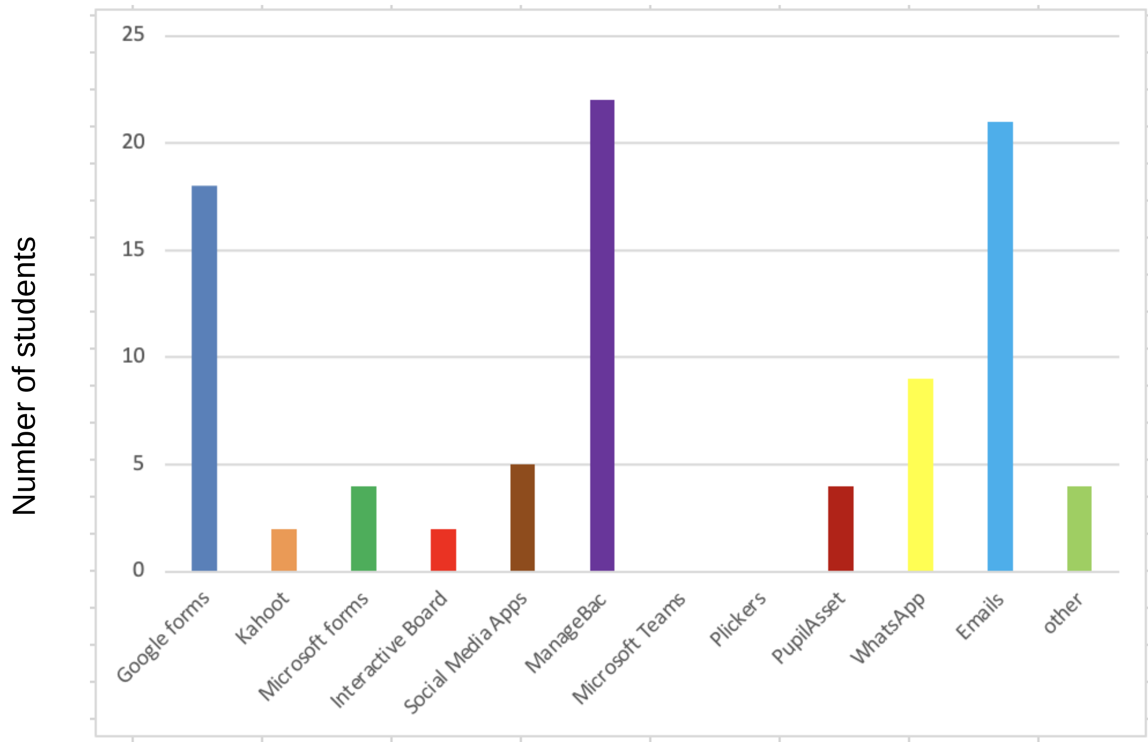


Figure 4.12

Technology for Feedback (Students)



The findings of the next section present potential factors related to technology-aided formative assessment and feedback that could affect teachers' teaching and students' learning which is related to the second research question. Regarding feedback providers, both student and teacher respondents reported that students receive feedback to their learning mostly from three providers: teachers, peers, and through self-assessment

Figure 4.13

Feedback Providers (Teachers)

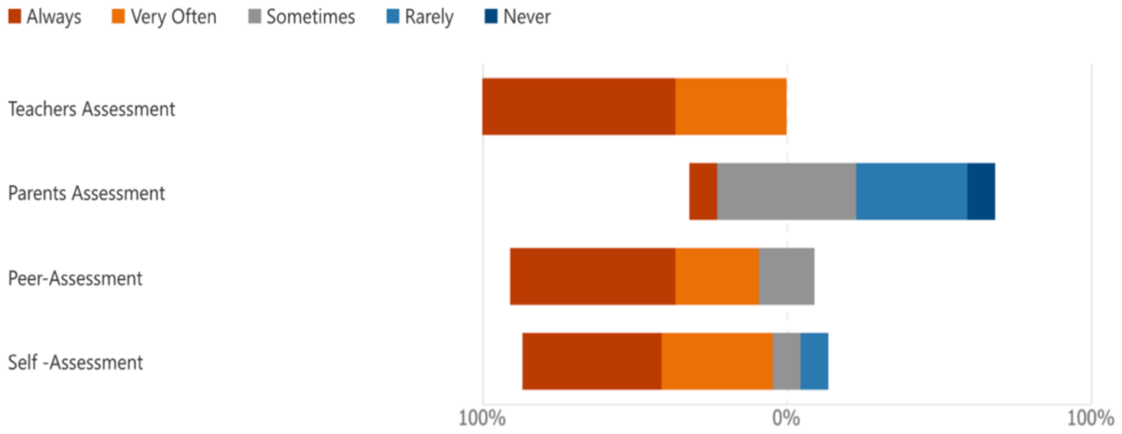
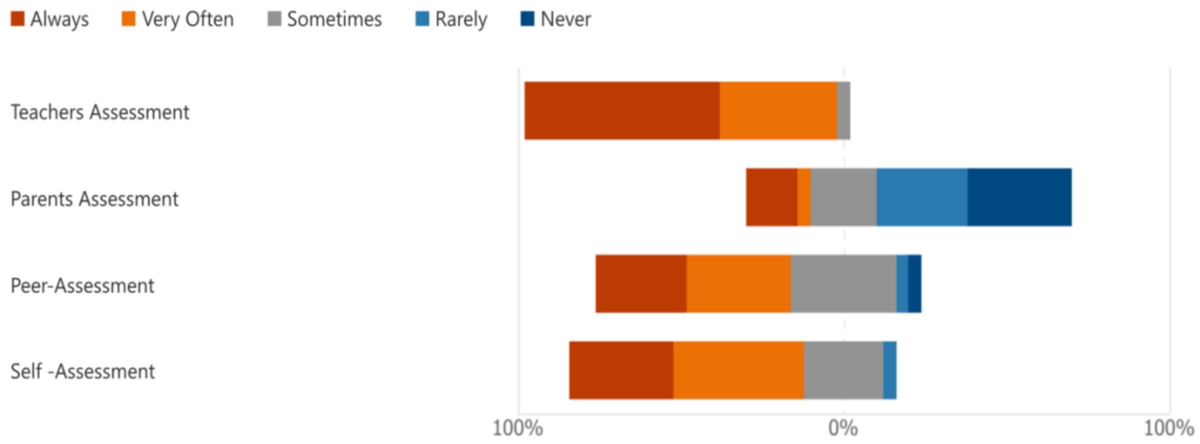


Figure 4.14

Feedback Providers (Student)



Regarding feedback levels (Hattie & Timperley, 2007; Xiao & Yang, 2019), respondents reported that their feedback almost equally covers all feedback levels; self-level, task-level, process-level, and self-regulation. Table 4.4 presents the question items of each level, and Figure 4.15 presents the corresponding regularity of each type of feedback.

Table 4.4

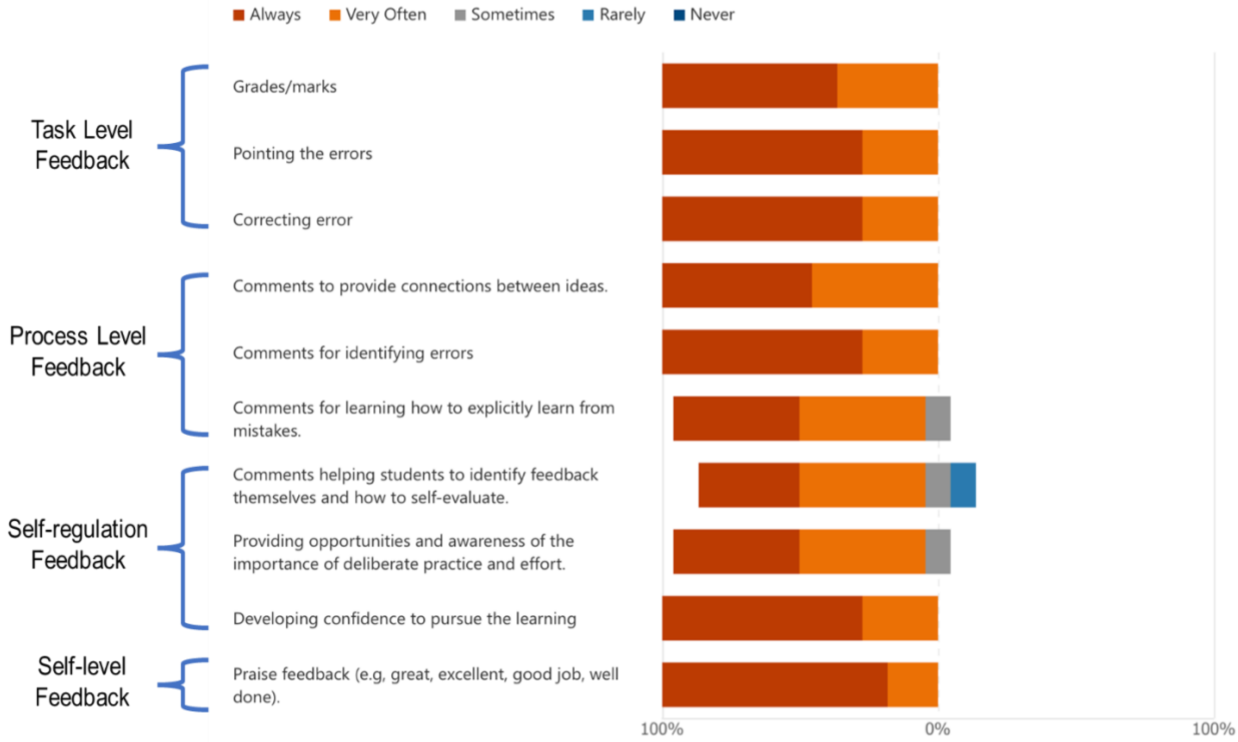
Feedback Levels Question Items

Feedback Levels	Question Items
Task Level Feedback	Grades/marks Pointing the errors Correcting error
Process Level Feedback	Comments to provide connections between ideas Comments for identifying errors Comments for learning how to explicitly learn from mistakes
Self-regulation feedback	Comments helping students to identify feedback themselves and how to self-evaluate Providing opportunities and awareness of the importance of deliberate practice and effort Developing confidence to pursue the learning
Self-level feedback	Praise feedback (e.g., great, excellent, good job, well done)

Note. Based on Hattie and Timperley (2007) and Xiao and Yang (2019).

Figure 4.15

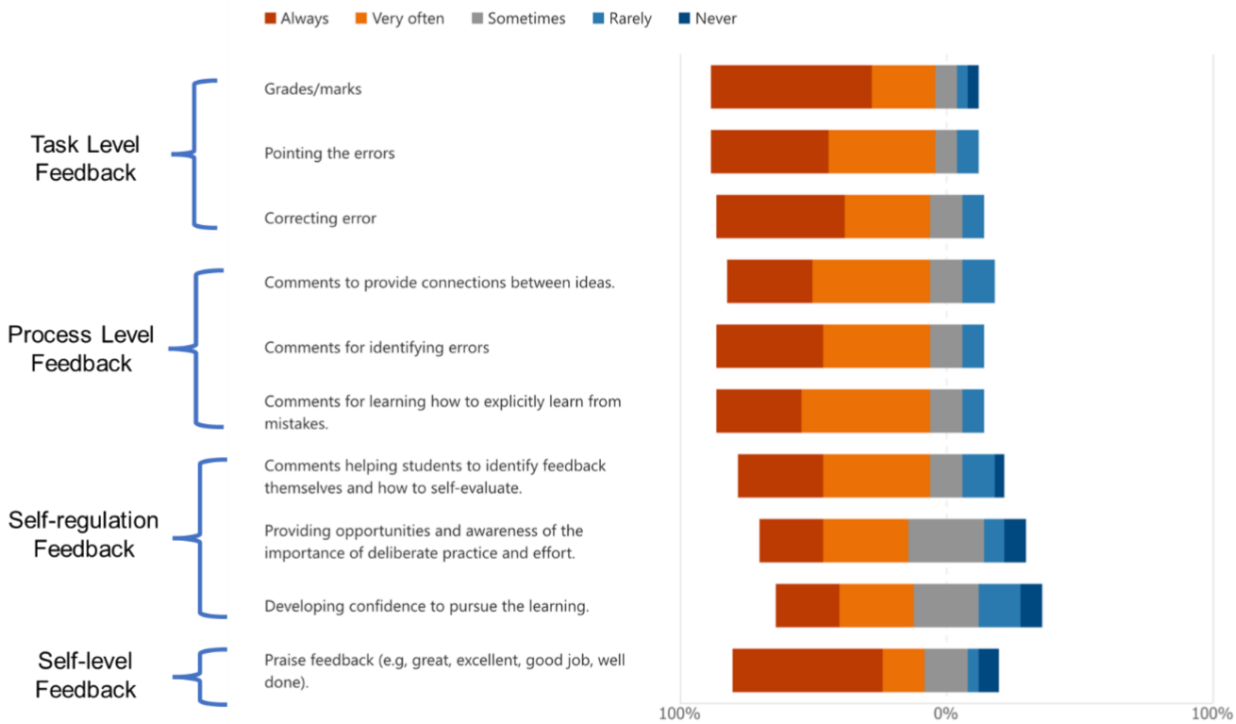
Teachers' Frequency of Providing Feedback



More than 80% of student respondents reported that the feedback they receive from their teachers covers self, task, and process feedback levels (see Figure 4.16). Thus, there are some sort of gap between the perceptions of the teachers and students. For example, while teachers believed that they often provided self-regulation and self-level feedback, some students thought that they did not receive these types of feedback. The role of technology in facilitating feedback levels and ensuring teacher feedback is aligned with student needs will be explored in under Research Question Two in the feedback levels theme section (see section 4.3.4).

Figure 4.16

Students' Frequency of Receiving Feedback Levels



In addition to the findings derived from interviews that have already been discussed, observational findings related to the participant responses is useful for comparison. The observations confirmed that students and teachers often used technological devices in the classroom (see Appendix 7.7). For example, students used laptops for all humanities subjects, while all teachers used Smartboards in those classrooms. Likewise, in the languages department, students used laptops and iPads, whereas only a minority of language teachers used Smartboards. The observations also showed that all STEM subjects teachers used Smartboards, with Maths1 being an anomaly. In STEM subjects, students used a mix of devices between iPad, laptop, and cell phones.

In technology use for formative assessment purposes, the observations showed that all teachers in humanity subjects used some form of technology to provide feedback to students. Each type of feedback used two of the three types of technology available. While language subjects did not use any form of technology for their feedback, English B did use ManageBac for task feedback. As for STEM subjects, 50% of teachers used at least one form of technology for feedback, with Biology and Maths2 being two of the three subjects using technology for feedback, while using only the Smartboard for feedback in the learning process. Unlike Chemistry (IB), HL/SL used at least one technology for every type of feedback. Appendix 7-8 provides more details on these observations. The classroom observations also showed that for STEM subjects, three out of six subjects used technology for only one type of formative assessment. Moreover, while none of the language subjects used technology for formative assessment, three out of four humanity subjects used technology for either one, two or three types of formative assessment (see Appendix 7-9).

The observation findings also showed specific uses of the Smartboard in classrooms (see Appendix 7.10). The table presented 6 out of 13 subjects using the Smartboard to show slides/presentation of the objectives, with only the history subject using the Smartboard for slides and interactive activities. Appendix 7.11 illustrates how all subjects where the active motivation to learn was observed included Smartboard use. While students in biology and arts subjects did not use laptops, out of the six subjects, maths was the only subject where students used iPads.

The following part presents the quantitative findings related to Research Question Three on how teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it.

4.2.4 *Overall Enthusiasm for Technology Use*

Technology adoption studies mostly focus on negative effects, including technology anxiety, fears, and worries, whereas studies tend to overlook positive emotions, such as interest, joy, contentment, and, finally, enthusiasm (Taherdoost, 2018). In this study, enthusiasm for technology use was explored by asking the teachers and students two specific questions.

Regarding their overall feelings towards technology in education, participants were asked to choose a number from 0 to 10, where 1 is the lowest and 10 is the highest level of enthusiasm towards technology use. All the student respondents reported high enthusiasm towards technology use, as they scored 6 and above. 12 % (*N*=3) scored 6 and 88% (*N*=22) scored 7 and above (4.18). Thus, both groups generally demonstrated a high level of enthusiasm toward technology use, which supports the argument that technology has become a part of the process of education, including formative assessment.

Figure 4.17

Teachers' Overall Enthusiasm for Technology Use

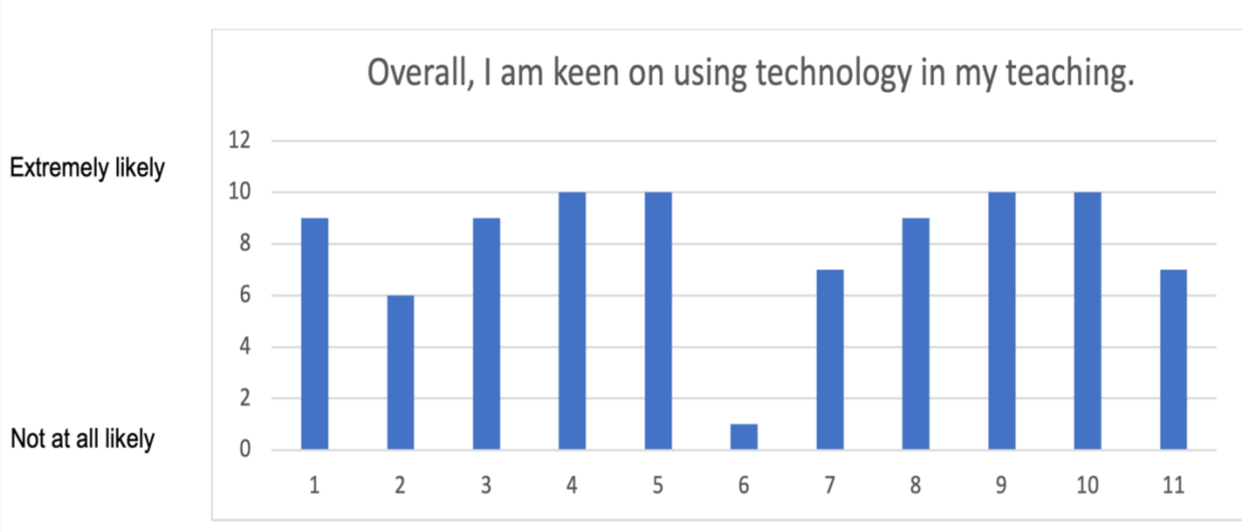
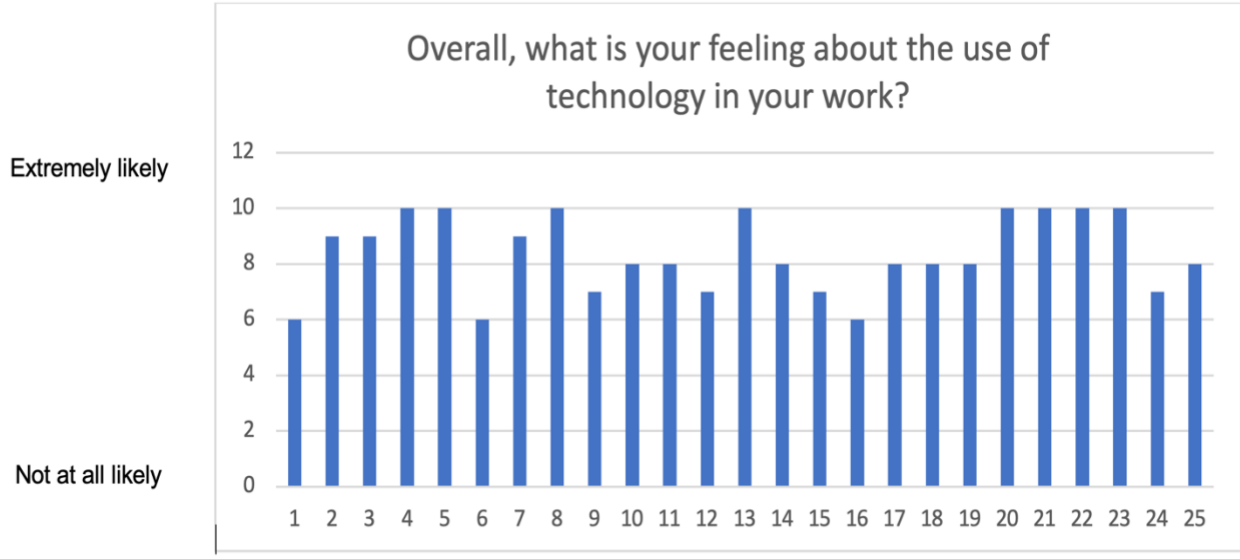


Figure 4.18

Students' Overall Enthusiasm for Technology Use



The role of technology in facilitating the learning process and technology-aided formative assessments, the strategies used, the data collected, and the underlying motivation for the participants' choices will be explored in more detail using the observation and interview data findings in section 4.3.

4.2.5 TAM Survey Analysis

The participants were asked to answer the technology acceptance model (TAM) survey with formative assessment and feedback activities in mind. In this study, TAM is categorised into six constructs toward technology in formative assessment, and each construct is presented in the form of statements. The constructs are perceived usefulness (PU), perceived ease of use (PEU), attitude (ATTU), behavioural intentions (BI), facilitating conditions (PC) and perceived technological self-efficacy (TSE) (Davis, 1989; Teo, 2019). While the original study by Teo (2019) used a 7-point Likert scale, this study used a 5-

point Likert scale, which is generally acceptable in research (Nunnally, 1978; Peter, 2018; Shaw, 1967).

4.2.5.1 Reliability Test

Reliability is computed using Cronbach's alpha (see Tables 4.5-4.8). Both teacher and student groups exhibit an acceptable level of overall reliability, where Teachers=0.736 and for Students= 0.732, which are above 0.7. As George and Mallery (2003, p. 231) reported guidelines of Cronbach alpha levels: "≥0. 9 – Excellent, ≥0 .8 – Good, ≥0 .7 – Acceptable, ≥ 0.6 – Questionable, ≥0 .5 – Poor,". At such small sample sizes, this score can be easily skewed with a few rogue respondents. Moreover, studies reported that a sample size of less than 30 cannot measure reliability using Cronbach's alpha (Bujang et al., 2018; Conroy, 2016; Samuels, 2015). It is worth mentioning that this thesis has benefited from a pre-validated questionnaire items that reported high degree of reliability (Teo, 2015, 2019; Teo et al., 2015; Teo & Zhou, 2014).

A six-part questionnaire was sent to 11 teachers. The PU subscale consisted of 4 items that showed good level of reliability (α = 0.805), the PEU subscale consisted of 3 items (α = 0.826), the ATTU subscale consisted of 3 items (α = 0.848), the BI subscale consisted of 3 items (α = 0.898), and the TFC subscale consisted of 3 items (α = 0.819). The TSE subscale of 3 items (α = 0.912) shows an excellent level. The overall average perception scale consisted of 19 items (α = 0.736) ≥ 0.7, which is acceptable. The negatively phrased questions' scores were reversed before calculating the results. The negatively phrased questions are as follows: perceived facilitating conditions items (Table 4.20) and perceived technological self-efficacy item (Table 4.24).

Table 4.5

Reliability Statistics (Teachers)

Cronbach's alpha	*N* of Items
0.736	19

Table 4.6

Reliability Statistics per Group Items (Teachers)

	Cronbach's alpha
PU	0.805
PEU	0.826
ATTU	0.848
TSE	0.912
BI	0.898
TFC	0.819

A six-part questionnaire was sent to 25 students. The PU subscale consisted of 4 items (α = .642), the PEU subscale consisted of 3 items (α = 0.584), the ATTU subscale consisted of 3 items (α = 0.520), the TSE subscale consisted of 3 items (α = 0.485), the BI subscale consisted of 3 items (α = 0.596), and the TFC subscale consisted of 3 items (α = 0.751), and the overall perception scale consisted of 19 items (α = 0.732). The negatively phrased questions' scores were reversed before calculating the results. The negatively phrased questions are as follows: perceived facilitating conditions items (Table 4.21) and perceived technological self-efficacy items (Table 4.25).

Table 4.7

Reliability Statistics (Students)

Cronbach's alpha	*N* of Items
0.732	19

Table 4.8

Reliability Statistics per Items Group (Students)

	Cronbach's alpha
PU	0.642
PEU	0.584
ATTU	0.520
TSE	0.485
BI	0.596
TFC	0.751

4.2.5.2 Response Distribution

Table 4.9 shows high percentages of teachers' positive responses for PU, PEU. ATTU and BI, while in TSE items the responses are mostly D. TFC also showed that teachers are more neutral in their perception towards the facilitating conditions that support their learning of the used technologies. This will be analysed in detail in 4.2.5.5, 4.2.5.6 and 0.

Table 4.9

Teachers' Response Distribution per Percentage

Teacher		SA	A	N	D	SD
PU	PU1	63.6	27.3	0	0	9.1
	PU2	54.5	36.4	0	0	9.1
	PU3	54.5	27.3	18.2	0	0
	PU4	72.7	18.2	0	9.1	0
PEU	PEU1	27.3	63.6	0	0	9.1
	PEU2	18.2	9.1	9.1	54.5	9.1
	PEU3	27.3	54.5		9.1	9.1
ATTU	ATTU1	45.5	27.3	18.2	9.1	0
	ATTU2	36.4	36.4	9.1	18.2	0
	ATTU3	36.4	9.1	27.3	18.2	9.1
TSE	TSE1	9.1	18.2	0	72.7	0
	TSE2	9.1	36.4	9.1	45.5	0
	TSE3	0	18.2	0	72.7	9.1
BI	BI1	54.5	27.3	0	9.1	9.1
	BI2	54.5	18.2	9.1	9.1	9.1
	BI3	45.5	27.3	0	27.3	0
TFC	TC1	27.3	54.5	9.1	0	9.1
	TC2	27.3	63.6	0	0	9.1

	TC3	36.4	54.5	0	0	9.1

Table 4.10 shows the students' distribution of TAM responses. Similar to teachers' responses, students showed high percentages of SA and A responses in PU, PEU, ATTU and BI, while in TSE items the responses are higher under D and SD. This will be analysed in detail in sections 4.2.5.5, 4.2.5.6 and 0.

Table 4.10

Students' Response Distribution per Percentage

Student		**SA**	**A**	**N**	**D**	**SD**
PU	PU1	64.0	36.0	0	0	0
	PU2	52.0	36.0	4.0	8.0	0
	PU3	60.0	32.0	8.0	0	0
	PU4	76.0	20.0	4.0	0	0
PEU	PEU1	64.0	32.0	4.0	0	0
	PEU2	32.0	32.0	28.0	8.0	0
	PEU3	68.0	28.0	28.0	0	0
ATTU	ATTU1	36.0	24.0	32.0	8.0	0
	ATTU2	48.0	32.0	20.0	0	0
	ATTU3	44.0	32.0	20.0	4.0	0
TSE	TSE1	4.0	4.0	8.0	28.0	56.0
	TSE2	28.0	12.0	28.0	16.0	16.0

	TSE3	12.0	20.0	28.0	8.0	32.0
BI	BI1	64.0	32.0	4.0	0	0
	BI2	52.0	24.0	20.0	4.0	0
	BI3	28.0	36.0	24.0	12.0	0
TFC	TC1	36.0	16.0	16.0	16.0	16.0
	TC2	8.0	44.0	20.0	16.0	12.0
	TC3	32.0	36.0	8.0	12.0	12.0

As can be seen in Figure 4.19 and Table 4.11, one teacher that may be considered an outlier scored below 2 in all perception variables (PU, PEU, ATTU, PTSE, BI, FC). If the outlier was to be excluded, the score in teachers' perceived usefulness (PU) would be equal to the students' (100% positive). Most of the teachers ranged from 4 to 5, which indicates that they 'agreed' or 'strongly agreed' on the usefulness of technology in education. Facilitating conditions (FC) is also rated highly, ranging between 3.5 and 5, except for the one outlying teacher; the results indicate that technical support for technology use in schools is not perceived as a concern for 90% of teachers. Teachers constantly seek direct help when using technology in the school environment. The PEU and ATTU have a wide range of variations in teachers' responses, while PU and FC range from above 2.5 to 5. In BI, eight teachers range from 4-5 while one participant scored 3, and two participants scored less than 2. TSE scored the lowest amongst all variables, as ten teachers ranged 2-3.5, except one participant who scored 5, indicating a negative sense of self-efficacy opposite to the positive perception of PU, PEU, ATTU, FC and BI. The individual charts for the teachers are presented in Appendix 7.27 and 7.28 for further clarification.

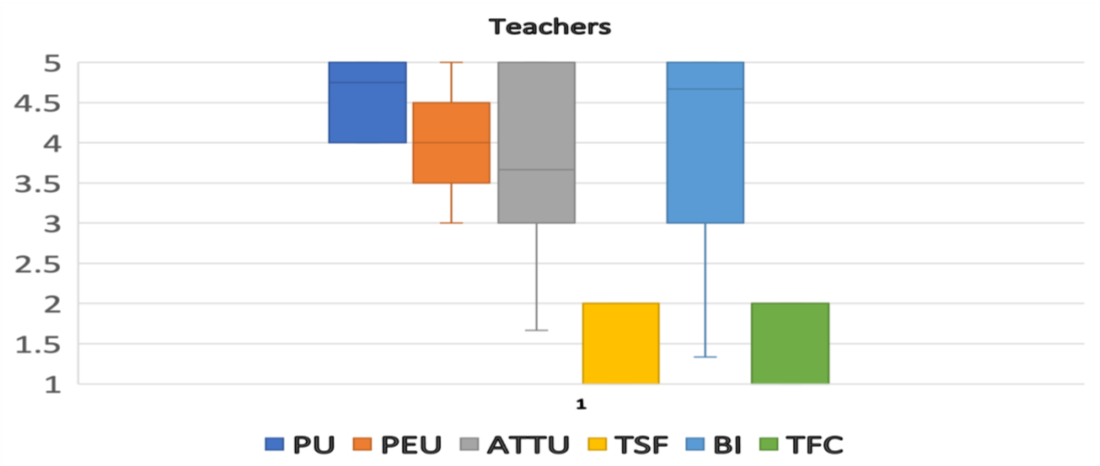
Table 4.11

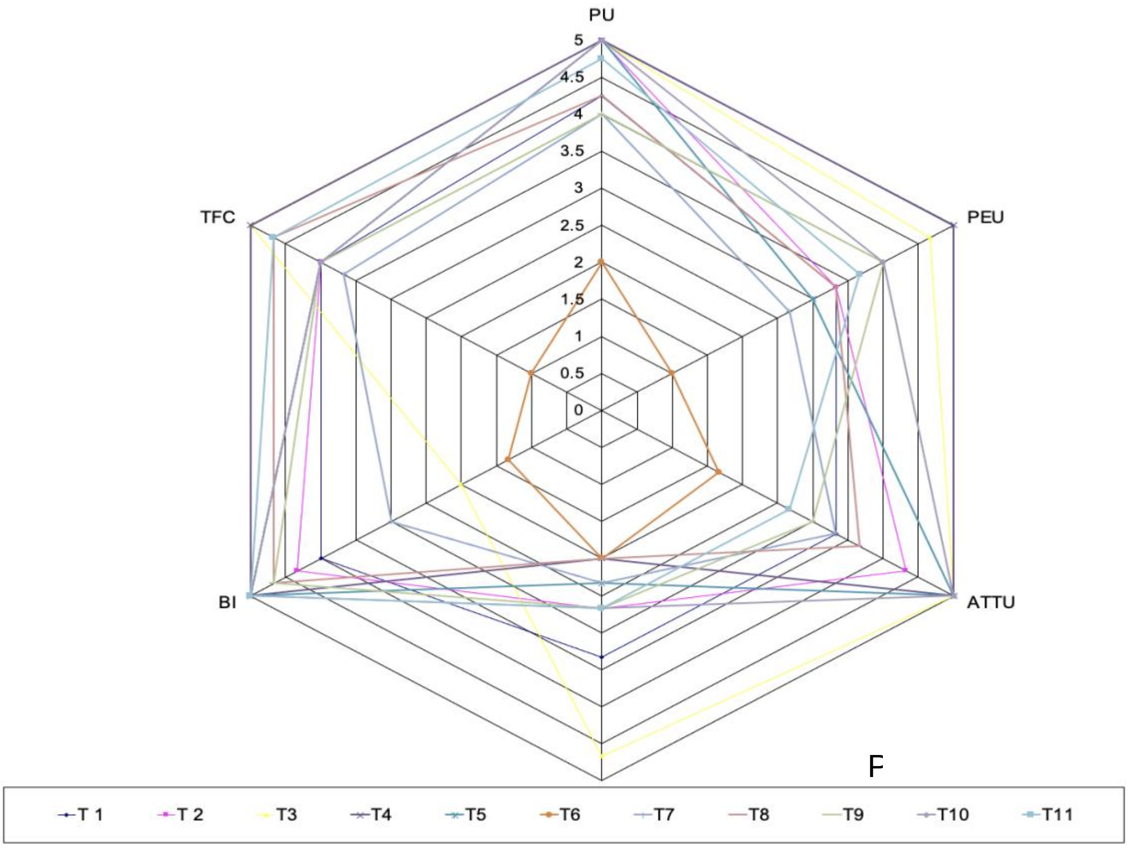
Data Explaining the Spider Chart (Teachers)

Datasets	T 1	T 2	T3	T4	T 5	T 6	T 7	T 8	T 9	T 10	T 11
PU	4.25	5	5	5	5	2	4	4.25	4	5	4.75
PEU	3.33	3.33	4.67	5	3	1	2.67	3.33	4	4	3.67
ATTU	3.33	4.33	5	5	5	1.67	3.33	3.67	3	5	2.67
TSE	3.33	2.67	4.67	2	2.33	2	2.33	2	2.67	2.67	2.67
BI	4	4.33	2	5	5	1.33	3	4.67	4.67	5	5
TFC	4	4	5	5	4	1	3.67	4.67	4	4	4.67

Figure 4.19

Teachers' Overall Results Charts





In the students' overall results chart (Figure 4.20), PU, PEU, and BI show the same high level of acceptance; PU ranges from 4 to 5, while PEU and BI scores range from 3.5 to 5. The ATTU of students is more spread but still above 2.5, which indicates positive acceptance or neutrality. The spread of FC and TSE is broad and ranges from 1 to 5. Yet the chart shows the students with lower scores, indicating negative perception of facilitating conditions, while technological self-efficacy tends to show higher scores, indicating positive perceptions towards the rest of the parameters (See S2 & S10 in Figure 4.20 These results, however, need to be interpreted with caution since the alpha scores are rather low for the students surveyed due to low sample size. Table 4.12 below shows the data scored by each student. The individual charts for the students are also presented in Appendix 7-27-Appendix 7-28.

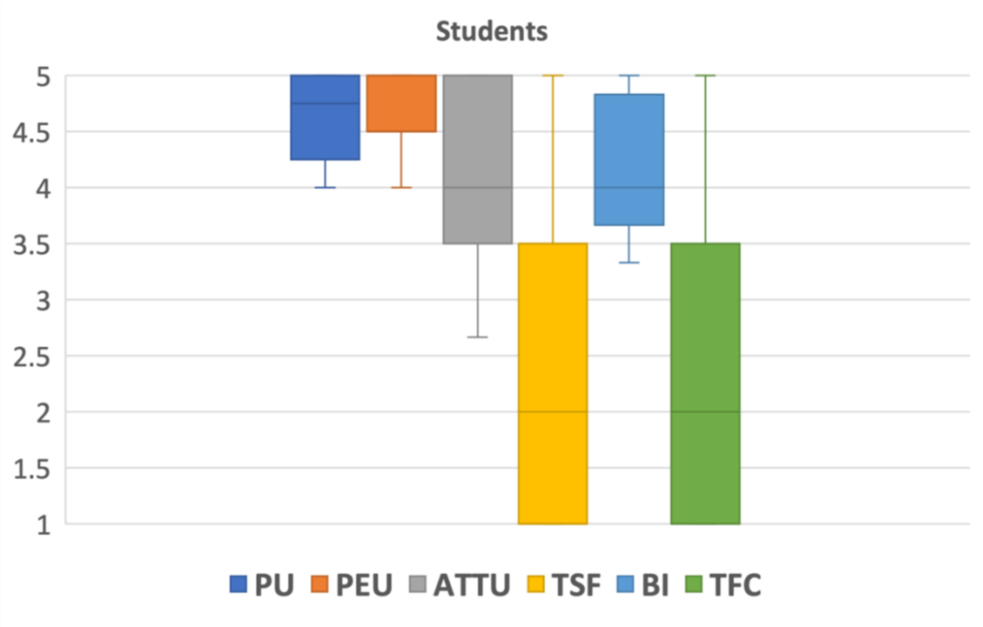
Table 4.12

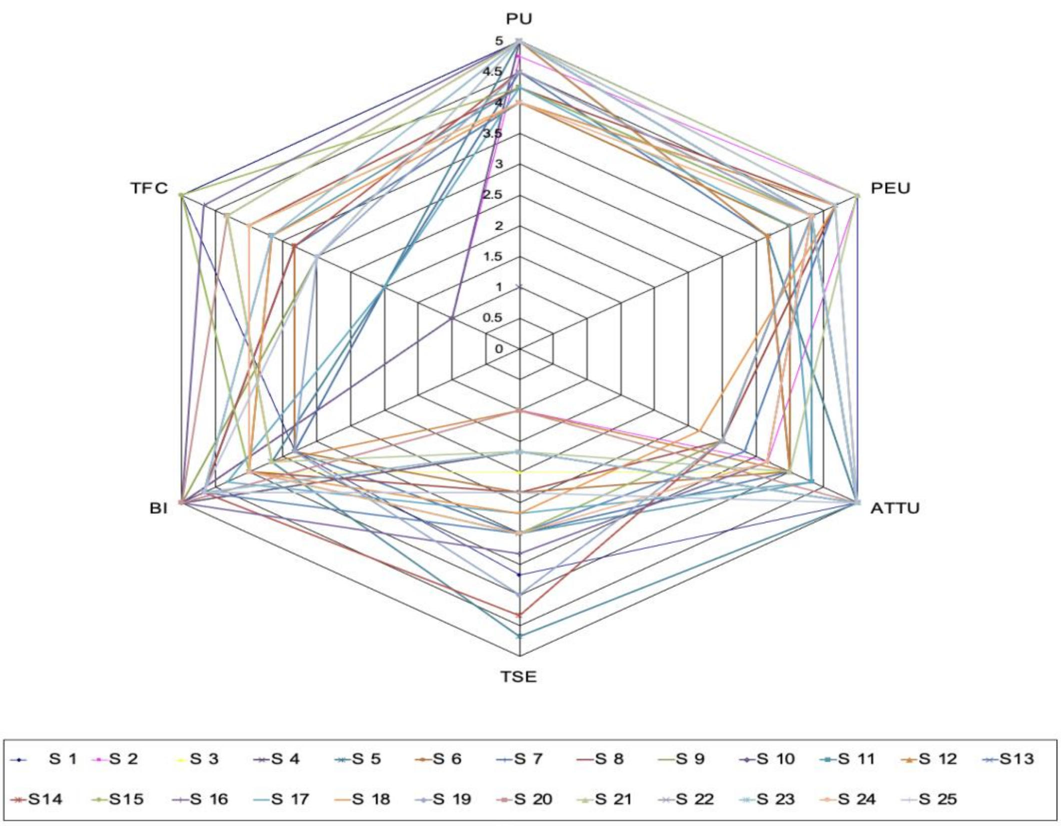
Data Explaining the Spider Chart (Students)

Datasets	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9	S 10	S 11	S 12	S13	S14	S15	S 16	S 17	S 18	S 19	S 20	S 21	S 22	S 23	S 24	S 25
PU	5	4.75	4	5	5	4	4.5	4.25	5	5	4.25	5	4	4.5	4.25	5	4.25	4	4.5	5	5	5	5	4	5
PEU	5	5	4	5	3.67	4	3.67	4.67	4.67	4.33	4.33	3.67	4.67	4.33	4.33	4.33	4	4.67	4.33	4.33	5	4.33	4	4.33	4.67
ATTU	5	3.67	4	5	5	4	4	3	5	5	4.33	4	3.33	3	3	3.67	4.33	2.67	3	5	4	5	5	3.67	5
TSE	3.67	1	2	2.33	4.67	2.33	3	2.33	1.67	1.67	3	1	3	4.33	3	3.33	2.67	2.67	4	1	1.67	1.67	2.33	3	2.33
BI	3.33	5	4	4	3.67	3.33	3.33	4	5	5	4	3.67	4.67	4.67	4	5	4.33	4	3.33	5	3.67	4.67	5	4	4.67
TFC	5	1	4	4.33	2	3.33	2	4	3	1	3.67	4.33	3.33	3.33	5	4.67	2	3.67	3	4.33	4.33	3.67	3.33	4	3

Figure 4.20

Students' Overall Results Charts





4.2.5.3 Mann-Whitney Test

I conducted a Mann-Whitney Test that indicated there were no significant differences between teachers and students; both have positive perception of five TAM dimensions (PU, ATTU, TSE, BI and FC) (see Appendix 7.29). However, the PEU was greater for the students (*M*=21.56) than for teachers (*M*=11.55), *U*= 61.0, *p*= 0.008. In PEU the *Z*= -2.753 and *N*=36; therefore, the *r* value is 0.46 (*p* >. 5). This would be considered a large size effect (Cohen, 1988).

As shown in the graphs, students have a more positive perception towards technology's ease of use, while teachers seem to have a less positive perception of its ease of use translated in the frequency and spread of the histograms shown in graph **. This supports the statement made in section 3.2.5.4 "…teachers find technology more challenging and require more effort than students."

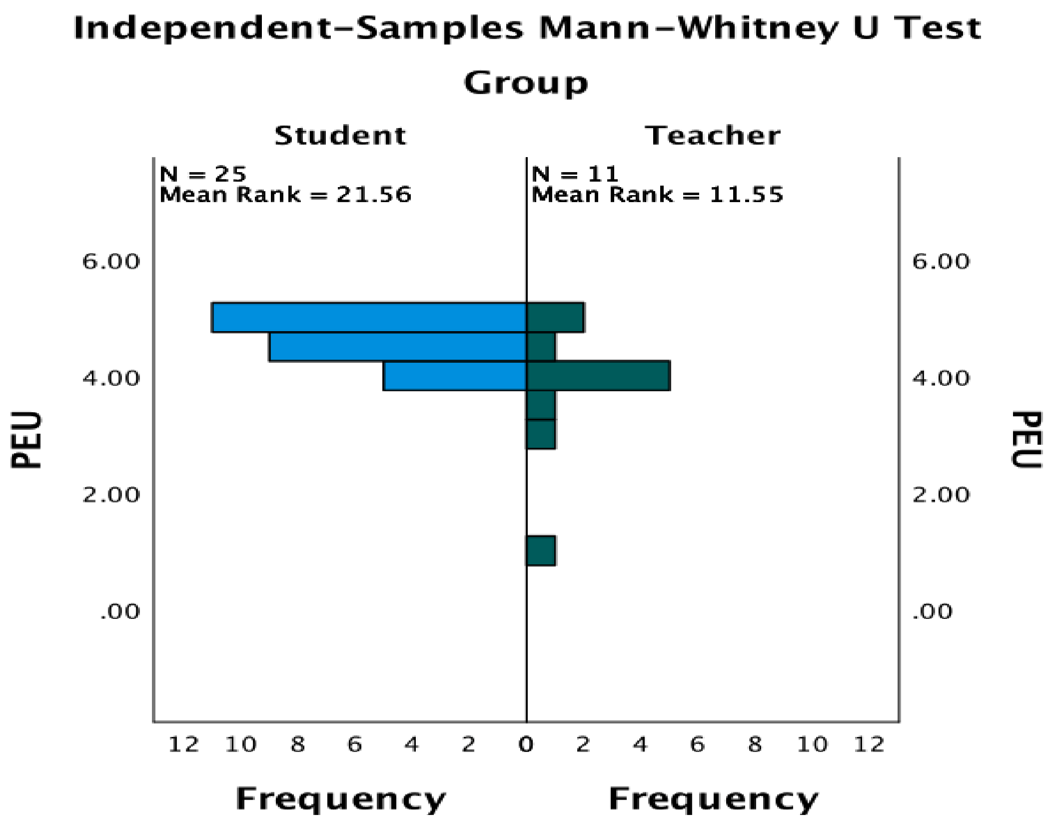
Table 4.13

PEU Across Group Independent-Samples Mann-Whitney U Test Summary

Total *N*	36
Mann-Whitney *U*	61.000
Wilcoxon *W*	127.000
Test Statistic	61.000
Standard Error	27.788
Standardized Test Statistic	-2.753
Asymptotic Sig. (2-sided test)	.006
Exact Sig. (2-sided test)	.008

Figure 4.21

Independent-Samples Mann-Whitney U Test Group



4.2.5.4 Perceived Usefulness (PU)

The participants' perceptions of the usefulness of the technological tools were explored by giving them four statements presented in Table 4.14. More than 90% of teacher participants 'agreed' or 'strongly agreed' that technology is useful (QPU4), supporting the effectiveness of their teaching (QPU3), and improving it (QPU1). Moreover, more than 81% 'agreed' that using technology would facilitate the use of more task options while developing an assessment or quiz (QPU3) (see Table 4.14).

Descriptive statistics for PU reveal an overall mean score of 4.39 (*SD* = 0.90). This shows a positive perception of PU amongst the teachers' participants. However, this was highly variable among teachers since one teacher scored lower on the scale. PU4 had the highest mean value, indicating that the teachers find the technology useful in improving their teaching. Nevertheless, it should be noted that although the teachers were more highly variable than students, the sample sizes for both teachers and students were small, and a greater sample size could have revealed more variations in the results. This statement refers to all the analysed TAM parameters and their averages.

Table 4.14

Teachers' Descriptive Statistics for PU Construct

Perceived Usefulness Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Using technology will improve my teaching.	11	1	5	4.36	1.21
Using technology will help my teaching to be more effective.	11	1	5	4.27	1.19
I have a wider task option when I use technology.	11	3	5	4.36	0.81
I find technology to be useful in my work.	11	2	5	4.55	0.93
PU_Avg	11	2.00	5.00	4.39	0.90

Descriptive statistics for PU reveal an overall mean score of 4.61 (SD = 0.42). This shows a positive perception of PU amongst the student participants within this small sample. PU4 had the highest mean value, indicating that the teachers find the technology to improve their learning (see Table 4.15).

Almost 100% of student participants ‘strongly agreed’ or ‘agreed’ that technology is useful (QPU4), supporting the effectiveness of their learning

(QPU3) and that it improves it (QPU1). Furthermore, using technology would allow them to use more task options while learning (QPU3). See Table 4.15 for more detail.

Table 4.15

Students' Descriptive Statistics for PU Construct

Perceived Usefulness Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Using technology will improve my learning.	25	4	5	4.64	0.49
Using technology will help my learning to be more effective.	25	3	5	4.56	0.58
I have a wider task option when I use technology.	25	3	5	4.52	0.65
I find technology to be useful in my studies.	25	3	5	4.72	0.54
PU_Avg	25	4.00	5.00	4.61	0.42

4.2.5.5 Perceived Ease of Use (PEU)

Regarding the perceived ease of use (PEU) construct, more than 72% of survey teacher participants ‘agreed’ or ‘strongly agreed’ that technology is easy to use (PEU3) and 91% ‘agreed’ or ‘strongly agreed’ that technology easily does what they need (PEU1). Although technology requires mental effort, almost 68% of the teacher respondents ‘disagreed’ or ‘strongly disagreed’ that using technology does not require much mental effort (PEU2) (see Table 4.16). While more than 64% of student survey participants ‘agreed’ or ‘strongly agreed’ that technology does not require mental effort (PEU2), 28% were ‘neutral’. 96% of student participants ‘agreed’ or ‘strongly agreed’ that technology in learning is easy to use (PEU3) and easily does what they need (PEU2).

Teacher participants' descriptive statistics for PEU reveal an overall mean score of 3.45 (*SD* = 1.07). This shows a positive perception of PEU amongst the teacher participants. PEU3 had the highest mean value, indicating that the teacher participants find technology easy to use, and PEU2 shows that teachers are variable in the extent to which they think technology does not require mental effort (see Table 4.16). Over 63% of the teachers reported that using technology is mentally challenging, while 9% were 'neutral'.

Table 4.16

Perceived Ease of Use Descriptive Statistics (Teachers)

Perceived Ease of Use Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
I find it easy to get technology to do what I want it to do.	11	1	5	4.00	1.10
Using technology does not require a lot of mental effort.	11	1	5	2.73	1.35
I find technology easy to use.	11	1	5	3.64	1.36
PEU_Avg	11	1.00	5.00	3.45	1.07

Student participants' descriptive statistics for PEU reveal an overall mean score of 4.37 (*SD* = 0.41). This shows a positive perception of PEU amongst the student participants. PEU3 has the highest mean value, indicating that the student participants find technology easy to use (see Table 4.17). Only 8% of the students reported that using technology needs mental effort, and 28% were ‘neutral’. This could indicate that teachers find technology more challenging and require more effort than students.

Table 4.17

Perceived Ease of Use Descriptive Statistics (Students)

Perceived Ease of Use Items	*N*	Minimum	Maximum	Mean	Std. Deviation
I find it easy to get technology to do what I want it to do.	25	3	5	4.60	0.58
Using technology does not require a lot of mental effort.	25	2	5	3.88	0.97
I find technology easy to use.	25	3	5	4.64	0.57
PEU_Avg	25	3.67	5.00	4.37	0.41

4.2.5.5.1 Attitude (ATTU)

More than 73% of the teacher participants ‘agreed’ or ‘strongly agreed’ with perceiving technology as fun (ATTU2) and interesting (ATTU1). Furthermore, 46% ‘agreed’ that they look forward to those aspects of teaching that require them to use technologies (ATTU3).

Teacher participants’ descriptive statistics for attitude reveal an overall mean score of 3.82 (*SD* = 1.14). This generally shows a positive attitude towards technology use amongst the small sample of teacher participants. ATTU1 had the highest mean value, indicating that technology makes teaching interesting among teacher participants (s). However, ATTU3 shows that teachers are variable regarding the third statement.

Table 4.18

Attitude Descriptive Analysis (Teachers)

Attitude Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
The technology makes teaching more interesting.	11	2	5	4.09	1.04
Teaching with technology is fun.	11	2	5	3.91	1.14
I look forward to those aspects of my work that require me to use technologies.	11	1	5	3.45	1.44
ATTU_Avg	11	1.67	5.00	3.82	1.14

At the same time, 60% of the student participants ‘agreed’ or ‘strongly agreed’ with the statement of perceiving technology as interesting (ATTU1). While almost 80% ‘agreed’ with the statements “Learning with technology is fun” (ATTU2) and 76% “I look forward to those aspects of my learning that require me to use technologies” (ATTU3). This indicates that students’ attitude towards technology in learning is higher than the teachers’ attitude towards technology in teaching with lower SD.

Student participants’ descriptive statistics for attitude reveal an overall mean score of 4.11 (*SD* = 0.80). This shows a positive attitude towards technology use amongst the student participants. ATTU2 had the highest mean value (4.28) with the lowest *SD* (0.79), indicating that technology makes learning fun (see Table 4.19).

Table 4.19

Attitude Descriptive Analysis (Students)

Attitude Items	*N*	Minimum	Maximum	Mean	Std. Deviation
The technology makes learning more interesting.	25	2	5	3.88	1.01
Learning with technology is fun.	25	3	5	4.28	0.79
I look forward to those aspects of my learning that require me to use technologies.	25	2	5	4.16	0.90
ATTU_Avg	25	2.67	5.00	4.11	0.80

4.2.5.6 Perceived Facilitating Conditions (FC)

The facilitating conditions items are written in negative form. Of these, 81% of teacher participants ‘disagreed’ or ‘strongly disagreed’ that learning to use technology takes too much time (FC1, FC3). Furthermore, 90% ‘disagreed’ or ‘strongly disagreed’ that learning and using technology involves too much time (FC2).

Descriptive statistics for PC reveal an overall mean score of 2.00 (*SD* = 1.09). This still shows a positive perception of PC amongst the teacher participants since the statements are negative. PC1 had the highest mean value, indicating that teacher participants do not find learning computers takes too much of their time (see Table 4.20).

Table 4.20

Perceived Facilitating Conditions Descriptive Analysis (Teachers)

Perceived Facilitating Conditions Items	*N*	Minimum	Maximum	Mean	Std. Deviation
Learning to use the computer takes up too much of my time.	11	1	5	2.09	1.14

Using the computer involves too much time.	11	1	5	2.00	1.10
It takes too long to learn how to use a computer.	11	1	5	1.91	1.14
PFC_Avg	11	1.00	5.00	2.00	1.09

Among students, 52% of participants ‘disagreed’ or ‘strongly disagreed’ that using technology (FC2) and learning to use it (FC1) takes too much time. Moreover, 68% ‘disagreed’ or ‘strongly disagreed’ that learning to use technology involves too much time.

Descriptive statistics for FC reveal an overall mean score of 2.59 (*SD* = 1.10). This still shows a moderate/neutral perception of FC amongst the student participants since the statements are negative. FC2 had the highest mean value, indicating that student participants do not find using computers takes too much time (see Table 4.21).

Table 4.21

Perceived Facilitating Conditions Descriptive Analysis (Students)

Perceived Facilitating Conditions Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Learning to use the computer takes up too much of my time.	25	1	5	2.60	1.53
Using the computer involves too much time.	25	1	5	2.80	1.90
It takes too long to learn how to use a computer.	25	1	5	2.36	1.38
PFC_Avg	25	1.00	5.00	2.59	1.10

4.2.5.7 Behavioural Intentions (BI)

Among teachers, 82% of the participants ‘agreed’ or ‘strongly agreed’ with the statements indicating their intention to use technology in the future in teaching (BI1), while more than 72% ‘agreed’ or ‘strongly agreed’ that they intend and plan to use technology in their teaching (BI2, BI3).

Descriptive statistics for BI reveal an overall mean score of 4.00 (*SD* = 1.31). This possibly shows a positive perception of BI amongst the small sample of teacher participants. BI1 had the highest mean value, indicating that teachers will use technology in the future (see Table 4.22). Interestingly, one language teacher responded that they do not plan to use technology in the future and do not plan to use it often.

Table 4.22

Behavioural Intentions Descriptive Analysis (Teachers)

Behavioural Intentions Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
I will use the technology in future.	11	1	5	4.09	1.37
I plan to use technology often.	11	1	5	4.00	1.41
Whenever possible, I intend to use computers for learning.	11	2	5	3.91	1.30
BI_Avg	11	1.33	5.00	4.00	1.31

Among students, 96% of the participants ‘agreed’ or ‘strongly agreed’ with the statement indicating their intention to use technology in the future (BI1). Although 32% ‘agreed’ or ‘strongly agreed’ with the statements indicating they plan to use technology often (BI2), 28% were ‘neutral’. Moreover, 64% intend to use technology in their learning (BI3).

Descriptive statistics for BI reveal an overall mean score of 4.21 (*SD* = 0.60). This shows a positive perception of BI amongst the teacher participants. BI1 had the highest mean value and the smallest *SD*, indicating that student participants intend to use technology in the future (see Table 4.23

Table 4.23

Behavioural Intentions Descriptive Analysis (Students)

Behavioural Intentions Items	*N*	Minimum	Maximum	Mean	Std. Deviation
I will use the technology in future.	25	3	5	4.24	0.93
I plan to use technology often.	25	2	5	4.60	0.58
Whenever possible, I intend to use computers for learning.	25	2	5	3.80	1.00
BI_Avg	25	3.33	5.00	4.21	0.60

4.2.5.8 Perceived Technological Self-Efficacy (PTSE)

Among teachers, 73% of participants ‘agreed’ or ‘strongly agreed’ with the statement, “I can complete a task using technology if I could call someone for help when I get stuck” (PTSE1). Moreover, 46% ‘agreed’ or ‘strongly agreed’ that they need book guidance to complete tasks regarding technology (PTSE2) and 82% ‘agreed’ or ‘strongly agreed’ with the statement “I can complete a task using technology if someone demonstrates how to use it first” (PTSE3).

Descriptive statistics for PTSE reveal an overall mean score of 3.33 (*SD* = 0.77). This shows a negative perception of PTSE amongst the teacher participants. PTSE3 had the highest mean value and low *SD*, indicating that teacher participants need demonstration to complete a technology task (see Table 4.24

Table 4.24

Perceived Technological Self-Efficacy Descriptive Analysis (Teachers)

Perceived Technological Self-Efficacy Items	*N*	Minimum	Maximum	Mean	Std. Deviation
I can complete a task using technology if I could call someone for help when I get stuck.	11	1	4	3.36	1.12
I could complete a task using technology if I ONLY had a book to guide me.	11	1	4	2.91	1.14
I can complete a task using technology if someone demonstrates how to use it first.	11	2	5	3.73	0.90
PTSE_Avg	11	1.33	4.00	3.33	0.77

Among student participants, 84% ‘agreed’ that they need help from someone when they get stuck in dealing with technologies (PTSE1). Moreover, 32% ‘agreed’ with the statement “I could complete a task using technology if I ONLY had a book to guide me” (PTSE2), and 28% of them were ‘neutral’. Furthermore, 40% ‘agreed’ on “I can complete a task using technology if someone demonstrates how to use it first" (PTSE3), and 28% of them were 'neutral'.

Descriptive statistics for PTSE reveal an overall mean score of 3.45 (*SD* = 0.99). This shows a negative perception of PTSE amongst the student participants. PTSE1 had the lowest mean value, indicating that student participants may need help to complete a technology task (see Table 4.25

Table 4.25

Perceived Technological Self-Efficacy Descriptive Analysis (Students)

Perceived Technological Self-Efficacy Items	***N***	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
I can complete a task using technology if I could call someone for help when I get stuck.	25	1	5	4.28	1.06
I could complete a task using technology if I ONLY had a book to guide me.	25	1	5	2.80	1.44
I can complete a task using technology if someone demonstrates how to use it first.	25	1	5	3.28	1.43
PTSE_Avg	25	1.33	5.00	3.45	0.99

Thus, the survey results show that, in general, the teacher and student participants are keen to apply technologies and already use a wide range of devices and software in the teaching and learning processes and for providing and receiving feedback. At the same time, despite the teachers' and students' generally positive perceptions regarding the usefulness, ease of use, behavioural intentions, and facilitating conditions of technologies, they still might need training in teaching and learning. The first part presenting quantitative results mainly addressed Research Question Two, and the second part was related to Research Question One. The next several sections will explore the research questions from a qualitative point of view, based on the analysis of the interviews and observations of teachers and students.

4.3 Qualitative Data Analysis

The answers to the research questions are based on data collected from the surveys and interviews with the teachers and students, as well as on some findings resulting from classroom observations (see Appendix 7-15 for more detail on observations). The final interviews represent 15 teachers out of 38 (39.5%) and 18 students out of 42 students who are 16 years and older (38.1%), and the final number of classroom observations was 12. It should be noted that one participant withdrew from the study after they were interviewed/observed. While most of the comments regarding technology in the classroom and formative assessment were positive, a few negative opinions and perceptions were expressed, often by the same teachers. The following section will present the findings in the form of themes identified during the analysis. This section presents themes derived from the coding process of the interview responses supported by the survey results from the previous section (see 4.2.).

To address the second research question, it is crucial to assess the teachers' and students' perceptions, attitudes, and behaviours to understand to what extent new technology-based practices and tools influence learning in the classroom and to explore how the results of this mixed methods analysis could inform further research. As follows from the survey analysis and analysis related to the first research question, participants mostly perceive technology as useful, easy to use, supporting engagement, and promoting deeper learning with formative assessment and feedback. At the same time, it is also crucial to explore how technology-aided formative assessment assists teachers and students as observed and described by the participants, plus exploring the actual support for teaching and learning.

As a part of the triangulation approach, data in this section are collected through several methods: survey, observation, and interviews. The results are presented on a theme basis, revealing a range and extent of technologies that teacher and student participants use in FA and feedback practices, affordances of these technologies, and challenges the participants face during their FA practices. The findings concerning the use of technology in FA practices will be presented under the following themes, which are presented in Table 4.26
, in relation to their respective research questions.

Table 4.26

List of Themes in Relation to Research Questions

Research Questions	**Themes**
Research Question 1: How teachers and students are using technology in relation to formative assessment. What are they using and in what context and in what way?	Theme 1. Available Technologies and Their Uses. Theme 2. Actual Usage Challenges.
Research Question 2: How is technology providing feedback and how does this affect the teachers' teaching and the students' learning? What are its strengths and limitations?	Theme 3. One Size Does Not Fit All. Theme 4. Technology and Feedback Levels. Theme 5. Technology as a Tool of Engagement. Theme 6. Technology as a Tool for Ownership and Autonomy. Theme 7. Balancing Time and Effort in Managing Learning.

Research Question 3: What are the perceptions and attitudes of the teachers and students concerning technology-aided formative assessment and feedback?	Theme 8. Perceived usefulness. Theme 9. Perceived ease of use. Theme 10. Perceived challenges and concerns.

Table 4.27 shows the classroom and lab observations conducted in the school. The main focus of the classroom observation was the FA practices and strategies conducted in the classroom with the aid of technology. The observations covered multiple subjects categorised under three main subject groups: STEM, languages, and humanities and three separate year groups: Grade 10, IB1, and IB2. The number of students who attended the classes is also documented in the table. Some of the teachers conducted FA strategies, but not all were facilitated with technologies. The ticks in the table show which strategies were used and whether they were aided by technology.

Table 4.27

Classroom Observation

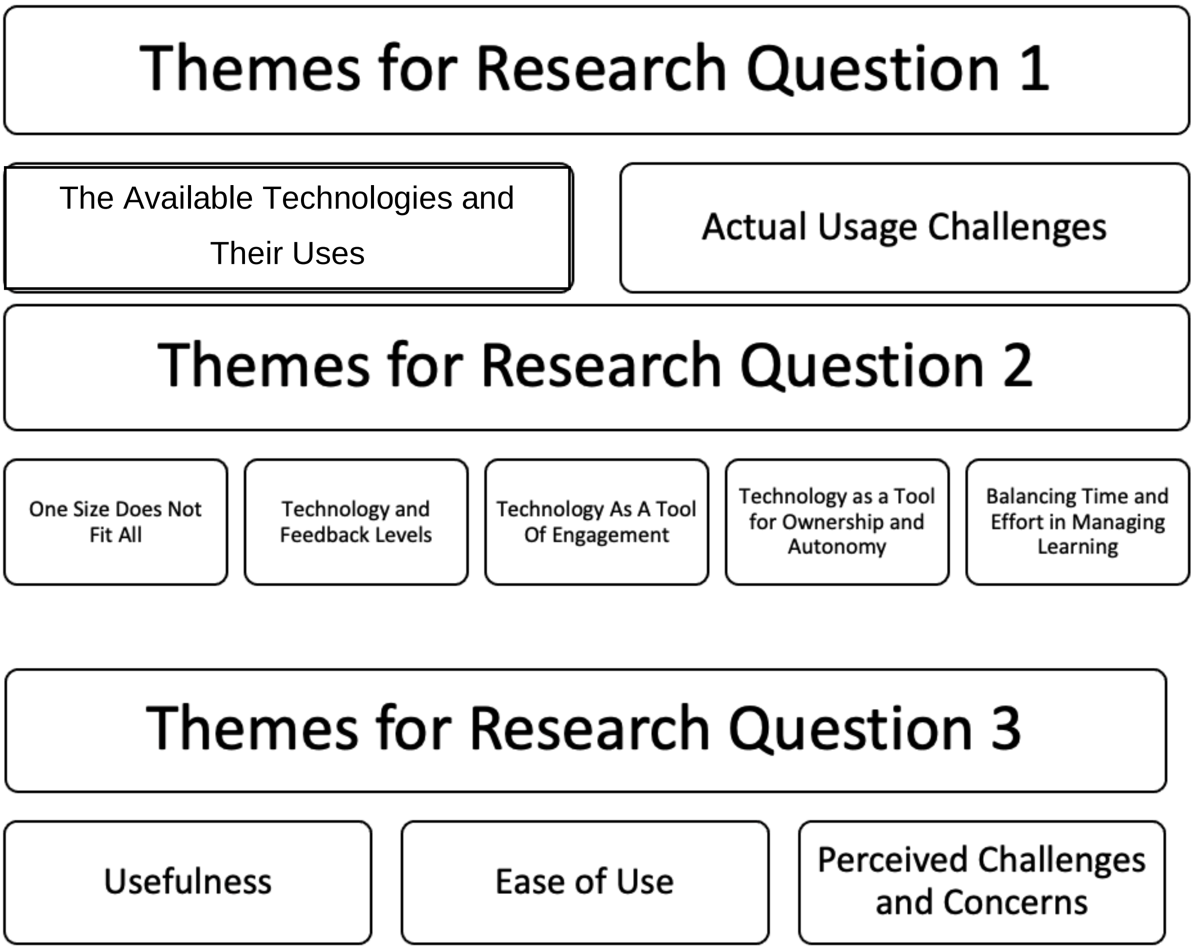
	Classroom Observation	Year	Class	Number of Students	Subject	FA Strategies					Technology
						Learning Intention	Discussion	Feedback	Students Groupwork/Peer	Student's Self-assessment	
STEM	1	IB/ HL, SL	Lab	HL: 3 SL: 2	Chemistry	✗	✗	✗	✗	✗	✗
	2	IB1	Lab	13	Chemistry	✓	✗	✗	✗	✗	✓
	3	IB2	Lab	3	Biology	✓	✓	✓	✓	✓	✓
	4	IB1	IT Lab	5	Computer Science/ IT	✗	✗	✓	✓	✗	✓
	5	IB2	Classroom	3	Maths1	✗	✗	✗	✗	✗	✗
	6	Grade 10	Classroom	10	Maths2	✗	✓	✗	✗	✗	✓
Languages	7	IB 2	Classroom	4	English A/ HL	✗	✓	✗	✗	✗	✗
	8	IB 1	Classroom	10	English B	✗	✓	✗	✗	✗	✗
	9	Grade 10	Classroom	10	English	✗	✓	✓	✓	✗	✗
Humanities	10	IB2	Classroom	13	Geography	✓	✓	✓	✓	✓	✓
	11	Grade 10	Classroom	11	History	✓	✓	✓	✓	✓	✓
	12	Grade 10	Classroom	7	Humanities	✓	✓	✓	✓	✓	✓

The codes present the perceived adoption and adaptation of diverse affordances of the related technology, whereas whatever is not perceived as a benefit is considered a constraint or concern, as can be seen in the themes' discussion and Figure 4.22. The same chart demonstrates that the Ease-of-use theme discusses how the technology, in hardware and software forms, was perceived as accessible, fast, and straightforward for both teacher and student participants. The Usefulness theme shows how technology is perceived as an aid in organisation, communication, and support for learning for both teachers and students. Finally, the Challenges theme covers the distraction perceived with technology and how the effects of the used technology are perceived as unsustainable.

Overarching themes emerged from the coding process after following the ten phases of thematic analysis discussed in section 4.3. Codes were generated and refined into initial descriptive codes. The codes then were categorised into themes related to the research questions: formative assessment technologies usage, utilisation, and perception (see Figure 4.22). These themes will be discussed in more detail in the subsequent sections.

Figure 4.22

Research Questions and Their Corresponding Themes



4.3.1 *Theme 1*: *Available Technologies and Their Uses*

This theme explores available technologies and their use. The technologies are divided into Devices (portable and non-portable), Software, and Websites, as shown in Figure 4.23.

Figure 4.23

Theme 1 Available Technologies and Their Uses

The Available Technologies and Their Uses

- Devices
- Software
- Website

During the interviews, participants reported a broad range of technological tools, software, and websites used daily. Devices, such as laptops, iPads, and desktops, are available to all teachers and students; concurrently, teachers and students are allowed to use their own devices in classroom work or privately. Nevertheless, students seemed to have more freedom to use their smartphones than teachers did. In some observed classes where teachers allowed students to use their mobile phones, students used their smartphones alternating with other, school supplied devices. Students were also observed using all kinds of personal devices such as smartphones, laptops, and iPads everywhere at school. The use of these devices and software differed based on the purpose of learning and teaching. For example, each subject teacher and department used specific educational and assessment software that suited their subjects; in contrast, students' choices were based on their preferences.

Table 4.28

Technology Used in School as Reported by Interview Participants

	Technological Devices	Learning and Assessment Technological Software and Websites	
Portable	Laptops iPad Smartphone	STEM Group: Science Maths	Kognity, Caboodle, Assess prep MyMaths, Kognity
	Desktops	Computer Science	BlueJ, CodeAcademy, Google Drive, Google Sheet
Non-portable	Interactive White Boards Projectors Sound System	Humanities Group	Encyclopaedia Britannica, Kognity
	Visualizer	Languages Group	No software or websites are used or funded
School's Formal Software and websites Shared by all Subjects			
ManageBac, Google Classroom, Google Docs, Google Forms, Google Sheets, Google Slides, Khan Academy, Email, Quizlet			
Informal Software Mainly Used by Students			
PhotoMath, Symbolab, YouTube, Microsoft Apps, Google Search, Grammarly, social media			

All teacher participants stated that the primary technology used in FA and feedback was ManageBac, and its principal function was administrative. Teachers used it for assigning tasks and providing feedback. This software is integrated with many educational and formal applications, such as Google applications, Email, AssessPrep, Caboodle, and Quizlet. Teachers reported that the school assigned ManageBac to organise students' input, assign tasks, submit them, and provide feedback and grades to record and follow students' progress. They also said that ManageBac is designated for communication between students themselves, teachers and students, and parents.

ManageBac allows teachers to use different applications to upload and document students' grades in Google Sheets to follow them up later. At the same time, both teachers and students could check target and expected grades and the criteria that students need to follow to understand their position and progress. ManageBac generates students' reports and performs valuable and accessible data analysis for teachers, students, and parents. Besides, students stated that ManageBac allows group communication features for formative assessment purposes and can be linked to each subject. They follow up and provide process feedback in groups within the ManageBac platform. Students also reported that ManageBac is integrated with Google Applications. It enables them to receive feedback through Google applications such as Docs (Google Docs, n.d.) or Slides (Google Slides, n.d.) using sharing and editing features or even emails.

Furthermore, some teacher participants (Teachers 1, 6, 8, 10) elaborated on how FA software supports their assessment practices. First, they assign a task from assessment software, such as Kognity, or online websites, such as Encyclopaedia Britannica. This task could be assigned as a class activity or homework. Then, teachers can track students’ progress instantly or anytime and decide what went wrong on each task. These technologies allow teachers to set different tasks individually according to students’ strengths and weaknesses. Teachers reported that they primarily used the formal software that the school provided. Those technologies promote instant feedback to the teachers, which supports their instructional process on the spot and planning for the next lesson. Furthermore, student interviewees reported that this technology allows them the needed resources to complete the assigned task.

Students in classrooms 10, 11, and 12 were observed to manage their tasks online, either in pairs or groups using Google Applications such as Google Slides. They were able to share their work with each other as a group and with the teacher using the live sharing feature. They could also share their work with the rest of the class using the integration feature with the Smartboard. The teacher instantly monitored the students through the IWB and provided process feedback that connected ideas and identified errors. For example, the teacher gave all students feedback by describing the process orally and writing some examples on how to and how not to approach the task on the IWB. However, one-to-one task level and self-level feedback were provided, such as in classroom 1 (see Table 4.27

The teacher was observed spending a long time explaining and giving feedback to one of the students while doing the exercise.

Moreover, all teachers cited the Internet as one of the primary information resources for assessing students. Teachers utilise the Internet to locate specialised information, standards, and tools that assist them in organising and planning their students' evaluations. During interviews, teachers revealed that they utilise particular websites to access many test questions, marking schemes, and examiner comments in math, science, and English. The materials are easily accessible online, and teachers can rapidly download and print the necessary materials. Online resources also help students to understand topics at their own pace. According to Student 7, if they cannot understand some concept in class, they prefer to learn it from the Internet. Moreover, the Internet facilitates students in FA and self-regulation. Student 5 shared the importance of online resources such as Google Search for feedback, which is beneficial for informing them of the areas where they have weaknesses and the areas where they need to improve. Student 5 also mentioned that they tend to seek online resources first before going to the teacher:

If we have an assignment, we try to go through the books by ourselves, but we often search it up on Google because we can find online PowerPoint and essays analysed and provide resources. Then we go to the teacher and ask for face-to-face feedback or any question.

Most student survey and interview participants said Google applications (Classroom, n.d.; Google Docs, n.d.; Google Forms, n.d.; Google Slides, n.d.; PupilAsset, n.d.) are used in their daily teaching and learning. It makes it easier to share work and submit assignments to the teacher. In addition, students also recognised that software like Google Docs helps to share their reports with the teacher and for teachers to write feedback easily and for specific aspects. In chemistry, students were observed to share their work with the teacher through Google Docs, while waiting for their feedback. Humanities students also used this tool to share the assignment with the teacher and their peers and receive feedback. The Smartboard was also used for this activity. They shared the group presentations on their laptops with the teacher in real-time, and the teacher projected them on the Smartboard for evaluation.

As observed, teachers generally use the Smartboard to share with students' documents, slides or even the activities' objectives, instructions, and criteria for carrying out the tasks, exercises, and other assignments. It was also used to project content, such as videos, images, and texts through Google applications and YouTube complemented with the questioning and encouragement of student participation in class discussions. In the geography subject, the teacher used Google Classroom to share the files and ask students to submit the task they did in class through Google Docs to give feedback and adjust online. The students completed internal assessments and mini-research projects and discussed work using the Internet, social media, and platforms, such as Google Docs and Google Slides. It was observed in the geography and history classes that students used their laptops to write the search results in Google Docs (geography and history) and on slides (humanities), which allowed them to share their work with the teacher and other classmates.

As already stated in the previous section, the use of technology has become even more prominent with the onset of the COVID-19 pandemic. About the theme Available technologies and their uses, Student 11 pointed out:

Technology allows me to communicate with teachers and classmates using the school Gmail or Google Classroom. It also allows me to chat with my friends using social media apps such as WhatsApp for educational purposes and not only for entertainment. Technology allows easy access to the Internet, which makes researching a much simpler process. During those times in the lockdown, we realised the importance of technology in education when not attending school. In other words, technology can sometimes replace real life even when it comes to education.

Another interview participant, Student 9, stressed that technology-based FA improved their learning in different subjects, making studying more engaging and online formative assessments more interesting. Here too, the student pointed out that the assessments differ depending on the subject. For example, in science, online simulations could be used to test knowledge, whereas in maths, Student 9 said it "mostly is not as eye-catching, and it uses questions with blanks due to the nature of the subject."

Despite obvious advantages offered by technologies, there are affordances and constraints to using technologies that need to be mitigated. Student 10 made a related point that sometimes technology hinders the student from hearing the actual meaning of purpose behind the feedback. In person, a student can ask questions and have a conversation that yields a better outcome in assimilating the feedback. Student 6 said they use the Internet to revise concepts but value the communication with the teacher and ask the teacher about topics and concepts covered in class. Another potential affordance then to analyse is how to keep this personalised and iterative dimension to the feedback that the face-to-face interactions seem to provide.

In some instances, students went into their personal use of technology in their learning in more depth. The interviewees discussed responses to the use of technologies and the adaptations they have made to their learning. Student 2 explained that they use Google Slides and Docs for projects because it allows them to share the document with their teammates. Another advantage of working with teams is that Google Docs are updated instantly if any changes are made and are accessible through a link. Student 12 liked this method because the teacher can highlight a specific part of their work and provide feedback on it, such as correcting it or asking to extend the answer without changing the student's actual work.

Thus, technology aids teachers in assessing students more accurately because it allows them to track the students' progress in real-time. The tracking attribute could be achieved through various means. These means include Google Applications used to show real-time answers and discussions that arise throughout the activities, online websites for exercising the new knowledge gained, assessment software for testing students' knowledge and providing feedback instantly, and devices facilitating the stated software and websites. Interestingly, the most popular programme among the teachers was Pupil Asset (PupilAsset, n.d.). However, the teachers mentioned this tool during the interviews only twice, whereas the second and third most popular choices, ManageBac and Google Classroom, were widely discussed during the interviews.

4.3.2 Theme 2. Actual Usage Challenges

Although most participants acknowledged the benefits of using technology in formative assessment and feedback activities, integrating technology entails certain challenges, as was already discussed in the previous sections. However, the previous themes did not cover all issues expressed by the teacher and student participants. Thus, a separate theme, Actual usage challenges, was identified. The challenges which are described in the next subthemes include:

- Policy and accountability
- Teachers’ training and technology resistance
- Ethical issues
- Technical issues (see section 4.24)

Figure 4.24

Theme 2: Actual Usage Challenges

Actual Usage Challenges

- Policy and regulation.
- Teachers’ training and technology resistance.
- Ethical issues.
- Technical issues.

Challenges related to policy and accountability often arise from the conflict between what is required and what is convenient or customary. For example, while Teacher 8 (humanities) reported their total reliance on technologies in assessment and feedback practices, this practice contradicts the Ofsted regulation that enforces the use of exercise books, which enable teachers to inspect student work. Nevertheless, Teacher 8 has their rationale:

We find that if everything is online, it is becoming quite helpful. Because when half is online, half is in books, it becomes scattered, so we prefer our feedback to go online. However, we do sometimes comment using our platform ManageBac.

When Teacher 8 was asked how they would overcome this challenge, they said:

For presentations, we print off them, not very environmentally friendly. I understand not to print one slide per page, but you can put six slides per page or three slides per page, and we find that when you print them.

Teacher 5 was also not happy with the Ofsted regulation notion since technologies are supposed to increase efficiency and with Ofsted regulation, it takes more effort and time. They said:

What we do is we use any tool that we have on iPhone or iPad, and laptops. But for Ofsted regulation, students should fill this form or do the assignment in class, handwritten, and then I can scan it in the camera here and go back to review and write the feedback and give it back to them. Again, the whole point of it is quickly have them to complete and get back, or quickly get them the feedback they need, and making your life easier because of all these data.

The second subtheme, teachers' training, and technology resistance is related to the tendency for some teachers to not use technologies during the learning process due to a number of considerations. For example, Teacher 11 reported the lack of available information related to the potential use of technologies:

I'm sure there are things that we could use in technology which would make my life much easier. But until I'm shown them, I don't know they exist. If nobody tells me this exists, I can't use it, but I find I get on okay without using it.

The second reason is the lack of time. For example, Teacher 4 emphasised: "I should be able to use all the features everything that it allows you to do, and I don't. Because I just don't have time actually to learn it."

Both teachers and students reported limited use of technologies in English language subjects in classroom practices. Student 4 said:

In English mostly we don't use technology. Not everyone is using Smartboards. Usually in English lessons we discuss topics. This week, for example, we have like "book week" we read a book and later we write a story.

Student 3 emphasised the same notion about the English language classes and reported related challenges by comparing the assessment and feedback practices between languages subjects and STEM:

For English we are given both oral and written feedback. We are informed of the areas we're lacking and the areas where we need to improve. As for science we are given written feedback on our homework, class work and assessments. Also, we get online quizzes where we are given general feedback depending on the questions as it’s not tailored to us and our way of studying.

Student 3 also expressed that feedback preferences vary with the nature of the subject taught, giving an example of lab work:

For the scientific laboratories I find it should be easier for us when needing answers, but unfortunately it is still quite difficult to get an answer to a specific question or query from the Internet, and it is more helpful to ask a teacher while being in a lab so that we may fully understand. Although apps like Google Docs help when it comes to sharing our reports with the teacher and for them to write feedback easily and for specific aspects.

It is worth noting that these notions correspond to the survey results showing that both English and chemistry subjects have limited uses of technologies in their assessment practices (see Table 4.27
), which could be due to the challenges mentioned by both teachers and students. Although teachers still use emails and Google Docs as a mandatory requirement of assignment submissions in ManageBac in the IB schools, Teacher 4 reported that they have limited use of these technologies:

They (students) will share their stories with me through Google Documents. And I print them out, I correct them. I do not like correcting on a computer; it's something I don't like. And then I give them back, and then they correct them and share with me. That’s what I prefer.

Teacher 9 reported further challenges while using technologies, especially with online quizzes or polls, including technology being distractive and having no clear distinction between educational and non-educational use of technology.

Nevertheless, students are often not content when their teachers ignore a potential offered by technologies. For example, Student 13 said:

… what is difficult sometimes is when my teachers are unable to use technology efficiently in the classroom and can't do simple things like putting a YouTube video on full screen, let alone sending the work/files/documents correctly.

The third identified subtheme is related to ethical issues while using technologies in the learning process. First of all, Teachers 1, 6, 10, and 11 expressed their concerns about current plagiarism and cheating opportunities offered by technologies. Nowadays, students use the Internet for assessment activities because they can quickly find the answers there and use them in their tests. Alternatively, they might copy and paste the information into a Word document or onto a PowerPoint slide. Thus, teachers should be cautious in assessing the students' works and use plagiarism software to check whether a student’s work is genuine. Also, students’ works are aided by the automated correction feature that software usually possess, such as Word Doc. Teacher 10 (economics) said:

They could do E-assessments at MYP level they do the E-assessments; I think grade 10 do the E-assessments. But you know, we were very much against the students doing E-assessments. I mean, they would, they could type it, it would be automatically made, I don't know whether that's banned in exam session for the computer to automatically correct grammatical errors or highlight grammatical errors that the students are making because then that would kind of be cheating in an exam, I don't think that we're allowed to do that.

To address this problem, Teacher 10 does not allow their students to type on a computer when working on their exams or even essays, only do handwriting, because, according to this teacher, “when they actually start typing things in the computer, what I find is they start to plagiarise, or just copy and paste things”.

Finally, according to some participants, technical issues also hinder the use of technology in the learning process. For example, Teachers 9 and 10 experienced technical issues with reliability while using the Smartboard, such as slowness in the writing attribute that those Smartboards offer. In particular, Teacher 10 said:

I don’t like actually Smartboard because it's not that refined. And it's easier for me to write on board. I said a long time ago now since I used it, I use it by, you know, it can go off. I mean, the writing isn't always very good. Now, for example, with pens and things like that, I mean, it's not, it's not perfect. And sometimes, you know, the writing goes on, you know the students, I want to get the students to come and write on the board as well, then the writing can go kind of wonky, and in an angle and, you know, cannot be legible at times. So, it's just easier to use the actual board over there. It takes time personally, but to set it up for a start, then. Yeah, I mean, it's just, it's almost like a hindrance in some ways.

Teacher 9 talked about how the interactive feature in the Smartboards glitches, freezes up while using them and how the teacher stopped using this attribute since it slows down his instructional activities. It takes more time and effort in planning, according to Teacher 9:

The interactive capabilities have been disabled from this Smartboard. I've used it before when we were able to, but at the moment, I think it can be a bigger distraction than the actual learning process. That's the problem because it's so almost like a fun activity but the concepts are not being learned when I'm teaching IT. So, I avoided most of the interactive capabilities. I think the actual way it's been used, and software that supports it has different capabilities, and I haven't gone into it much, but I've noticed a few different matters, since it does slow things down when you're trying to teach a lesson, it can become a waste of lesson time with you. It can freeze up, and you're waiting for it to load, and it can be quite problematic.

Furthermore, Teacher 15 expressed some issues with the sharing and storing document attributes that the used technology offers. They also explained how the new technologies are overwhelming to them as they always seem to be in an experimental mode: "…we're constantly experimenting, (…) we can't find the document or it's shared incorrectly or this or that, but for the most part, it's not a success".

Student participants also shared some problems with using platforms and digital storage systems and file sharing. For example, Student 12 told how once they accidentally deleted their answer on AssessPrep (AssessPrep, n.d.). They were under time constraints and had to either retype everything summarised or move on since AssessPrep assignments are timed. After the time given, the application shuts, and there is no opportunity for editing answers. The student described this experience as very stressful, as opposed to paper-based exams.

Student 12 also experienced other problems with AssessPrep when they lost their work due to the application glitching. Furthermore, Student 12 expressed a health concern related to technology: "…since we mainly use technology in our studies now, it can be harmful to our eyes as we constantly look at a screen for long hours every day".

Thus, the interview and observation findings seem to be in correspondence with the survey results, which showed that there is a range of opinions on whether it is easy to use the technologies during the learning process (see 4.2.5) with students being more positive (see Figure 4.20
) than teachers (see Figure 4.19). Possibly, because of these perceived and actual challenges, some teachers significantly limit the use of the technologies during their classes and disallow their students from using some devices and technologies.

4.3.3 Theme 3. One Size Does Not Fit All

Many participants perceived that technology-based formative assessments improve learning in different subjects, making studying more engaging and online formative assessments more interesting. Nevertheless, participants point out that one kind of technology is not suitable for all subjects or users. In this regard, the One size does not fit all theme will be explored in two parts:

- How certain technologies are not compatible with all subjects
- How certain technologies are not suitable for everyone (see Figure 4.25).

Figure 4.25

Theme 3: One Size Does Not Fit All

One Size Does Not Fit All

- Not compatible with all subjects
- Not suitable for everyone

Assessment activities differ depending on the subject, according to some participants. For example, online simulations could be used to test knowledge in science. Whereas for maths, as Student 9 said, "mostly it is not as eye-catching, and it uses questions with blanks due to the nature of the subject". For science, Student 3 noted they are only given written feedback on homework, classwork, and assessments. For online quizzes, they are given general feedback depending on the questions they got wrong. According to Student 3, this feedback is more automatic; they can tell it is not tailored to students personally and their way of studying. English and maths were the most discussed in terms of striking differences. Still, these disciplines seem to be the subjects with less technological penetration because English requires reading a lot of literature and interpretation and maths is complex because of the need to calculate at every step and show your work.

Science teachers explained that their assessment technology choices do not depend on their preferences. They usually decide, as a department, on assessment tools based on the subject. Kerboodle (n.d.) is suitable for all sciences, and teachers prefer it because it allows them to design their tests. They can adapt it to the International Baccalaureate (2021) curriculum, using an online IB question bank and designing their assessment, grade scheme, and mock exams. They also mentioned ExamPro (2021) software for year ten students since they used a different curriculum (GCSE).

Similarly, the available technologies were not perceived as suitable for all subjects, especially maths and labs. Students expressed how maths application is not suitable for all branches of maths such as algebra and geometry. For example, Student 14 said:

Some challenges that I face is during math assessments. I found it really hard to do the maths work as it's a little bit difficult to show working out and plotting graphs online.

Student 3 talked about difficulties with the feedback process in maths:

I find it difficult when feedback for maths is given via email or when I receive the automatic feedback after doing an online quiz, it is easier when the teachers give oral feedback personalised to each student so they can also show us examples on how to solve the questions right or show us where we went wrong because if it's done via email it would be very difficult for them to explain and for us to understand.

Maths and science teachers shared the same sentiment regarding the suitability of used technologies to their subjects or specific topics. For example, chemistry Teacher 1 said that technology is not useful during the lab work:

When you're doing a lab, the most important thing is hands on experience. So unfortunately, technology has nothing to do with that.

Biology Teacher 2 conveyed a more detailed view of how technological features provided in assessment software are suitable for giving fast, simple insights about students' level of knowledge, but when it comes to complicated matters, technology cannot help:

…when you are using technology tools for formative assessments, you can do some things that you just cannot do without technology, right these digital tools can give you a window into students' thinking in a way that just would not be possible from a logistical perspective, the ability to have a meaningful conversation with each one of your students in your class is just really tough over a course of, you know, a lesson like how do you know for sure that they've got this. No, it's one thing if your students are submitting a couple of multiple-choice questions when they are answering say a maths question or, you know, figure out what the answer is and add these fractions, and yeah like you definitely could get some great information from kids, filling out a Google Form with that.

With regard to specific programmes, Student 12 emphasised the ubiquity of technologies across the different subjects using AssessPrep tests and exams, such as using technology to put together presentations or formulating an essay. According to this student, some subjects are better suited than others to technological tool platforms . Student 10 echoed this idea and said it was harder to show calculations in maths in the digital format. They said that it is more challenging for more mathematically focused subjects, such as statistics, because students use the exam paper to write down thoughts and show the methodology. On the computer, it is much harder to illustrate that. However, Student 10 pointed out that it is easier for subjects like economics and business to type out the student's answers and thoughts.

According to classroom observation (see Figure 4.23
and Appendix 7.15), the humanities subject classes were the only group using technology-aided formative assessment to facilitate all formative assessment strategies in all subjects. With technology, teachers in these classes covered

learning intentions, discussions, feedback, engagement, group/peer assessment, and self-assessment. Teachers and students were using varieties of technology for assessment and feedback purposes, such as IWB, Google Slides and Google search. Students also reported using technologies in these subjects outside the classroom for formative assessment and feedback purposes.

The languages were the subject group least using technology-aided formative assessment and feedback. I observed three different English teachers in their classrooms, and they did not use technology-aided formative assessment and feedback in any of these classes. The teachers reported that their use of technology in FA was limited to Google Docs as they are compelled by IB regulation to receive students' assignments through ManageBac and provide feedback for assessment purposes. One English teacher reported that they printed the assignments to provide handwritten feedback and sent them back to the students, although students reported that they do not use technology for assessment purposes in the language classrooms. However, they use online portals for resources and social media applications to communicate with peers for assessment purposes in these subjects outside classrooms. It is worth noting that one of the English teachers raised the plagiarism concern, and the other raised the concern that students were unprepared for the e-assessment final because they did not use the technology enough.

STEM subject-group technology use in formative assessment and feedback varied depending on the subjects and topics. Maths subject had the least technology use in their assessment practices and activities, if any, compared to other STEM subjects. At the same time, biology was the subject that showed technology facilitating all formative assessment and feedback strategies. Students reported using some learning portals in biology, chemistry, and sciences subjects, such as Kognity and informal portals. However, their view regarding maths was similar to their teachers' as they do not use technology in maths, since technology was not regarded as suitable for most maths topics.

According to the results of the analysis, certain technologies used in the learning process are not suitable for everyone; therefore, one size does not fit all. Consequently, there are some constraints to applying technologies that need mitigation. For example, Student 10 made a related point that sometimes technology hinders the student from hearing the actual meaning or purpose behind the feedback. Face-to-face, a student can ask questions and have a conversation that yields a better outcome in assimilating the feedback. Moreover, Student 6 said they use the Internet to revise concepts but value the communication with the teacher about the topics and concepts covered in the class. Thus, another potential affordance would be to analyse how to retain this personalised and iterative dimension that the face-to-face feedback interactions seem to provide, while also using technologies in a kind of hybrid approach.

Further evidence suggested that, although teachers may send elaborative feedback using technology, not all students could comprehend the teachers' feedback through the text-formatted communication. Some students preferred direct, verbal communication with the teacher while others complained that teachers did not respond quickly enough to their emailed enquiries. As Student 11 put it:

Sometimes used technology does not help when you do not understand the feedback fully, because feedback that you get when you talk to your teacher face-to-face in school is just easier to understand than a typed comment on your document, which is also a problem. When I was doing an essay the teacher wrote me a long comment on my introduction and it seemed like the teacher understood what they were talking about, but it was hard for me to understand where exactly to improve. In other words, sometimes used technology challenges communication which restricts education.

In particular, students expressed that email might not be the best communication tool for all teachers, since some teachers were unable to send timely responses to a student's enquiry. For example, Student 11 reported:
Sometimes when I email a teacher about something related to my work, the teacher replies late or does not reply at all, which challenges communication if people are not very active on Gmail.

In his turn, Student 7 elaborated on why he prefers onsite feedback on online feedback:
We can still use Google on that and to check our answers, but I feel it's better to ask my teacher cause it's more personal and I can ask questions, and he's right in front of me. I believe face to face feedback is better than like going online and then like on YouTube because your teacher knows where you're struggling in your area. But with YouTube or like on the website, it's generalising what people think that they have an issue in. But when it's with a teacher, they know specifically where you're struggling and what area you are in. Technically, normally, we're asking the teacher about the process. So sometimes you don't understand the certain process we go through. So, we in maths, it's certain stages, and we have, if you can't complete a stage, you can't move on to the next stage. So, it's like sequence.

It could also be challenging for some teachers and students to develop competency with technologies that might require new or specific skills, highlighting the importance of training. In this regard, Student 10 said:

Technology, in general, can be a challenge for some people who do not know how to benefit from it optimally and use the resources it offers at hand and the opportunities it opens up to. So sometimes that seems to be unfair for those unable to use technology.

Student 13 was even more articulate in their view towards teachers' abilities and skills:

As a young person, technology is really easy for me to work around, and many of my peers share study resources online; however, what is difficult sometimes is when my teachers are unable to use technology efficiently in the classroom and cannot do simple things like putting a YouTube video on full screen, let alone sending the work/files/documents correctly.

Thus, variability in teachers and their skills and competencies also supports the findings that one size does not fit all. Thus, technologies should be tailored for their purpose and application, taking into account not only the disciplines but also the individualities of the teachers. The same can be said about the capabilities and skills of individual students, since these could be highly variable with some students experiencing disadvantage due to having lower self-efficacy with technology.

It should be noted, though, that students showed more freedom in technology choices than their teachers, as teachers are more governed by suitability to the subject and the school and Ofsted's regulations and policies. In contrast, students appeared to be at liberty to choose whatever technology they decided was fit for purpose. For example, Student 2 discussed their choice of specific applications:

In regard to the apps for note taking, I use GoodNotes for proper note taking and for assignments and Notability for rough notes. The reason why ‘GoodNotes’ is more formal, as it’s limited in the functionality as it mostly serves to be a life like notebook with lined paper and a pen. Whereas Notability doesn’t limit you to that, you can insert pictures create shapes, sketch and also write.

Furthermore, inequalities in access to technology for some students was also important to consider when considering the use of technologies by teachers and students. As Student 10 pointed out, technology can be a challenge for some people who do not know how to benefit from it optimally and how to use the resources it offers and the opportunities it creates. Sometimes, it seems unfair for those unable to use technology adequately to be forced to place so much reliance on it. For example, Student 6 mentioned that they prefer pen and paper over the keyboard because they lack computer keyboard skills. Therefore, not only for earlier generation teachers but also some students, technology can be challenging, and they require motivation and opportunity to develop the necessary skills. For these individuals, gaining acceptance of the technology depends on several elements, including their perceptions of how useful the technology would be to them and how easy it would be to use.

Finally, students also expressed some constraints in technology use. For example, they recognised that some technology might require a certain level of skills that would not be convenient or would be too difficult to learn due to time constraints or cost, in the situation when taking a training course or participating in a seminar involving payment. Also, students reported that accessing the

Internet from their own devices outside school computers may be perceived as difficult or expensive. Students may need to pay for data they download or time searching online, which could be cost-prohibitive and lead to inequities in education and academic achievement gaps for economically disadvantaged students (Hobbs & Mutebi, 2021).

Thus, the classroom observations and interviews showed that the emergence of new technologies in education and personal devices inside and outside the classroom was perceived as a challenge in some circumstances and that choices of these technologies should ideally be tailored for each subject, teacher, and student. This process is already ongoing in the IB school, as the survey data analysis (section 4.2) shows a wide range of devices and applications chosen by different teachers and students (see Figures; 4.1, 4.2, 4.3 and 4.4)

4.3.4 Theme 4. Technology and Feedback Levels

This theme demonstrates how technology could aid both teachers and students in moving learning forward by promoting a swift transition between three feedback levels: task-level, process-level, and self-regulation level (Hattie & Timperley, 2007; Xiao & Yang, 2019) (see Literature Review and Figure 4.26).

Figure 4.26

Theme 4: Technology and Feedback Levels

Technology and Feedback Levels

- Task level
- Process level
- Self-regulation

Classroom observations showed that several technologies were used to share feedback during the learning process. Observations of chemistry students indicated that they share their work with the teacher for their individual feedback through Google Docs. Students in the humanities classroom also used this tool to share assignments with the teacher and peers to receive feedback. Furthermore, the Smartboard was also used for this activity, along with students' laptops. The students were live sharing and presenting their projects on the Smartboard for discussion and feedback. They were receiving both oral and online feedback from their teachers and peers; the teacher's feedback was in the form of purposeful questions for integrating ideas and questioning assumptions in an open discussion with all the students. The teacher was referring to the criteria presented on the board and shared via slides.

At the same time, it was clear that both students and teachers interacted and showed enthusiasm and engagement while the students were working together on one document on their laptops using a live document/presentation collaboration tool of the Smartboard. In geography, the teacher preferred to use Google Classroom (Classroom, n.d.) to share the files and asked his students to submit the task, which they did in class through Google Docs, so that he could give feedback and adjust online. Some humanities subjects used Google Slides or Docs according to the nature of the task. Teacher 2 said the following:
One of my favourites of course is Google Docs integration. And here you'll see that it is a tool that can be used to give feedback. can be used for comments and texts on the side, lots of different options, you'll see some similar features when you jump into, say, Google Docs or Google Slides. And so, ability to peek in student work is an important part of formatively assessing students, figuring out where they are in making a decision about what they need to move forward.

Biology Teacher 2 also emphasised the timeliness of feedback when comparing past and present experiences:

What I love about these types of tools such as Google Docs or Google Slides, is that it makes feedback more timely and more purposeful. So, I am not only looking at student work, but they can see my responses in a much timelier manner. So yes, when I think back to the times where I was putting a post it notes with a you know a glowing and grow or a next step for students, and the amount of time it would take for that to go from, you know, their desk to my desk and back to their desk, you know a lot was lost of time in that process right.

These technological platforms and devices were observed to be used in all levels of feedback depending on teachers' skills, goals, approaches, or even questions. At the task level, the teachers used them to facilitate knowing how good the task is being executed, how explicit or relating to the core tasks process, and even in supporting students to monitor and regulate progress in the learning goals. In this regard, Teacher 14 said:

I could focus in the classroom on assessing them, checking where the gaps in knowledge were, and helping them deal with that.

Regarding the process level, the humanities teachers consistently checked students' work from the teacher's desktop and gave feedback on various processes. The teachers used multiple-choice questions and questions like, “Which part is this related to?” or “who can elaborate and how?”. These were to check students' knowledge and transition to other feedback levels. In some subjects, such as social sciences and science subjects, the teachers asked about the concept. In others, students were asked to search for more information online and justify their answers and their peers' answers for process-level feedback. Teacher 8 said the following on the process level feedback:

What we found in this class is that knowledge and understanding is kind of lacking. So in-depth knowledge, you probably saw it, that we're just skimming the surface of the revolution. So again, we need to you know what kind of idea is to them (students). Build that so we had a discussion with the department yesterday and we're really trying to enforce more research, more knowledge, not relying on the textbook as I showed you so that you know they don't just rely on all the textbook because that's just very, very basic. So, we want them to look at other sources, other websites, not Google but official, like Britannica, have a few tests choices that we use. I find Britannica is the most useful because there's journals, articles and images and videos. And that way they can kind of build that content. Technology in the feedback process, that's a good one.

Finally, technology assists students in self-regulation feedback processes. History Teacher 7 supported the importance of technology in self-assessment, arguing that it makes the process even quicker since self-assessment is already the quickest feedback process. Along with self-assessment, peer assessment could be classified as a part of self-regulation, as teachers often discuss self-assessment and peer assessment together. For example, Teacher 1 said the following:

During the self-assessment, basically they have a mark scheme, and they follow that through, and they check their peers. So, it's really nice the peer assessment, for example, because they can see someone else's misconceptions or how they are giving the wrong answer and how an examiner corrects to help them. This is how self-assessment and peer-assessment are done in class. They give feedback to each other, which is excellent, and then I review it to make sure it is perfect.

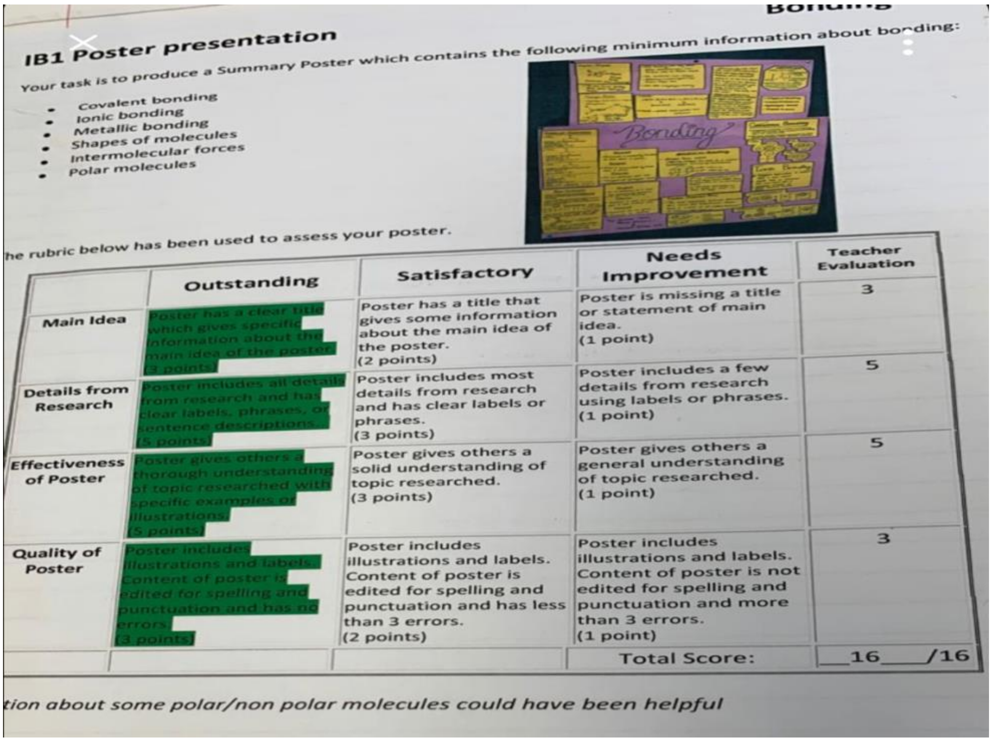
Teacher 1 presented examples of the rubric provided to aid students in their self-regulation process. Figure 4.27, for example, is about a poster. The rubric describes how each assignment should be evaluated. The rubric divided the poster into four main sections: main idea, details from the research, effectiveness of the poster and the quality of the poster. The rubric is showing for each section the criteria of assessment and how is it assessed, as outstanding, satisfactory or needs improvement.

Figure *4.28*

Figure 4.27 shows an example of the feedback provided to one of the assignments. However, both rubrics and feedback are for grading and reporting purposes and there is no data regarding if these rubrics are provided earlier before submitting the task or the role of technology in the assignment formative assessment and feedback.

Figure 4.27

IB Poster Presentation Rubric



Bonding

IB1 Poster presentation

Your task is to produce a Summary Poster which contains the following minimum information about bonding:

- Covalent bonding
- Ionic bonding
- Metallic bonding
- Shapes of molecules
- Intermolecular forces
- Polar molecules

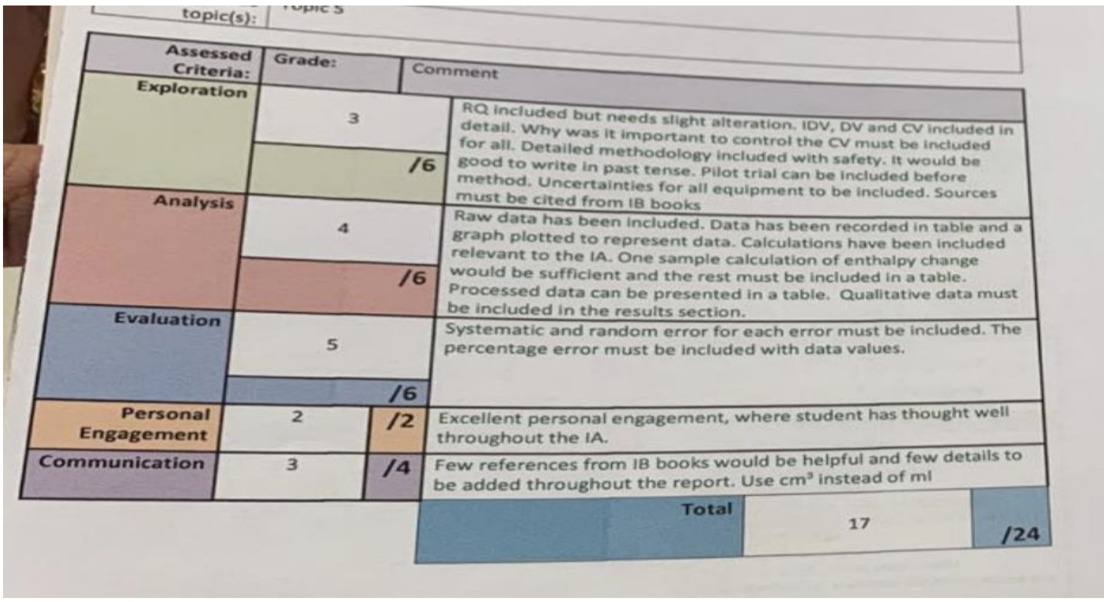
he rubric below has been used to assess your poster.

	Outstanding	Satisfactory	Needs Improvement	Teacher Evaluation
Main Idea	Poster has a clear title which gives specific information about the main idea of the poster. (3 points)	Poster has a title that gives some information about the main idea of the poster. (2 points)	Poster is missing a title or statement of main idea. (1 point)	3
Details from Research	Poster includes all details from research and has clear labels, phrases, or sentence descriptions. (5 points)	Poster includes most details from research and has clear labels or phrases. (3 points)	Poster includes a few details from research using labels or phrases. (1 point)	5
Effectiveness of Poster	Poster gives others a thorough understanding of topic researched with specific examples or illustrations. (5 points)	Poster gives others a solid understanding of topic researched. (3 points)	Poster gives others a general understanding of topic researched. (1 point)	5
Quality of Poster	Poster includes illustrations and labels. Content of poster is edited for spelling and punctuation and has no errors. (3 points)	Poster includes illustrations and labels. Content of poster is edited for spelling and punctuation and has less than 3 errors. (2 points)	Poster includes illustrations and labels. Content of poster is not edited for spelling and punctuation and more than 3 errors. (1 point)	3
			Total Score:	16 /16

tion about some polar/non polar molecules could have been helpful

Figure 4.28

Internal Assessment Rubric and Feedback



topic(s): Topic 5

Assessed Criteria:	Grade:		Comment
Exploration	3	/6	RQ included but needs slight alteration. IDV, DV and CV included in detail. Why was it important to control the CV must be included for all. Detailed methodology included with safety. It would be good to write in past tense. Pilot trial can be included before method. Uncertainties for all equipment to be included. Sources must be cited from IB books
Analysis	4	/6	Raw data has been included. Data has been recorded in table and a graph plotted to represent data. Calculations have been included relevant to the IA. One sample calculation of enthalpy change would be sufficient and the rest must be included in a table. Processed data can be presented in a table. Qualitative data must be included in the results section.
Evaluation	5	/6	Systematic and random error for each error must be included. The percentage error must be included with data values.
Personal Engagement	2	/2	Excellent personal engagement, where student has thought well throughout the IA.
Communication	3	/4	Few references from IB books would be helpful and few details to be added throughout the report. Use cm^3 instead of ml
			Total 17 /24

Regarding the students, it was observed that, as a part of self-regulation feedback, they used technological tools on their own to search for information that would help them complete the tasks and understand the teacher's content. In maths 2, the students used their laptops and iPads to access platforms, such as Google and YouTube, to complete the assigned exercise. Likewise, it was observed that while some students and the history teacher were discussing the lesson, one student searched for information on Google about the topic discussed. Some maths 2 students also consulted eBooks to complete the exercise. A geography student expressed relief that they found the books required for the subject in digital format during class.

Finally, many teachers pointed out the role of technological tools used within instruction in facilitating timely and flexible moves amongst levels of feedback. Teacher 9 said the following about the technological tools:

They are means for the teacher to enable a soft transition from level to level in a shorter time than the traditional way, thus informing teachers' instructional design and teaching methodologies to adjust to the student's learning needs. Furthermore, it also saves teachers' time, "With one click of a button saving you the time".

Furthermore, Teacher 2 stressed the role of saving and tracking feedback, such as using the discussion threads in different applications, in the continuous improvement of the learning process across all feedback levels:

The discussion thread is also great; I check the work, give feedback, students can use that information and apply it to their learning. I check again, provide feedback, and it is all there. It's all about moving forward; embedding formative assessment instruction.

Teacher 1 also described how the sharing and tracking attribute, particularly of Google Docs, enabled swift move between feedback levels:

What I do is I give some sort of assessment on Google Docs where I give feedback and monitor their progress. They get detailed feedback from me. And they respond to it, for example, what they need to improve on their work and work on it. Also, they do self-assessment and peer assessment. So, they continuously know what they're doing. They've also got like a reflection sheet to reflect on it in every step. So, they're tracking in a way their progress by reflecting on each of their assessments.

As for the students, they reported that they receive feedback to their learning mostly from three providers: teachers, peers, and self-assessment. Some reported that parents are the least involved in the feedback process, as discussed in the survey section (see 4.2.3). In the survey regarding the feedback levels question, most student respondents reported that the feedback they receive from their teachers covers almost all feedback levels: self-level, task-level, process-level, and self-regulation (see Figure 4.16). They also reported that teachers encourage them to identify feedback by themselves, self-evaluate, develop the confidence to pursue learning, and see the importance of deliberate practice and effort on a self-regulating level. Simultaneously, four respondents did not find it helpful on the self-regulation level, and six did not find it helpful in developing their confidence for learning.

4.3.5 Theme 5. Technology As a Tool of Engagement

The second theme under this research question is related to technology as a tool of engagement and autonomy. Technology arguably provides teachers with tools of instant and timely assessment and feedback to keep track of students' levels and promote students' learning autonomy. At the same time, the connectivity and sharing attribute may allow the tool to attract and engage students in learning. This theme is divided into two subthemes: 1) Technology as a tool of engagement in the classroom and 2) Technology as a tool of engagement outside the classroom (see figure 4.29).

Figure 4.29

Theme 5. Technology As a Tool of Engagement

Technology as a tool of engagement

- Technology as a tool of engagement in classroom
- Technology as a tool of engagement outside classroom

Classroom observation showed that many teachers, such as in humanities and biology (see Table 4.27

), incorporate technologies into the classroom environment to interact with students. For example, in classroom 7, the teacher presented the lesson on the Smartboard in the form of slides, and the same presentation was shared with students on their laptops. Furthermore, all the assessment activities were shared with students on their laptops, and the teacher was consistently checking their work from his desktop, giving both oral and written feedback. Finally, the teacher in classroom 7 encouraged students to use the Internet and look for the information as they gave them time to search the web. It was observed in some classrooms that technology allows for the interaction between the student and teachers since both students and teachers were interacting smoothly and showing enthusiasm and passion while using technology.

Moreover, all students with no exceptions were engaged in the learning process, working on the tasks.

Technology also gives teachers access to the information on how the student is performing in the class and allows them to instantly amend their instruction to keep the interaction and engagement ongoing. In this regard, Teacher 8 stated during the interview that technology helps in giving timely feedback so students can see and respond to it if they want to. Thus, technology has the potential to provide more common ground between teachers and students, since youth are now generally very agile at using technologies, as was noted in the previous section.

Various software and applications also serve as tools of engagement, as the interviews and observations showed. For example, Student 12 said Google applications such as Google Drive, Docs, Slides, and Google Classroom are used. These applications make it easier to share work and assignments with the teachers. Besides, Student 12 also recognised that platforms like Google Docs help share their reports with the teacher to easily provide feedback for specific aspects. Observation in the chemistry class showed that students share their work with the teacher through Google Docs, and then wait for their feedback. Humanities students also used this tool to share the assignment with the teacher and their peers and receive feedback.

It was observed that the Smartboard was also used for this activity since the slide presentations made by the groups on their laptops were shared and projected by the teacher on the Smartboard for evaluation. During this task, students and teachers communicated their feedback and interacted with each other. The Smartboard was generally used to share with the students the slides with the lesson's objectives or instructions on how to carry out exercises, exams, and other assignments. The Smartboard was also used to project content (videos, images, and attractive texts) that were complemented with questions encouraging students' participation in class discussions.

In the geography subject, the teacher used Google Classroom to share the files and ask students to submit the task, which they did in class, through Google Docs to give feedback and adjust online. The students completed internal assessments and mini-research projects and discussed work using the Internet, social media, and platforms like Google Docs and Google Meet. It was observed in the humanities group – geography, history, and humanities classes – that students used their laptops to write the search results in Google Docs and on slides, which allowed them to share these results with the teacher and other classmates.

Observations showed that teachers and students used instant feedback attributes. This was observed in classrooms such as humanities, as the teacher was able to check students' logs against websites, such as Britannica Digital Learning LaunchPacks, and provide feedback, as these are integrated with Kahoot. During the interviews, some teachers also talked about incorporating Quizlet (n.d.) and Kahoot assessment software into classroom instruction for immediate automated feedback. For example, chemistry Teacher 1 stated that instant feedback tools enhance the learning process by empowering teachers to adapt their instruction techniques to satisfy the needs of individual students and allowing for innovative ways to learn, such as group competition quizzes. The easy sharing and instant feedback tools also promote students' ownership and decrease students' test anxiety. For example, Teacher 9 reported:

I avoid tests because they do stress out when I said it's a test. I tend to use quizzes, and it's like, even the one I did today, at the end of the lesson, gave me an indication of which one of them really grasp the topic that I just taught. I just use Google Sheets to just keep a track of how the learning is going.

Apart from supporting instant feedback, technology as a tool of engagement benefits FA in many ways. Student 8 stated that this is because the technology supports more dynamic and interactive assessment methods than traditional assessment modes. They explained they had experienced both assessment methods: conventional and with the use of technology. Student 8 mentioned it is easier and more exciting for them to use technology and that this is the path forward for today's youth:

I feel easier in expressing and portraying my knowledge with the use of technology due to technology being one of the necessities of modern human daily life.

Student 3 supports this claim:

Us as young people use technology in every aspect of our lives, we always have our phones with us, we always use our phones for everything whether it is an assignment, assessment, exam, is studying, or even managing daily life, and entertainment technology is essential to know it is, therefore.

Both teachers and students highlighted the importance of technology in promoting engagement and interaction through the interactive attributes technology provides. For example, Teacher 1 said:

It has like video links which students like to interact with. There are exam questions as well. Student can have battles, like they compete and receive instant feedback. Ongoing feedback is very important because ongoing will have an impact on the outcome.

Student 3 had a similar opinion that technology serves teachers as a tool of interaction and saves their time. They also highlighted that technology serves as a tool to learn independently, at the same staying engaged in the learning process and boosting students' confidence. Teacher 14 also emphasised the importance of instant feedback and students' self-autonomy beyond the classroom. They said:

I think that's (technology) really, really powerful because the students could manage their own pace through the content helped by the teacher. From an engagement point of view, the way that it's structured means that the students get immediate feedback on how they're doing. They don't have to wait for the teacher to give them that feedback.

In this regard, Student 1 explained how technology-related interactive features with instant assessment and feedback helped his assessment and learning engagement for better outcomes. Student 1 even admitted that his grades improved thanks to the Kognity software. Student 1 also expressed that the way of working at his pace with technology is satisfying and compelling to him and always showed better outcomes.

Although the survey results showed that both among the teachers and students, there is a wide range of perceptions on whether technology is fun and engaging and makes teaching more interesting (see Figure 4.19 and Figure 4.20), the interviews and classroom observations seem to reveal somewhat different results. The findings show that technology appears to be a powerful tool supporting the engagement of students and teachers in the learning process. Both students and teachers argued that technology solutions allow for more dynamic and interactive assessment methods and support instant sharing of the results, recognition of different abilities of different students, allowing them to work at their own pace, and, finally, instant and effective feedback process. The technology and feedback levels theme was a separate theme emerging from the data analysis. It will be discussed in the next section.

4.3.6 Theme 6. Technology As a Tool for Ownership and Autonomy

Internet access inside and outside the classroom facilitates the activation of students as owners of their learning. Learners use various information sources; their choice depends on their preferences, skills, and knowledge, not just on the teachers or school management guidelines (see Figure 4.30
).

Figure 4.30

*Theme **6:** Technology as a Tool for Ownership and Autonomy*

Technology and Feedback Levels

- Task level
- Process level
- Self-regulation

Chemistry students mentioned that social media, such as WhatsApp and Snapchat, are used to receive faster feedback than ManageBac or Google Docs inside and outside the school. In addition to the peer feedback teachers encourage in group discussions, students provide feedback to each other during the completion of tasks inside and outside of the classroom. As Student 11 noted:

(Technology) allows me to chat with my friends using social media apps such as WhatsApp for educational purposes and not only for entertainment. Technology allows easy access to the Internet which makes researching a much simpler process. During those times in the lockdown, we realised the importance of technology in education when not being able to attend school. In other words, technology can sometimes replace real life even when it comes to education.

Students also expressed how social media aids their learning practices and promotes learning autonomy. Many mentioned Snapchat as a primary software to use when they need immediate information and feedback from their peers. At the same time, students prefer WhatsApp for group work and projects for sharing all kinds of multimedia and documents. For example, Student 16 said:

I ask friends in voice note through Snapchat when I have a question. I ask questions like how I can write this sentence? Is this sentence correct? I like Snapchat because, in Snapchat, we talk about school mostly. We use Instagram when we talk about random things. Snapchat is just easier for me to use; you can video chat, voice chat, send voice notes, text, and send like videos and photos. WhatsApp takes so long to do that so it's much faster and easier with Snapchat.

Student 15 also mentioned WhatsApp as a primary instrument for group work, which is useful for sharing YouTube videos:

We use WhatsApp for group work. We just make a group, text each other, view, and assign each other parts. So, we can share a document and check each other's work, copy, and paste, and choose the videos from YouTube and present it. We can like search videos and send them to each other to see WhatsApp.

Regarding the devices, Student 4 expressed students' preference to use smartphones in most of their work since they can download all needed applications and use them whenever required:

When you're working on a project or assignment, you need to ask your peers anything. I use smartphone, depend on it, I already downloaded presentation app, Google Docs, Google Drive on my phone because unlike a laptop, I always have the phone with me all the time everywhere, so I download everything on my phone so I could do everything quickly.

What has been described indicates students' motivation to learn, which is promoted by incorporating technologies in the formative assessment. In this sense, technology affords a self-regulatory feedback process, whereby students monitor their learning process and gain the confidence to complete their homework.

Classroom observations showed that students used their laptops to carry out individual and group tasks in the chemistry lab, geography, history, and humanities classrooms. They used Google Docs to share their work with their classmates and receive feedback during the assignment. History students were required to individually conduct online research that they completed using the Internet to access websites (usually through Google Search). This same activity was carried out in geography and humanities but in teams. Students were also encouraged not to look for the information on Google or Wikipedia but on verified websites and platforms such as Britannica Digital Learning so the teachers could monitor their access and assess their process. The students used their laptops to write the search results in Google Docs (geography and history) and on slides (humanities), which allowed them to immediately "live share" it with the teacher and other classmates.

The observed students showed signs of being committed to the task, as they were not distracted and focused on completing the assignment. In these cases, technology allows students to act as their learning and instructional resource to each other, what would also be related to self-regulatory feedback. This is where the role of peers plays an important function. For example, Student 3 emphasised this kind of role for technology as it not only supports learning; it enables students to depend on themselves. They learn to research and read before asking for help. It teaches students to be more independent thinkers. It lessens some of the teacher's burdens because students explore topics or go over the PowerPoint slides to answer their questions rather than ask the teacher right away. As Student 3 explained, "It supports us by allowing us to figure out the answers on our own, and giving us a sense of independence, which motives us and boosts our confidence."

Furthermore, student participants voiced their experience of how technology affords access to knowledge and resources and promotes self-regulation. For instance, Student 3 emphasised having worksheets onscreen in OneNote as a feedback resource while studying and assessing activities:

I can upload my worksheet to have it onscreen and, in the page, while being able to solve the questions either on the sheet itself or on the endless page next to it. This way I can solve the questions while adding notes and turning it into a full guide easily.

Online resources also help students to understand topics at their own pace. According to Student 7, if they cannot understand concepts in class, students prefer to learn them from the Internet. Moreover, the Internet has been an excellent facility for students in formative assessment. Student 5 shared the importance of feedback in informing them of their weaknesses and the areas where they need to improve, and how they tend to seek online resources first before going to the teacher:

If we have an assignment, we try to go through the books by ourselves, but we often search it up on Google search engine because we can find an online PowerPoint and essays that are analysed and provide resources. Then we go to the teacher and ask for face-to-face feedback or any questions.

Furthermore, students shared that software provided by the school, such as Kognity, offers them great resources, which are very useful in promoting their learning autonomy and self-regulation in learning and online assessments. By using Kognity, students can learn concepts and assess their level of understanding, which is quite useful according to them.

Teachers also generally agreed that technology is a tool offering ownership and autonomy to the students. For example, Teacher 7 stressed the same sentiment as the students regarding online platforms such as Kognity and the other formal platforms students use, such as Google Docs, Google Forms or Encyclopaedia Britannica:

(Technology) is helping students balance their work, developing good study habits and I think Kognity is helping. Doing the online self-assessment exercises, it's a good way for them to reinforce what we've done in class, and it makes revision at the end much more effective; sometimes we do that in the class itself, sometimes I set cognitive exercises for homework.

Furthermore, Teacher 6 said:

It is really hard to deliver enough classroom time to get the content, so we do rely on technology a lot. Such things like signposting resources that they can access.

There is a lot about the self-study and being an independent individual that it provides.

Despite these multiple benefits offered by technology, some participants outlined the issues brought by the use of technology with regard to ownership and autonomy. For example, Student 3 expressed a critique of the overreliance on self-study and independence instead of the teaching staff in some scenarios:

For the scientific laboratories, I find it should be easier for us when needing answers, but unfortunately, it is still quite difficult to get an answer to a specific question or query we have from the Internet, and it is more helpful to ask a teacher being in a lab so that we may fully understand.

In short, although the students used their laptops or iPads to carry out their assignments (group or individual), search for information, or share documents with their peers and teachers, the preferred device for information searching, exchanging messages, and receiving and sharing feedback seems to be a smartphone. This corresponds to the survey results (see Figure 4.2). For all these devices, access to the Internet was essential, promoting self-regulatory feedback and peer-to-peer feedback. Among the platforms accessed from these devices were Britannica digital learning, Google Search, Google Docs, Google Classroom, and YouTube. What has been described offers an overview of the benefits of incorporating technology in formative assessment, which can be seen in students' responses to its use. Although the technology used is insufficient in specific subjects, such as chemistry, it encouraged commitment and ownership. Despite this positive attitude towards technology serving as a tool for ownership and autonomy expressed during the interviews, the survey results demonstrate that there were mixed behavioural intentions towards the use of technology among teachers and students (see Figures 4.19 and 4.20).

4.3.7 Theme 7. Balancing Time and Effort in Managing Learning

This theme discusses how technology-aided formative assessment supports participants in managing learning by saving their time and effort. The presentation of results is divided into two parts: 1) technology attributes aiding teachers in teaching and learning and 2) technology attributes aiding students in their learning (see Figure 4.31)

Figure 4.31

Theme 7: Balancing Time and Effort in Managing Learning

Balance time and effort in managing learning

- Technology attributes aiding teachers' teaching and learning
- Technology attributes aiding students' learning

During the interviews, teachers discussed how the technology-aided formative assessment methods help them manage their instruction time and interactions with the students. For instance, Teacher 14 stated that the formative assessment process aids in shifting the time balance so that a large part of the classroom time is dedicated to the assessment process. Teacher 14 also said that when students manage their own learning, it helps a teacher to plan:

I can manage my learning, I can work at my own pace, I can deal with the assessment that is in front of me, those two things together are motivating for student and their confidence will increase. (…) I could focus in the classroom on assessing them, checking where the gaps in knowledge were, and helping them deal with that.

With regard to technology attributes, the teachers mentioned an array of them, such as monitoring and tracking, that aided in classroom management and interactions with their students. For example, Teacher 8 uses Gmail file sharing, which allows teachers to see what students are doing. They also explained how technology helps to keep a record of what students have done. When the students log into a particular group presentation, this helps the teacher ensure equal distribution of responsibility and work. In this sense, technology makes it easier to keep track of classroom practice so that teachers do not have to spend too long looking at the names, how many times they have logged in, or to know what students are doing and what they have added. As observed, teachers follow the activities of students by clicking on where they are and viewing what they have added.

Moreover, teacher participants (Teachers 2, 8, 6, 7, and 11) stated that technology aids in identifying when a student is not proactive, and their input is not acceptable by the teacher when working with groups, which allows teachers to intervene. Teachers use the assessment platforms and software to click on the students' names and see what they have done and how they contributed to group assignments.

The observed and interviewed teachers gave several examples of using technology directly in the classroom setting as lessons were underway. Teacher 14 gave an example of an exercise they use in the classroom that helps to incorporate activities using technology into their instruction in valuable ways:

I pose a question; I do use a word cloud generator software work with Google Classroom to shorten up the link for students. (…) The students would begin putting in their responses on their laptops or mobiles. And it starts generating a word cloud, so I know, the bigger the Word gets, the more the students are familiar with that concept. There is a limited time that you can leave your answer online. You can leave it up to I think maximum for a week and the students can go in and review it or can go in and add to it. At the end I usually take just take a screenshot. But I mean, if you're standing there you're teaching and you're seeing that you're asking students and they're putting in the Word cloud you know you have a big problem and you've done something wrong. And it happens enough. It's nice. So, as you're working with students, you cannot block a user, however, you can moderate this.

This example shows how the technology creates an interactive task that can improve the classroom dynamic and make something tangible out of discussion sessions.

Technology has improved the teaching process also in terms of introducing new types of learning materials that teachers use in the classroom. For example, Teacher 11 explained that teachers would make Xeroxes or copies of the materials in the past. These would then be handed out to the students, and the students would comment, edit, and return them to the teacher, depending on the assignment. This process required spending considerable time and energy in the copy room in order to make that happen. Thus, one of the actions that the teaching staff at school decided to do this year was to explore technology to determine if they could somehow encourage students to devote more time to writing rather than copy-pasting, which was a problem discussed in the previous section using the example of business Teacher 11.

Some teachers seemed to favour technologies because the technologies allowed them to receive feedback from the students. For example, Teacher 7 said electronic resources were beneficial in their courses because students enjoy just getting easy access to useful content. Teacher 7 also used self-help answers to judge how the students are learning and receive and provide feedback to the students quickly, even instantly, in some cases. They believed the teacher has a vital role in helping students determine how to apply their efforts more effectively. In their turn, Teacher 7 said that they apply a kind of flipped classroom model when the students prepare for classes using the resources online. Teacher 7 observed that it is becoming a more active model used in the classroom for more and more students. This model is also helpful because it saves a teacher’s time in class and in preparing for the lesson.

Teacher 6 (geography) made similar observations, noting that it is difficult to get through the content in the allocated classroom time. Therefore, they rely heavily on technology, such as signposting resources that students can access and that encourage independent self-study at a time convenient to each student. So, teachers can assign the resources to the students to see the trigger, monitor them, and make them respond to tasks. Also, when it comes to reading and self-study, the teachers can suggest how much they want the students to do. Furthermore, students sometimes show their teachers how to utilise certain technological advantages to save time. For example, economics Teacher 10 described their experience of using Google Docs and how the students taught them about using the different features in the platform that the teacher was not familiar with.

According to the teacher participants, certain applications are especially useful for saving time and effort. Apart from Google Docs, nine teachers mentioned ManageBac**.** Some highlighted the importance of ManageBac, which is used for management and sharing purposes. With the help of ManageBac, teachers can share tasks, emails, results, or reports anytime, and they can send the documents to all of their students collectively. Moreover, ManageBac is accessible to every student and even their parents, who can access tasks and results from home. As Teacher 10 put it:

ManageBac is great. Actually, I think it's really helpful. And it's brilliant that we can do things online now, rather than having to do it in person because then people would have to scan. Even that requires technology, scanning across and so on and so forth. You can work remotely with students. The holidays as well, I'm trying to get them to do their internal assessments in the holidays.

This point interacts with the Usefulness theme; instead of scanning or printing reports and distributing them face-to-face to students or sending letters to parents, this specific management technology made it easier for teachers, students, and parents to access all the data anytime and anywhere.

Both teachers and students stressed that technologies save time and effort for the students, too. The used technologies make it easier for students to manage and organise their schoolwork and the whole learning process. For example, Teacher 15 explained their adoption of Google Docs (Google Docs, n.d.), which supports creating a journal that the students can use every day. Furthermore, they can hyperlink to different charts so that, when they go in, there is a glossary of dates. They click on the date; there is a hyperlink, it pops in, but down to the bottom of the page. They do all of their work through Google

Docs. Teacher 15, together with the students, created a shared folder so that once a student writes something, they can drop their story in there, and every other student also gains access to it.

Student 1 talked more broadly about the learning process and that one of their biggest challenges is to know precisely what they need to study for every subject. Technology can help with this dilemma of having too much information and not knowing what is most significant because, as Student 9 said, technology-based formative assessments improve their learning in different subjects, specifically because it gives them more choices. This suggests the technology format makes learning more manageable and less monotonous, at least in the students' perception. Another student, Student 3, said they value technology because it helps them to keep track of their progress. Student 3 explained that they use technology in both their classwork and homework to store all the lessons and PowerPoints, and they can refer back to the teachers' explanations rather than their personal notes, which sometimes are not clear or incomplete.

In less academic and more hands-on subjects, such as drama and PE, technology allows students to track their personal progress and achieve growth in certain areas. These students valued doing the tracking themselves without the help of their teachers to foster independence. For instance, Student 13 mentioned that, in the case of PE classes, tracking personal progress is a motivating factor, and Student 1 also pointed at increased motivation provided by technological tools for tracking progress.

Thus, according to the classroom observations and interviews, technology saves time and effort for both teachers and students. This corresponds to the survey results and supports the finding that the perceived usefulness of technologies in the learning process is high (see Figures 4.29 and 4.20). At the same time, the survey results demonstrate that the perceived technological self-efficacy and behavioural intentions are not uniform for both teachers and students. The next section discusses the comparison across the quantitative and qualitative and different qualitative results in more detail.

4.3.8 Theme 8. Usefulness

This theme discussed the usefulness of technology-aided formative assessment and feedback in terms of supporting teaching and learning, and being a communication facilitator (Figure 4.32).

Figure 4.32

Theme 8: Usefulness

Ease of Use (Hardware and Software)

- Accessible
- Fast
- Straightforward

To distinguish between the themes Usefulness and Ease of use, the following procedure was applied. The use of technology involves multiple codes, but what is most relevant to this theme are the words "useful", “helpful”, “practical”, and "convenience"; the codes were all gathered and interpreted under the code “Useful”. At the same time, codes such as “straightforward”, “easy”, “simple”, and “practical” are interpreted under the “Ease of use” code. Usefulness and Ease of Use were always present when discussing the technology, regardless of what it offers to formative assessment and feedback.

As already discussed, the Usefulness theme was one of the central themes during the interviews.

Figures 4.33 and 4.34 exemplify how the words useful and helpful were emphasised by words such as ‘really’, ‘quite’, and ‘very’ on multiple occasions. For example, the Britannica portal is mentioned as the most useful technology for providing resources, some technologies are quite useful for providing instant feedback, and using technology is very helpful for teachers to provide clear feedback.

Figure 4.33

Word Tree (Useful)

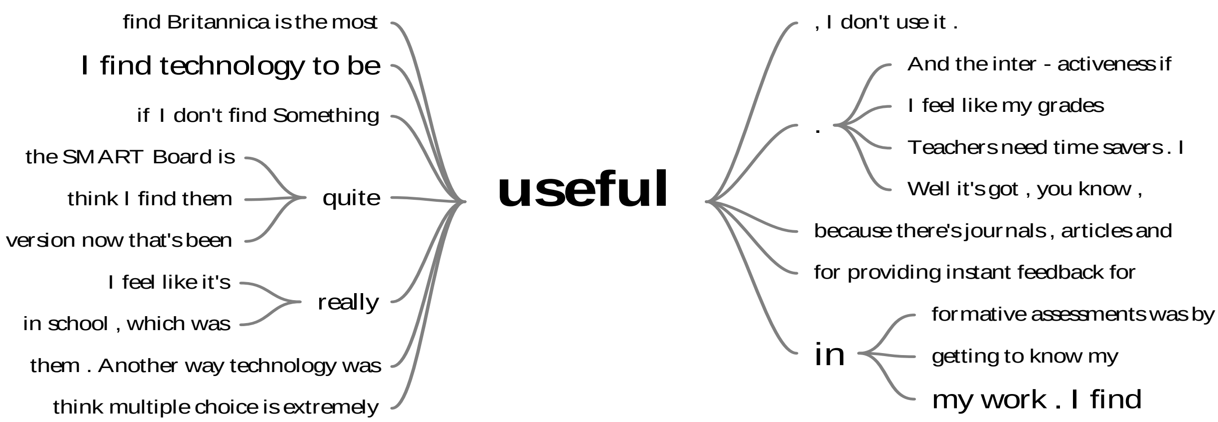
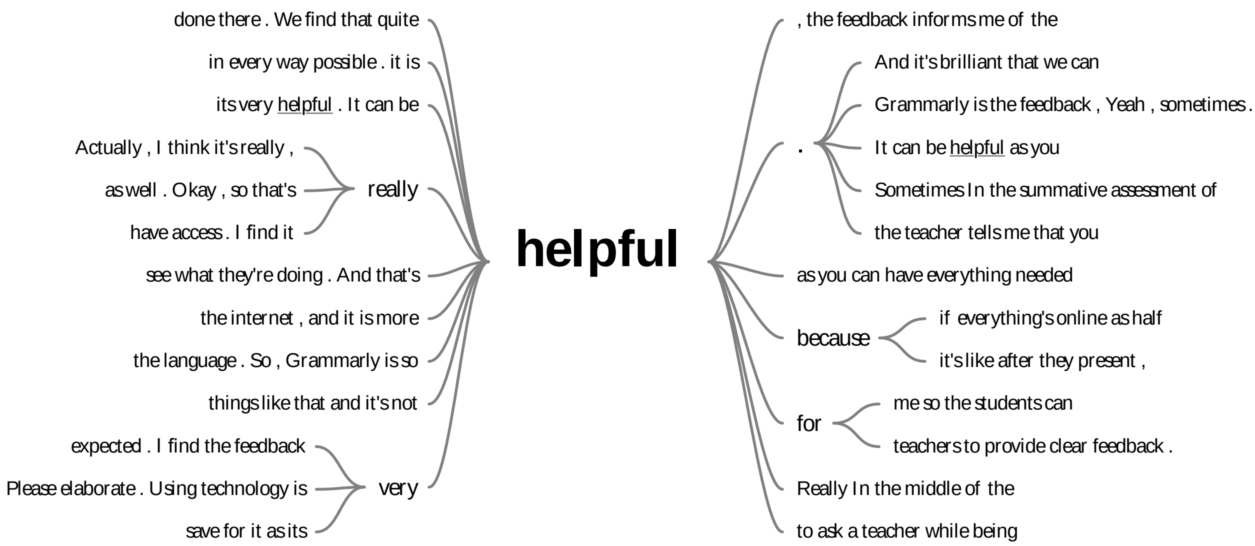


Figure 4.34

Word Tree (Helpful)



The next several sections discuss the Usefulness theme during the interviews in more detail.

SUPPORT TEACHING AND LEARNING

During the interviews, students discussed the convenience and usefulness aspects of technologies and the attributes of the technologies themselves, not necessarily as tied directly to formative assessment, although supporting it. Student 1, for example, talked more about general technology advantages, such as “condensing” or compressing information in a software and using applications on their mobile phone that create checklists to keep them on task and organised. Student 2 found it helpful to gather all the resources in the iPad or the laptop instead of lugging a heavy bag of books. Classroom observations confirmed that students were carrying their laptops and mobiles all the time at school. They use them in their free time, but mainly for educational purposes. For example, Student 2 noted that technology is helpful because “it keeps everything you need at hand” and Student 10 also emphasised the convenience of technologies in studies and completing assignments. As Student 2 explained regarding technology:

It serves you as a notebook, a tool to create projects, and it has a split-screen function, so multitasking is also an option. An example of the convenience technology can serve split screening; the note taking app with the page of the slide used in this lesson/ homework/ project.

Specific functionalities were also mentioned as particularly useful. For instance, Student 2 acknowledged the "split-screen" functionality of making learning easier in feedback navigational affordance. Student 18 described how some functions support their learning by providing the feedback within the same window to utilise as a resource of feedback by focusing, relating, and linking to the teacher's feedback or even a resource. Another finding is that each group of students used media that they considered exciting and fit for purpose while also offering them independence in sourcing information or accomplishing tasks. For example, Student 7 checked his answers by watching a YouTube (YouTube, n.d.) video showing how to solve a mathematical problem. This took place during a classroom session; meanwhile, the teacher was circulating around the classroom checking the other students' answers and providing feedback.

Although all students used technology, a few students seemed to echo the notion that they use technology across all the subjects but in different ways. Student 13 said that, in language or other writing-based subjects, they use technology to get more work done in less time. They take notes of the teacher's feedback by typing and taking pictures because it is faster than handwriting. Furthermore, during the interviews, most of the participants perceived technology as an essential part of young people's lives and a key in adapting to the new era. Student 8 said:

Us as young people we use technology in every aspect of our lives. We always have our phones with us, we always use our phones for everything whether it is assignment, assessment, exam, studying or even managing daily life and entertainment; technology is essential. Therefore, the utilisation of technology and formative assessment is key in adapting with the new era.

Interviewed teachers also highlighted the importance of technology. For example, Teacher 8 said that students today are more accustomed to dealing with online information sources in their daily lives. They normally read articles from their tablet, smartphone, or laptop. They are often quite comfortable using an online resource that is more dynamic in nature than print resources, such as books, magazines, and newspapers. Teachers said: "it's just the generation; the technology seems to be very normal to them" (Teacher 9) "Students have technology anywhere they turn. Let's face it" (Teacher 4).

To utilise this opportunity of the students being deeply engaged with technologies, teachers tend to use the Internet and other technologies. Furthermore, formal online platforms, such as Google (Google Docs, n.d.), Google Forms (Google Forms, n.d.), Kognity (Kognity, n.d.), and Encyclopaedia Britannica (Britannica, n.d.), enable the teacher to gain a better understanding of students' strengths and weaknesses when they are working on assignments.

For instance, Teacher 15 reported that the comments feature in Google Docs makes it easier to keep track of records and helps students who accidentally delete the text because there is a revision history with Google Docs. Users can go back to retrieve information from earlier drafts in a much easier way than in MS Word. Teacher 9 also expressed their preference for quizzes at the end of each lesson over summative assessment because it gives them “an indication of which one of them (students) really grasps the topic that I just taught. I just use Google Sheets to keep a track of how the learning is going”. Another teacher, Teacher 8, claimed to improve their teaching because they can quickly see from the results of student work what areas remain problematic for students. They can easily access notes to review the students’ approaches and provide them with feedback.

Another important advantage of technology highlighted both by the teachers and students is that it supports formative assessments and assignments. For example, it helps to create assignments instantaneously and receive feedback. As a teacher can look at the questions, rearrange them and edit the deadline, these platforms are perceived as being user friendly and convenient. Teacher 8 (history) explains this point:

It is possible to add more challenging questions and take that into account as I visualise the class performance. When I look at the results and actually for some of them, what I would call the drier topics that are more difficult to teach, I rely on technology more there because I find that that method of assessment helps me get through some of these subjects, I do not enjoy teaching.

The usefulness of technology about formative assessments and completing assignments is also supported by the students. Student 8 summarised that technology benefits formative assessment in many ways because it is a more dynamic and interactive assessment method than the usual traditional assessment modes. Furthermore, Student 9 said that technology improves their learning and feedback process by changing the usual learning habit. Technology boosts their motivation and interaction, acknowledging the variation of effect on the nature of the subject:

I think that technology-based formative assessments improve my learning in different subjects, specifically because it cuts out the norm of studying, and the online formative assessments are more interesting and engaging. They differ depending on the subject; for example, in sciences, online simulations could test knowledge. Whereas maths mostly is not as eye-catching and its questions with blanks due to the nature of the subject.

So, thanks to the technology, as a part of formative assessments, students can have a pre-test to assess their level, an intervention that could either be from the teacher or the student themself and finally, a post-test to assess the student's level of improvement. Student 5 explained they had experienced both the conventional assessment method and assessment with the use of technology:

When you do the collaborative testing, this is a kind of motivation when you see that, for example, I'm less than her, so I need to work harder, I'm better. So, I'm good. Am I in the right way, or I need two marks? I did like one or two mistakes; I need to do better.

Furthermore, technology also supports students' tracking progress during the assessments. For example, Student 11 talked about the benefits of technologies in tracking progress in this way:

It also helps me stay on track and helps the teacher track my progress more easily. For example, if a teacher puts a comment to improve a specific area, I can mark it as "resolved" and the teacher will get a notification that I did this, which will help them track our work and improvement. It makes things much easier and quicker to complete.

Finally, during the interviews, the students expressed their views on how technology supports not only assessments but also students' research processes, presentation of research results, and further communication of these research results to teachers and peer students, keeping them engaged and, therefore, making the students' learning process more effective. This is what Student 13 said in this regard:

Technology helps me in my research, and in producing non exam presentations for grades. Examples of this have been making videos of myself showing my progression in my performing art piece, but also videos in other subjects which help to engage my fellow students in my research and knowledge. Technology also helps me in general communication with my teachers and peers to make my learning more effective.

Finally, students and teachers stressed that technology makes the learning process more interactive, effective communication-friendly, and simply more interesting. In this regard, the consensus among the students interviewed was that young people are accustomed to using technology in every aspect of their lives, rather than traditional methods of pen and paper and former methods of learning, which they find boring unless the technology is used. Some of the interviewed teachers held the same sentiments about the importance of fun and making topics of study interesting. Teacher 10 talked about how students usually are attracted to the interesting technologies that the teacher finds entertaining:

Well, the students create different kinds of presentations as well, like, I use PowerPoint, but they, they use Google, they create Google presentations, which I think are quite fun and interesting, something that maybe I could learn more about because their presentation is quite animated sometimes and not things that I normally do or able to do.

Thus, under the Usefulness theme/Support teaching and learning subtheme, the interviewed teachers and students highlighted several points related to technology. First, they admitted advantages offered to the learning process by different programmes, apps, and online platforms. In this regard, they noticed that various school subjects require different uses of technology. Then, the interviewees stressed that technology supports the development and execution of formative assessments and assignments, research process, and presentation of research results, as well as students' tracking progress, which is useful for both students and teachers. Finally, under this subtheme, the interviewees claimed that technology makes the learning process more interactive and communication-friendly. In addition to these previous main themes, the analysis of the interview results revealed Facilitate communication as a separate subtheme. This subtheme will be discussed in the next section.

FACILITATE COMMUNICATION

Facilitate communication is a subtheme under the Usefulness theme, which was identified during the analysis of the interview transcripts. Even before the COVID-19 pandemic, Student 12 had already noticed an increase in the amount of technology used in learning in comparison with the previous years. As they explained:

This year, most of our work was saved in Google applications such as Google Drive, Docs, Slides, Classroom. I adapted to this well because it makes things easier, and work can be easily handed in as it is shared with the teacher.

Several other interview participants had a different view on this subject. For example, Teacher 9 emphasised that although the new technologies, such as Google Classroom, organise, reduce, and gather all educational resources and feedback in one place, they would still rather use emails or Google Drive, because it is easier:

I mainly communicate through emails and through file sharing like Google Drive, Google Docs. Google Classroom a VL, a virtual learning environment where it creates a lot of files; feedback and everything in one place but I don't prefer it because I prefer just a Google Drive sharing files and get feedback through that.

Student 11 shared the same sentiment of convenience and ease of use regarding Google Drive and emails: “Emails allows me to communicate with teachers and classmates; it makes feedback more effective because it is very easy to use and access”.

Another type of communication tool used by students is social media software affordances, such as Snapchat and WhatsApp. Students referred to them as convenient and valuable. For example, Student 1 expressed how he finds it convenient to reach out to his peers on Snapchat for formative feedback purposes: "I just ask friends in voice note through Snapchat when I have a question because my spelling is atrocious"**.** This statement emphasises what Student 11 mentioned regarding their feedback preferences as each student has a preferred way of receiving and understanding feedback: "Another way technology was useful; informative assessments was by receiving verbal feedback." Finally, Teacher 6 pointed out that technology is useful when communicating the results of the students' research work or assignments: "My students are creating their tools every time they give a presentation. It is very impressive actually."

The use of technology became even more prominent with the onset of the COVID-19 pandemic as schools were closed and many students were required to switch to online education. Student 11 pointed out that during lockdowns, technology replaced real life social interaction with virtual communication, including in education. They also added:

Technology allows me to communicate with teachers and classmates using the school Gmail. It also allows me to chat with my friends using social media apps such as WhatsApp for educational purposes and not only for entertainment. Technology allows easy access to the Internet, which makes researching a much simpler process.

Thus, despite a wide range of available technologies facilitating communication available and the majority of teachers and students finding them useful, as shown in section 4.2, not all teachers are prepared to use the whole range during their work. Nevertheless, the COVID-19 pandemic appeared to further increase the interest in and the use of technologies during the teaching and learning processes and facilitating communication. When comparing these outcomes with the survey, it can be concluded that these practices indicate convenience and usefulness, as students receive immediate feedback online from peers and teachers, as demonstrated in Figure 4.13

and Figure 4.14

Feedback Providers (Student)

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4.3.9 *Theme 9. Ease of Use*

Participants expressed their perception regarding the technology-aided formative assessment as easy to use in terms of organisation, communication, and support of learning (see Figure 4.35).

Figure 4.35

Theme 9: Ease of Use

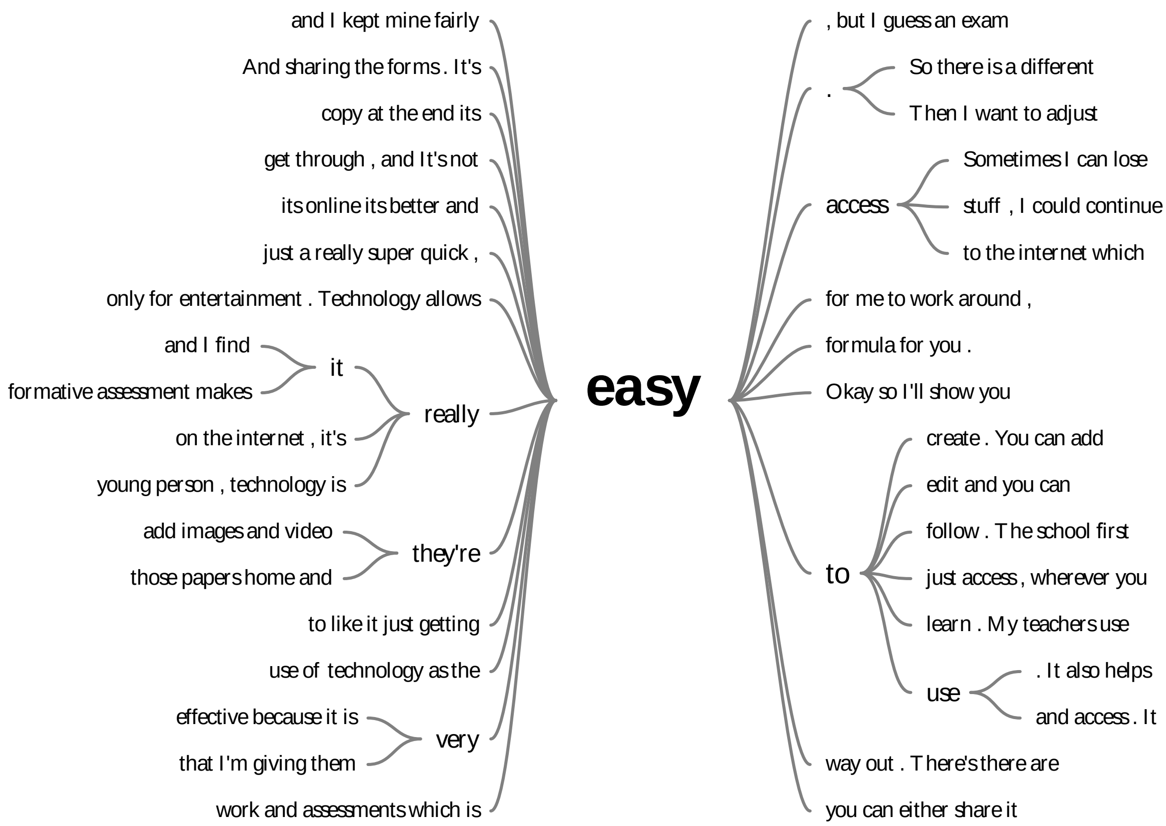
Usefulness

- Organisation
- Communication
- Support Learning

The second theme identified during the analysis was Ease of use. The word ‘easy’ was emphasised amongst teacher and student participants but in a specific manner. This word was linked to other words such as ‘access’, ‘communication’, ‘sharing of images’, and ‘creation of images’ (see Figure 4.36 6).

Figure 4.36

Word Tree (Easy)



Most student participants from year 10, IB1, and IB2 stressed that using technology was more straightforward than using traditional forms of study. Student 8, for example, claimed that when technology was used, it could be more straightforward and effortless to complete an assessment. Student 8 stressed the dynamic and interactive trait of using technology for formative assessment purposes and promoting their assessment processes that improve their growth and development opportunities. This once again supports the idea that for students, as young people, it was easier to express themselves with technology and finish their tasks more quickly when and where they find it suitable while receiving instant feedback. Technology also supports students' self-assessment and boosts their sense of ownership, as will be explained in 4.3.6.

Student 11 also acknowledged that the use of WhatsApp and the Internet on their Smartphone made communication with peers easier and more straightforward:

Technology also allows me to chat with my friends using social media apps such as WhatsApp for educational purposes and not only for entertainment. Technology allows easy access to the Internet, which makes communicating and researching a much simpler process.

Although SMS, WhatsApp, and Snapchat share similar functionalities, such as audio, video, text, and screenshot sharing, which offer Media and Temporal affordances, during the classroom observations, students reported that Snapchat is more convenient in finding a quick answer or feedback from their friends, as they are always available on the forum and can get a quick response easily. At the same time, they consider WhatsApp more formal, as it enables extended conversation and "saves everything". Considering the privacy issue, Snapchat software does not allow an immediate save feature to texts, audios, images or videos, and the user is informed if someone kept any of the communicated media since; otherwise, the software would immediately erase it.

Students also highlighted how technology facilitates quick communication for feedback, not only from their peers but also from teachers. For example, Student 9 said: "Technology also helps me with feedback from teachers because I could get answers quickly and they could highlight the exact problems in my work." Regarding feedback on assessment results, Student 7 favoured computers over papers and books because the information was more accessible when stored on computers, while handwriting can be illegible or be lost. Student 7 also prefers online assessments, as they explained:

I feel like if it is online, it is better and easy access. I can access the assessment anywhere from my phone from the laptop, desktop, tablet; I can access the assessment problems.

These outcomes can be compared with the survey. In the question regarding the use of educational technologies in different locations to access educational materials in the survey, most of the participants reported using technology for educational purposes in both school and home environments. Unlike teachers, some students seemed more flexible since they reported using the technology in various places, such as the computer suite, library, and while using transportations (bus, train, or car). Furthermore, the perceived ease of use of technologies was, on average, higher among the students than teachers.

4.3.10 Theme 10. Perceived Challenges and Concerns

Although the interview participants highlighted many advantages offered by technologies during the teaching and learning process, many of them also highlighted perceived challenges and concerns while using technology (see Figure 4.37).

Figure 4.37

Theme 10: Perceived Challenges and Concerns

Challenges

- Distraction
- Unsustainability

Some interviewed teachers admitted that while the practice of using technologies during the learning process is beneficial, it could also be a distraction from the studies. This is particularly true when the students use their smartphones. As Teacher 9 pointed out, students use their mobile device technology more for socialising and communication and much less for their schoolwork and exploring topics covered in the course. Furthermore, Teacher 11 said that software was used as a log for communicating between the students, which resulted in them being more focussed on social engagement than on schoolwork. Teacher 10 expressed their concern that today's youth use their phones more than a laptop and that the phones tend to distract the learners. Interestingly, as indicated before, the students admit themselves that they use smartphones and other devices more for social communication rather than for schoolwork.

Another problem highlighted by Teacher 3 was that because of the wide application of technology, there is a lack of independent learning among the students. This problem, according to Teacher 3, results in the need for more following up by teachers to make sure the students are keeping up, which creates more work. One more problem highlighted by Teacher 10 is the difficulty of sustaining motivation among the students, which tends to fluctuate, affecting their approach to schoolwork. Teacher 10 explained the difficulties they faced when, for example, asking the students to use their mobiles for specific activities or quizzes. It is difficult, the teacher pointed out, to control what could distract them once they are logged in to their devices. Even more, Teacher 3 described classroom teaching as a constant battle to get through the curriculum content and found students to be disengaged much of the time during the lessons. Thus, many of the 11 teachers interviewed expressed this problem of student distraction by technology in the classroom. They recognised that students have an integral and dependent relationship with their mobile phones, which enables them to communicate with family and friends, and manage their lives outside of school. However, in the classroom, the smartphone was regarded as a continual challenge.

Teacher 13, as a solution to this problem, encouraged students to bring laptops to classrooms rather than to depend on mobile phones. Teacher 10 also reported limiting use of mobile technology in the classroom owing to concerns about the technology being a significant distraction for students:

That is the problem with technology, especially with the existing technology where everything social media is integrated. So, there is no clear distinction between educational use of technology and non-educational use of technology. So, it does not have them to go on their phone when maybe a WhatsApp message might suddenly distract them. There is a fine line with aligning technology.

Outside of the classrooms, the interviewed teachers also pointed out several problems related to the use of technology and disrupting the learning process. Teacher 10 voiced concerns regarding students' capabilities to self-regulate and control their learning. They said that, although students are online all the time, they do not read enough; they do not even read the news while using the Internet. Teacher 10 believed that the students need to become more aware of what is going on around them and broaden their background knowledge of current events since only 60% of knowledge comes from the textbook.

Finally, students and teachers alike do have other activities, which may be impacted if they are overwhelmed by technological tools and platforms. The constant changing of these tools and platforms is time-consuming and inconvenient. Expecting both students and teachers to uptake new devices can cause dilemmas regarding family obligations and extra responsibilities. As Student 5 said: "I know these tutoring video clips are out there. I do not personally use it. Moreover, I do private tuition for four hours on Saturday. I do not have time for it". Teachers also are pressed for time and often unable to upgrade their digital skills and access to online education tools and platforms. As English Teacher 1 said, "I should be able to use all the features, everything that it allows you to do, and I do not. Because I just do not have time actually to learn it".

Thus, according to the teachers, unmanaged technology use during the learning process brings many challenges, such as distractions, especially from smartphones, lack of independent learning, and the difficulty of sustaining motivation among students. Indeed, according to the survey results, unlike the teachers, who did not use smartphones at all during the teaching process, 40% of students used them. Also, the students used a wide range of communication programmes. Both teachers and students stressed that learning how to use new technologies could be time-consuming and inconvenient. This last challenge could be a cause of the limited use of technology platforms available for the teachers surveyed.

4.4 Summary

This chapter presented the findings of the data analysis for the study, which explored the relationship between formative assessment and educational technologies implemented in a school environment. Two sets of data were analysed: quantitative and qualitative. The results of the analysis of these sets covered research questions presented in the Chapter 1 Introduction (1.4.3). The data collection methods included the survey of the teachers and students (quantitative data) and interviews and classroom observations (qualitative data). It should be stressed that sample sizes were small and overlapped and that greater sample sizes could have revealed more variations in the results. Despite the small sample sizes, the results seem to offer valuable insights into the research topic. Furthermore, the comparison between the quantitative and qualitative results, as well as with other academic studies, which will be conducted in the discussion chapter, allows for a triangulation approach. Triangulation aids in bias reduction and enhancement of the soundness of data analysis (Denzin, 1970).

The quantitative survey confirmed that all teachers from different disciplines and all student respondents used a wide range of technologies during the teaching and learning processes, including FA, although the language teachers applied the technologies less than others. Laptops and portable devices were the most used devices amongst students, followed by smartphones. At the same time, teachers relied more on the devices provided by the school: desktops and Chromebooks. The survey demonstrated that the teachers used these technologies either at school or at home, while students were more flexible as they used them almost everywhere: in computer suites, libraries, buses, trains, or cars. The IWB were reported by both respondents to be used in schools. Regarding technological apps and platforms, student respondents reported using Emails and Google Apps and formal apps in their schoolwork. Teachers showed more reliance on the school's formal Apps and Google Apps.

Regarding the FA and feedback practices, both sets of survey respondents believed that students depended on three assessment providers: teachers, peers, and self. 100% of the teacher respondents reported covering all levels of feedback, while student respondents showed less confidence than teachers, especially in self-regulation level feedback. Interestingly, parents were rarely or never involved in the feedback process. Furthermore, teacher respondents showed more keenness to use technology in education than students, although student respondents were generally willing to accept technologies more than teachers.

Based on the TAM quantitative data, most participants perceived technology as helpful and easy to use, reported a positive attitude towards assessment technologies in teaching and learning, and intended to use technologies in the future. Nevertheless, more than half of all surveyed teachers reported a negative perception of their technological self-efficacy. Furthermore, although student participants showed a positive perception of assessment technologies in learning, they reported some perceived difficulties in facilitating conditions and technological self-efficacy.

Qualitative data supports many, but not all, of the above findings related to Research Question One. Similar to the survey results, the interviewed teachers and students reported clear advantages offered to the learning process, including FA, by different programmes, apps, and online platforms. However, teachers reported that their technological choices depended on students' preferences which meant that they switched swiftly from one tool to another. Students, in their turn, got particularly excited with new technological tools and used them as long as they were easy to use, convenient and fun, but stopped using them when these tools got more challenging, or they lost interest. This could raise some questions about the effectiveness of these technological tools, primarily because some FA tools were connected with the school's leading platform, ManageBac, which was the primary platform for uploading assessments and receiving feedback.

Another potential issue is related to communication, including FA and feedback, and the corresponding challenges of applying technologies. Despite many technologies facilitating communication available and the majority of teachers and students finding them useful, as the survey shows, not all teachers were prepared to use the whole range during the teaching, feedback, and FA process. Indeed, according to the survey, the perceived ease of use of technologies was higher among the students than teachers. Nevertheless, teachers said that using technology during the learning process brought challenges to their students, such as lack of independent learning, difficulties sustaining learning motivation, and distractions, especially to students' smartphones and communication programmes. Indeed, the survey results showed that 40% of the students used their smartphones, unlike the teachers, who did not use their smartphones at all. Both teachers and students stressed that learning how to use new technologies could be time-consuming and inconvenient. Nevertheless, according to the interviews, the COVID-19 pandemic seemed to increase the interest in and the use of technologies during the teaching and learning processes and facilitating communication for both teachers and students.

With regard to Research Questions Two, quantitative and qualitative results also often, but not always, support each other. It became evident that technology helped teachers in assessing students more accurately, including FA, because of an opportunity to track the progress in real-time offered by different programmes. Interestingly, although the survey revealed Pupilasset as the most popular programme among the teachers, the teachers mentioned this tool during the interviews only twice. The second and third popular choices, though, ManageBac and Google Classroom, were widely discussed during the interviews in a positive way.

As follows from the surveys, students received feedback mainly from teachers (it covered all feedback levels), peers, and through self-assessment. The student interviewees also stressed that teachers encouraged them to identify feedback by themselves, self-evaluate, and develop confidence. Nevertheless, four respondents did not find the feedback helpful on the self-regulation level, and six did not find it helpful in developing their confidence for learning. The participants argued that self-regulatory feedback, peer-to-peer feedback, and FA processes were facilitated thanks to the Internet access on the devices used. Despite these advantages offered by technologies, the interviews and classroom observations clearly showed that one size did not fit all: the choices of technologies should ideally be tailored for each subject, teacher, and student, which was arguably already happening with a wide range of devices and applications chosen by different teachers and students, according to the survey results.

Finally, the interviews and classroom observations demonstrated that technology saved time and effort for both teachers and students. This echoes the survey results showing that the perceived usefulness of technologies in the learning process, including FA, was high, even though the perceived technological self-efficacy and behavioural intentions were not uniform for teachers and students. These findings were discussed in more detail in the next chapter.

Chapter 5. Discussion

The data analysis revealed several key data and themes, which this chapter seeks to explore, compare, and position within the current academic context; the role of technology-aided in formative assessment and feedback. Among these themes are perceived ease of use, usefulness, some challenges, and concerns about perception. And regarding uses, technology as a tool of feedback, engagement, ownership, and autonomy, one size does not fit all, balancing time and effort in managing learning and actual challenges of use. The triangulation of data collection methods, as well as comparing the research results with the findings of previous research in the literature, was used to increase the credibility and validity of the research findings. Using affordance theory, TAM insights, and constructivists' learning theories this study analysed how technology-aided formative assessment affects instructors' teaching and students' learning in the classroom. It also explores how technology-aided FA agents are deployed and the discrepancies that arise during the process. This chapter addresses the overarching research question:

What is the role of technology-aided formative assessment in teachers' teaching and students' learning in an International Baccalaureate Academy in London, UK context?

Furthermore, the following sub-questions are also addressed in this chapter in relation to the findings:

1- How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?

2- How does technology support formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?
3- How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?

The findings revealed that teachers and students used various devices, software, and websites for learning, assessment, and feedback (see Table 4.28). The devices vary from portable to non-portable and for personal and academic use. The school provided each teacher and student with a laptop, while desktops are available in classrooms, libraries, and at each teacher's desk. The classrooms have various technological equipment that aid teaching and assessment practices, such as IWB and Internet connectivity. Teachers and students use formal software and websites funded by the school for assessment and feedback purposes. The formal software is divided into subject-specific and general software and websites. Kognity, Kerboodle and Encyclopaedia Britannica are examples of subject-specific technology, while Google applications and Quizlet are examples of general ones. Personal smartphones and tablets are allowed on the school premises but vary in classrooms depending on the subject and teachers' practices.

Findings also revealed differences in technology use between different disciplines. Teachers and students from all subject-disciplines in the humanities group used technology-aided formative assessment. Teachers incorporated technology in each step of their teaching and feedback strategies, from sharing the learning intentions to reaching students' self-regulation (see Table 4.27 and Appendix 7-15). Students of these subjects also reported using formal and informal websites in and outside the classroom for their learning and assessment activities. In comparison, the languages group are the least to use technology-aided formative assessment and feedback. Although the school funds all the assessment and learning applications demanded by each subject group, the languages group does not use formal or informal subject-specific software or websites. The STEM group vary in the technology used depending on the subject itself; biology subjects incorporate technology in their teaching and assessment classroom strategies, while chemistry depends on the nature of the topic. Computer science partially incorporates technology in the assessment and feedback activities, while maths rarely uses technology in its assessment practices.

Furthermore, the findings demonstrated differences between teachers' and students' perceptions and utilisation of the affordances of various technologies as formative assessment instruments. Moreover, the data also revealed numerous benefits of using technology in formative assessment and feedback to increase learner autonomy, engagement, and self-regulation outside the classroom, although it varies depending on the subject groups, and it also varies depending on the teachers and students. For example, the findings demonstrated that the employed strategies emphasised the importance of students' comprehension of the learning objectives.

In addition, the outcomes of the interviews, observations, and surveys evaluating the affordances of technology-aided formative assessment and feedback varied. Although some teachers reported delivering immediate feedback in surveys and interviews, they were observed to spend most of their time offering face-to-face feedback. Moreover, while only two teachers and students reported providing comments via IWB in the survey, observation revealed that many teachers incorporated IWB into their teaching and grading processes.

Lastly, the findings revealed that teachers and students consider technology a useful tool for formative assessments and easy to use, and they were eager to utilise technology-aided formative assessment and feedback. Nevertheless, the findings highlighted differences between the students' and teachers' perceptions and attitudes toward technology-aided formative assessment and feedback. For example, while 72% of teachers agreed that technology eases their work, 68% of the teachers reported that they need mental effort to get the work done. On the contrary, 96% of students felt they could do their tasks easily using technology.

Furthermore, this study indicated a variety of differing teachers' practices in using technology, which may be attributable to disparities in teachers' attitudes and views regarding formative assessment and feedback aims as well as their own self-efficacy with technology. For example, some teachers in this study employed technology to increase learning and performance. Others managed time and effort using formative assessment and feedback. In addition, participant interviews revealed individual differences in how different teachers perceive technology affordances. As presented in the one size does not fit all theme, it was evident that what one teacher in the humanities group deemed to be affordances were not the same for another, such as in the language or maths group .

Table 5.1

Findings in Relation to Research Questions

Research Question	Findings
How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?	Technology-aided formative assessment and feedback uses. Differences in technology use between different disciplines.
How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?	Differences of the outcome in using different technologies, as tools of formative assessment (IWB, ManageBac, Kognity). Varying levels of students' engagement and autonomy. Differences between the results of the interviews, observations, and surveys.
How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?	Perception and attitude of teachers and students toward technology-aided formative assessment and feedback. Differences between perceptions of the students and teachers related to feedback. Differences in technological self-efficacy between participants.

The most significant research findings relate to the discrepancies identified between the technology-aided formative assessment behaviour and the perceptions of teachers in comparison to those of students. These include differences in teachers' and students' feedback levels expectations, differences between the findings according to the interviews, observations, and surveys, and varying levels of ownership, autonomy, and engagement as the most frequently discussed topics during interviews. Therefore, the next section will present the key findings addressing the research questions following the order in Table 5.1.

5.1 Technology-aided Formative Assessment and Feedback Uses

One of the important findings is that the technology-aided formative assessment and feedback could clearly be classified as 'in the classroom' and 'outside the classroom' (see 4.3.5 and 4.3.6). The first type involved using various technologies and websites by teachers and students in the classroom. For example, based on the observation, a teacher may assign project-based tasks to the students or serve them with a quick quiz or a survey/poll. Another example is that students may upload their assignments and projects for teacher and peer evaluation. Thus, the process integrated technology into regular assessment in the classroom. ‘Outside the classroom’ assessment mode, the teacher assigned tasks to students via a specific online portal, such as Google Docs and Kognity. The students logged into the platform/app to perform the work while the teacher gave real-time feedback. As some apps automatically corrected the answers, it helped to reduce the teacher's grading time and provided rapid feedback to the students.

Teachers may flip the classroom by giving students reading assignments to answer given questions helped students become active learners while enhancing classroom engagement, as reported by Ayçiçek and Yelken (2018) and Kawinkoonlasate (2019) (see 4.3.7). Importantly, this strategy encouraged students to utilise technology to find answers and self-learn at their speed before going to class. Then, in class, students productively participated in group learning, similarly to observations of participants in the studies by Aidinopoulou and Sampson (2017), Ayçiçek and Yelken (2018) and Kawinkoonlasate (2019). Online instructional films, digital slides, student discussion and communication, teacher-student contact, and teaching modules were among the most utilised technologies in this flipped method. In this study, tracking students' engagement and growth allowed teachers to monitor their progress, while it also helped students make the most of class time for active learning.

The research revealed that some students preferred to learn at their own pace or receive feedback from their desired source, which may be problematic in a typical classroom where students were expected to keep up with the lesson plan. Teachers usually proceeded at a pace suitable for most students in a typical classroom. At the same time, those who struggled with understanding the material could be left behind. This issue could be resolved with the help of technology. Independent learning using technology enables teachers to work individually with those students who require additional support. This observation was consistent with other studies about the benefits to students of technology (Dempsey & Aldon, 2016; Sheard et al., 2012; Vásquez et al., 2017). Studies found that when using technology independently, students who require additional time can review activities and exercises until they grasp the concept, whereas students who need less help may continue. Access to online and offline tools and software reduced the need for students to openly communicate to teachers about their inability to keep up with their peers.

5.2 Differences in Technology-aided FA Use Between Different Disciplines

The current study revealed differences between the effectiveness and efficiency of technological assessment activities of the teachers of different disciplines. This finding participates in the understanding of what influences teachers and students use and utilisation of certain technologies which would support the theoretical and conceptual argument on how to leverage the potential for increased learning through formative assessment and school-aided technology. Even though it was not surprising, some findings were very interesting, especially when considering them within the current academic context. As shown in the previous chapter, under the "one size does not fit all" theme, teachers and students expressed that the use of technologies did not fit well with some subjects. After the interviews, and observations, it became clear that the languages group and some subjects such as PE and maths are the subjects where teachers and students were least likely to use technology in their formative assessment and feedback practices. The languages, PE and maths teachers indicated not integrating technology in daily instruction was due to the lack of subject-specific or teacher-led software that would be suitable to the nature of the topics (displaying weaker affordance). Similarly, software was not used in the case of geometry and algebra classes, as seen from the observations and stated in the interviews. These results seem to contradict some previous studies, as a considerable body of research has focused on how technologies can assist learning and student competencies in maths and the English language (e.g., Aldon et al., 2008; Fujita et al., 2018; Miyazaki et al., 2017; Narciss & Huth, 2006; Panero & Aldon, 2016) .

The failure to use technology-aided FA in teaching and learning and, in particular, in formative assessment practices, would be because subject specialist teaching has distinct needs, and there is very little software specifically made for one particular subject area, especially when it comes to feedback. Furthermore, the software purchased by the case school is general and does not seem to meet the needs of specific subject specialists, particularly regarding feedback. This issue, though, could persist outside of the case school, too, at least, according to some older studies. Although there was evidence that the educational specialist industry was emerging (Peña-López, 2016), it was not until 2010 that more than 95% of the companies developing educational technologies were non-specialists (Foray & Raffo, 2012).

Thus, it is not surprising that some teachers found certain software useful while others did not. For example, in the case of Kognity software or Kerboodle, sciences teachers found it helpful but maths, IT, and language teachers did not. Chemistry teachers, for example, found it very useful; however, not in all topics, especially those that need a laboratory. In this regard, Li and Zhang (2022) emphasised the role of teachers as subject specialists in developing such systems. Moreover, the findings showed that one or two kinds of software are insufficient for all formative assessment and feedback activities for teachers who use technology in one subject. Teachers who tended to use more technologies, such as humanities and sciences, reported using many kinds of technologies, such as websites, portals, Google applications, and IWB in one lesson for formative assessment and feedback activities, as shown in the "available technologies and their uses" theme. Furthermore, I also observed situations when sometimes built-in software enabled or almost guided teachers in teaching and feedback in a certain way. Thus, I conclude that teaching and feedback processes could be not teacher-led or subject-led but technology-bound. Given the above evidence, I argue that developers need to focus more on subject-specialist pedagogy-based software.

Subject-specialist pedagogy-based software would also be useful because technology feedback is often inadequate regarding the type of automated feedback quizzes normally used in some subjects. In the literature, Spector (2016) confirmed that these quizzes do not provide extended feedback with further explanations that help students acquire fact-based knowledge, as students usually benefit better from elaborative feedback. In this case, the technology used to deliver feedback worked as an evaluation of the students' performance without including scaffolding for learners, which goes against the recommendations by Landry et al. (2008), Spector (2014), and Spector and Spector (2016). Such technology might even harm the learning process because students may accept the automated correction of their errors without questioning the reasons or gaining insight into the steps necessary to overcome their lack of knowledge. It might also lead students to seek feedback from other resources than technologies, such as getting private tutoring, as one student reported in the interview. Alternatively, asking the teacher about each step individually in the classroom could consume the lesson's time and negatively affect other students. For example, some students were observed playing a game or talking, waiting for the teacher to finish providing support for another student.

Fujita et al. (2018) noticed that students began to evaluate other possibilities after receiving computer feedback and, in some cases, teacher involvement. Therefore, my findings align with prior research conclusions that extended feedback is essential in enhancing knowledge modification (Ecker et al., 2020; Rich et al., 2017) while improving understanding and meta-comprehension precision (Prinz et al., 2019). Automatic grading and feedback, however, might help enhance students' confidence in some instances, such as in the Kognity case, even though they did not improve their knowledge or performance, although English and maths teachers regarded it as a constraint rather than an affordance. In a recent paper by Enders et al. (2020) on how extensive feedback in formal assessment may enhance learning on online quizzes with closed questions, researchers found that comprehensive feedback gives an additional and effective learning advantage.

So, my data analysis revealed the variety of tools and technologies used in teaching and learning and formative assessment and feedback in most subjects at the school; however, there was no evidence of incorporating any system or software that provided automated personalised feedback or adaptive assessment that identified personal differences, as described by Spector and Spector (2016) and Yang et al. (2014). This could be due to a lack of educational technologists' role and support in the case school, as teachers are the sole decision-makers regarding technological choices and use. Based on Huang et al. (2019), technology specialists could hold the responsibilities in supporting technology-aided teaching, learning and assessment practices which the case school lacks. I asked science teachers how they chose technology for their classes. Their responses revealed that the technology's suitability guided them to the specific subject and by what they considered advantageous and simple to use during the assessment design process rather than by what is beneficial for students based on a well-informed decision supported by educational technology specialists' expertise. Moreover, the case school does not seem to have a technological framework for teachers to follow in their implementation of these technologies, such as TPACK or SAMR. These frameworks would support teachers in planning and reflecting on technology integration in their classrooms, aid in evaluating if technology use meets student needs and learning objectives and reveal future paths and improvements (Harris & Hofer, 2011; Hilton, 2016; Koehler & Mishra, 2008) .

Technology integration frameworks, such as substitution augmentation modification redefinition (SAMR) or technological pedagogical content knowledge framework (TPACK), allow developers, researchers, schools and teachers to understand and analyse the level and nature of technology integration for learning while implementing or adopting it (Koehler & Mishra, 2008; Mishra et al., 2009). On a school level, they would illustrate the interrelationships between different disciplines in a school; how the components fit together. On a classroom level, they would aid teachers in adopting a specific technology, starting with the awareness of the technology and its functions and ending with embracing the relevant technological components and relationships by the user, including having innovative use of this technology. On a research level, technology frameworks would aid in a more profound understanding of how teachers comprehend the affordances and constraints of a particular technology and how this understanding can change both the teaching and learning experiences.

Another interesting finding refers to the differences in the use of face-to-face and technology-based feedback. Despite the positive perceptions expressed by STEM teachers in general and science teachers about using these technology tools in the surveys and interviews, the observations found that they continued to rely on traditional forms of face-to-face feedback. Similarly, students reported in the interviews that they preferred face-to-face feedback over methods using technology. The maths and English teachers, on the other hand, were found to have the minimum use of technology in their classrooms; observation also indicated that they may be traditional "instructionists" who are still teacher-centred with passive learners, as Johnson (2005) and Tallvid (2016) define this situation. In contrast, humanities teachers are on the other end of the spectrum. The survey also showed a high acceptance and positive perception of these technologies by teachers in the humanities subject.

I should stress in this regard that English and maths were the most discussed in terms of striking differences, although these disciplines seem to be the subjects with less technological use as seen in the “one size does not fit all” theme penetration because English requires reading literature and interpretation. Maths is complex because of the need to calculate at every step and show these calculations, as reported by some participants. Similarly to my study, Panero and Aldon (2016) concluded that maths teachers tended to use technology more in formative assessment phases than in their teaching, which tended to be more traditional, teacher-centred in style. This might suggest reasons for maths teachers in this study not using technology in their classrooms, despite the school being well-funded and supporting technology integration in teaching. In the survey and interviews, maths teachers and students stated that they were aware of various applications and software availability but did not find them beneficial, particularly in geometry and algebra. This finding aligned with prior research showing that gaining teachers' acceptance of technological devices to support teaching in the classroom can be problematic and time-consuming (Clark-Wilson, 2010; Stroup et al., 2002; Walling, 2014).

Other differences I found are less striking. For example, the chemistry teacher had a low opinion about technology-assisted learning in the chemistry lab sessions, even though the biology laboratories were observed to have utilised technology extensively. Likewise, during the interviews, the biology teacher expressed doubts about the usefulness of technology-aided formative assessment of students, even though they were using technology in their class. They stated that technology could assist in providing simple insights into the pupils' abilities but did not help deal with complex issues. In this sense, the teacher suggested that the feedback teachers receive via technology regarding their students' knowledge level is limited in scope and detail. Therefore, the teacher argued that it might indicate something is problematic in the student's performance, but the technology does not help explain that problem.

Finally, even when the same technologies are used, teachers from different disciplines often use them differently, and their usefulness varies for different subjects. For example, Kerboodle was only reported by science teachers to be suitable for all sciences. Teachers prefer it because it allows them to design their tests and adapt the software to their curriculum. On the other hand, the feedback Kerboodle allows is unsuitable for subjects such as maths, or a more descriptive topic, such as English writing, as reported by some participants. Interestingly, the Kerboodle software is advertised on the website as suitable for all the subjects mentioned above (McCollum, 2022). There might be something inherently more beneficial for a particular subject area, even though the app developers will not identify that because they claim it to be universal.

5.3 Differences of the Outcome in Using Different Technologies, As Tools of Formative Assessment (IWB, ManageBac, Kognity)

In addition to the findings presented above, the current study identified differences in the effect of use between different technologies as formative assessment tools, including IWB (n.d) as ICT, ManageBac (n.d) as LMS, and Kognity (n.d) as curriculum-aligned teaching and learning platform software. Regarding the ManageBac software, survey, and interview all participants reported that submitting assignments and receiving feedback through ManageBac is mandatory. Student participants reported utilising it for submitting assignments and receiving feedback, which use was mandatory in the case school. In the interviews, the participants perceived the benefits of its save-ability, share-ability, and communication affordances, which support formative assessment and feedback. Both interviews and observations demonstrated that teachers and students use ManageBac for submitting, uploading and saving their assignments and receiving formal feedback via Google Docs or grading. Interestingly, the observation and interviews revealed that teachers and students do not use the formative assessment and feedback functions of ManageBac in everyday teaching, learning, and assessment practices. At the same time, student participants reported in the interviews that functions such as virtual rooms with video, audio, and text functions used for projects and teamwork discussions are available, but they choose to use different informal applications, such as WhatsApp and Snapchat rather than the formal application, ManageBac.

Moreover, although the school uses a management system portal (ManageBac) that facilitates collaboration, teachers and students reported that they do not use the collaborative feature, although they spoke highly of it. Surprisingly, neither teachers nor students gave any reason for not using ManageBac in formative assessment and feedback communication. When I asked whether it was because the social media applications are on their smartphones, they reported that even though the ManageBac app is also installed on their phones, they prefer not to use it, and they did not provide an answer for why, although asked. With regard to the possible reasons for not using a mandatory technology, Wilson et al. (2015), in their study of the

Workshop tool, a part of Moodle (university learning management system) which offers similar features to ManageBac, found that for students to profit from the Workshop tool's collaborative potential, modifications needed to be made to the university culture. Thus, students' work monitoring affordances that teachers reported appear to hinder collaboration and communication through the monitored formal software and revealed a monitoring school culture which could be a reason in this case, too.

More specifically, this lack of use of ManageBac is likely related to privacy and monitoring reasons that are reflected in the school culture of monitoring teachers' and students' technological access and interaction, as shown in the findings chapter. In the literature, Phillips (2016) proposed that anonymous peer reviews can lessen social effects on learning processes because students do not know who provides feedback on their writing and value others' answers. Similarly in the current study, students do not seem to have an issue with receiving peer feedback, as they seek it from an informal application, but they seem to mind the teachers knowing who provided them with feedback, the information provided, or the language they use. Indeed, some students mentioned on different occasions that ManageBac "saves everything", which indicates students may be conscious of this feature and avoid using it. The same reason could also justify the preference for using Snapchat since it deletes communication, and users receive notifications when anyone saves the chat. This privacy and monitoring issue can also explain why teachers and students were hesitant to declare the reason for not relying more on ManageBac.

An alternative explanation for the unwillingness to use ManageBac could be related to the lack of teachers' and students' digital competencies. In the literature, Voogt et al. (2013) argued that teaching strategies for the 21st-century digital competencies are frequently misapplied in educational settings. They reported that this is due to a lack of integration of new technological capabilities in curriculum and assessment, inadequate teachers' training, and a lack of systematic focus on adopting new teaching and learning approaches that would cope with the vast technological development on a large scale. Table 5.2

shows ManageBac affordances and constraints from the teachers' and students' perspectives.

Table 5.2

Actual Affordances of ManageBac

Actor	Functional Affordances (Bower, 2008; Hartson & Pyla, 2018)	Constraints
Students	Instructive: Student users are afforded to upload assignment documents and projects and view all the required tasks by the teacher. They can also read, view, and receive feedback from their teachers and peers through messages or documents / records, and Managebac also affords grade accessibility. Collaborative/Productive: The portal affords shareability and accessibility by interacting with teachers and peers and forming group discussions. Moreover, it is integrated with AssessPrep, where students can undertake a test or quiz and receive immediate feedback.	***Efficiency***: Controlled, monitored, and classified communication limits interaction in feedback. ***Timely***: Take time and multiple clicks to access functions. ***Reliability***: The assessment apps integrated might shutoff and fail to save data.
Teachers	Instructive: read-ability/ accessibility/monitorability/ trackability. The portal allows recordability and tracking of all assessment activities and feedback. There is also a plagiarism checker for uploaded assignments, to provide the teacher with feedback. Collaborative/Productive: Teachers are afforded to share their feedback and resources and receive messages, questions or inquiries from students and another peer. They also control some portal features by giving permission or assigning assignments, quizzes, or tests with automated feedback for both students and teachers.	N/A
Both	Sensory: It is offered as both a laptop portal and mobile/iPad applications. Cognitive: There is a straightforward menu and dashboard. Physical: Access to some features such as AssessPrep or communication icons. Social: It affords communication by messaging and building a group for a specific target related to the project or assignment itself. Controlled and monitored social connections by school administrations and teachers. For example, unless they have been given permission, no one will be able to post a message to the teacher. Emotional: Both students and teachers reported a must and need to use with no emotional implications.	

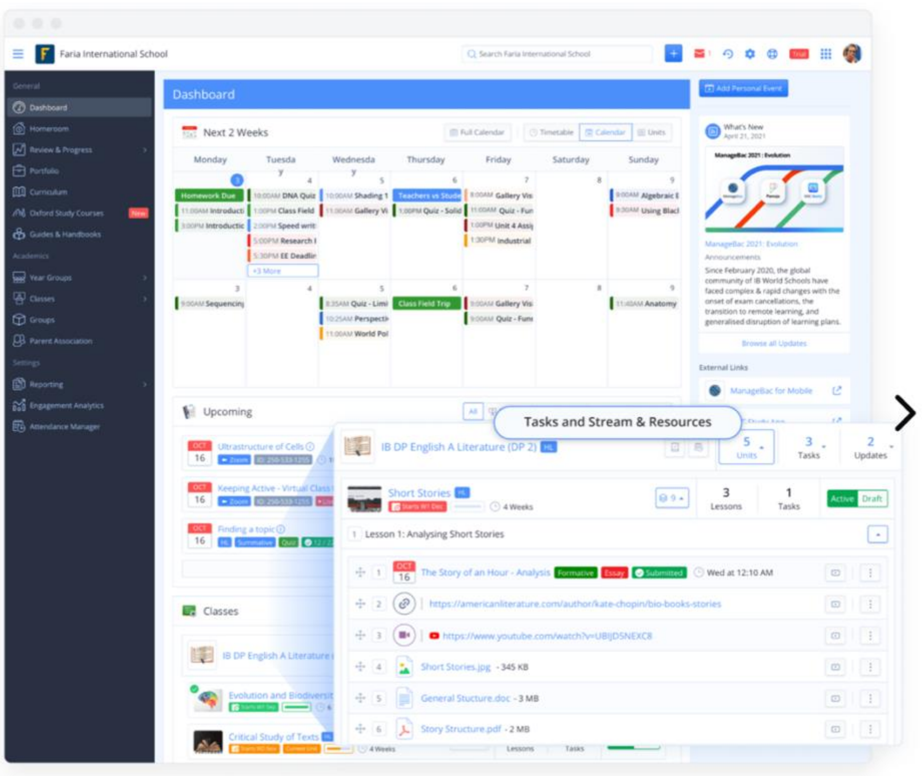
Another example of discrepancy is that AssessPrep permits teachers to construct online assessments directly from ManageBac. Nevertheless, only two teachers reported using AssessPrep. The observation showed that the use of AssessPrep appears almost only for summative assessment and reporting purposes. The classroom observation did not confirm that teachers used AssessPrep live assessment via ManageBac for formative purposes in teaching and learning activities. One explanation for this phenomenon is that usability constrains user and learner experience in classroom teaching and learning activities. Teachers tend to use the most suitable software to provide easy access and that is time-effective for teachers and students. as it could consume their time to access the AssessPrep from ManageBac.

In the literature, Li and Zhang (2022) assessed the prototype's interface usability in their study on a learning application prototype that can be integrated into classrooms. They concluded that displaying interface elements in unnecessarily elaborate configurations overcomplicates features. Furthermore, consistency and simplicity are essential to successful system design, especially for applications with a broad audience used in diverse classrooms. A complex user path with many clicks on the dashboard to the relevant functionality would be inefficient and overwhelming. A user journey is a path users can take to reach their goal on a website or portal. In an inclusive LMS portal such as ManageBac it might get overwhelming and time consuming to teachers and students to reach their targeted function (see Figure 5.1
). In Figure 5.1 there are no direct paths to the learning and formative assessment feature. The portal might be useful for management but not straightforward in classroom teaching, learning and assessment activities.

Sun et al. (2008) emphasised the importance of learner perceptions of learning technologies and the ease of technology used to enable learning technologies. While the goal of such ManageBac LMS systems is to provide high-quality education, teachers' and students' willingness to adopt and use LMSs is critical to the success of learning technologies. Furthermore, learning success relies heavily on user experience and views of such systems. The user experience (UX) is a broad phenomenon that describes how a learning management system (LMS) is viewed and used in online learning activities. While the user experience of LMS systems for teachers and students is essential, it impacts the teaching, learning and assessment process (de Carvalho & Silva, 2008; Maslov et al., n.d.; Saleh et al., 2022; Zanjani et al., 2017).

Figure 5.1

ManageBac Dashboard Example (ManageBac n.d)



Regarding Kognity, although all participants viewed it as highly beneficial for formative assessment and feedback, it did not seem to be utilised by students very much. Students said they intended to use it and were dismayed to learn that the school would no longer pay for its licencing. The rationale given by the school was that students did not use the software as they should. Yet, last year, when it was just implemented, students utilised it heavily; however, both teachers and students stated that the school observed low usage this year. One group of teachers reported assigning Kognity-based activities to the students, but students were not interested in completing the assignments. Other teachers, such as the chemistry teacher, gave a different reason.

They explained that they used Kognity because last year's topics were well-suited for Kognity; however, this year, there was no need for it because the curriculum focused primarily on laboratory investigations. Thus, since it is a newly implemented technology in the case school, it is unclear whether the formative assessment process at school would benefit from using Kognity, as reported by some participants, or there is no need to utilise this software, as reported by the school. Table 5.3 explains the Kognity affordances and constraints from the teachers' and students' perspectives.

Table 5.3

Actual Affordances of Kognity

Actor	**Functional Affordances (Bower, 2008; Hartson & Pyla, 2012)**	Constraints
Student	Instructive: Self-assessment after each section and allows access to performance and progress. Searchability Productive: Battles and competitions among students or the portal itself with immediate scores and feedback. Static/Instructive: Creating and allocating assignments to the classes or individual students. Allows assigning battles between students and each other or the pot track students' progress and allows performance overview—data manipulation by editing students' information. Collaborative/Productive: No collaborative features for teachers.	Provide general assessment and does not assess higher skills. More interesting to sciences than theoretical subject.
Teacher	Instructive: read-ability/ accessibility/monitorability, trackability. They also control some portal features by giving permission or assigning assignments, quizzes, or tests with automated feedback for both students and teachers. The portal allows recordability and tracking of all assessment activities and feedback. There is also a plagiarism checker for uploaded assignments, so it provides the teacher with feedback. Collaborative/Productive: Teachers are afforded to share their feedback and resources and receive messages, questions or inquiries from students and another peer.	Cost.

Both	Sensory: It can be accessed only from the laptop/desktop portal. Cognitive: There is a straightforward, attractive menu and dashboard. Physical: The access is straightforward. Social: It affords communication and battling between students and between students and the pot. Allows bundling a group or individual task—monitored social connections by teachers. Emotional: Both students and teachers reported huge desirability, enthusiasm, and joy of use

Another discrepancy between technologies as tools of formative assessment relates to the use of IWB. Observations showed that IWB is implemented and facilitated in teaching, learning, formative assessment, and feedback practices competently by both teachers and students. Nonetheless, participants did not report the use of IWB in their feedback practices, and few teachers reported difficulties in using some of the interactive features of IWB. The reason for this discrepancy could be that the IWB is normalised, and the participants are so accustomed to it that they do not notice that this technology facilitates formative assessment and feedback. Indeed, a widespread technology has its most significant impact when it passes its initial hype stage and becomes normalised (Lee, 2015; Shirky, 2009). Although the nature of IWB integration into assessment and feedback practices varies among teachers depending on need and skills, it should be noted that the way IWB is so integrated and normalised into the daily practice is different to ManageBac and Kognity that are reviewed above.

The reason for the discrepancies in the application of IWB, ManageBac, and Kognity in the learning process could be that while new technologies are rapidly evolving and encouraged by the schools, technological software may become overwhelming for its users. Also, some software requires considerable instruction adjustments, particularly regarding feedback procedures. One potential reason is that it takes so long for teachers to develop their teaching practice and pedagogy suitably, so they prefer to employ the same technology for several years, but educational technology businesses may become obsolete, out of style, discontinue updating their products, and eventually stop producing the product that the teachers used. In this regard, it is worth noting that IWBs were installed in 90% of the UK schools by 2007 (Kitchen et al., 2007). However, it is usual for emerging technologies to be utilised by users to do many of the old functions they used to do before the new technology arrived (Betcher & Lee, 2009). For example, most teachers who started using an IWB transformed many paper-based tasks into IWB-based assignments. In the current study, some teachers were just projecting a paper on the IWB.

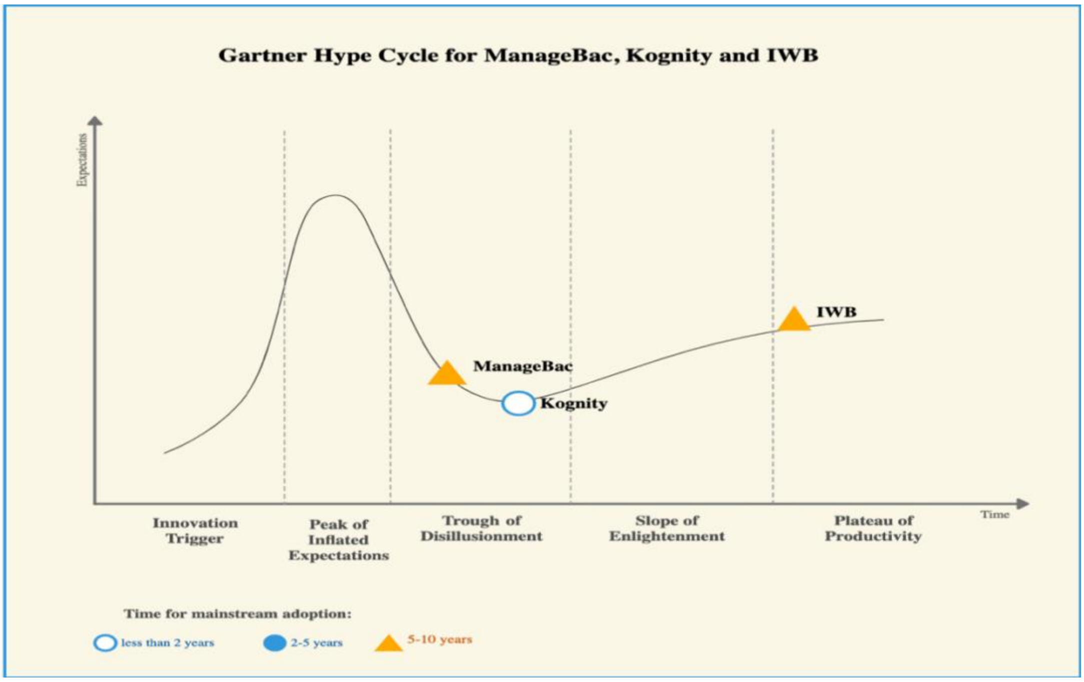
Thus, based on the literature, IWB is a successful example of a technology which is long implemented, well tested, and supported by the governments and educational entities with budget and training. Gillen et al. (2007) also pointed out effective prospects for bringing the IWB into the classroom as a mediating artefact. In their study, Gillen et al. (2013) found that teachers could efficiently employ the IWB's technical affordances while maintaining a traditional teaching approach but not in a way that changes teaching regarding classroom dialogue and underlying pedagogy. Their reason was that the IWB could enhance the practice's pace but limit the opportunity for extensive teacher-pupil conversation. The findings in the current study showed that IWB served both traditional and unconventional teaching methods. The long-term implementation appears to support the facilitation of IWB in teaching, learning, and formative feedback practices. The variation of teachers' digital skills, the experience of use and the updated software, such as the integration with different software (Google and assessment applications), allowed the variation of teaching methods (teacher-centred and student-centred) (See Appendix 7-15).

Unlike IWB, ManageBac and Kognity seemed to be rushed through implementation and testing for formative assessment and feedback by the case school. Educational institutions such as the case school may employ Kognity, for example, because it was advertised as the most recent and significant technology, but the results of its implementation were inconclusive, which led the same school to stop using Kognity and switch to perhaps something newer or a better-advertised software. Unquestionably, tech and IT companies will constantly introduce and advertise for unique and new technologies to persuade or sell to school authorities, and the market may be swamped with new and more powerful software, which the school may be tempted to use. As a result, teachers and students may continue to lack in software expertise. Therefore, a technological development cycle, for example, based on the Gartner Hype Cycle (GHC) model (Gartner, n.d), should always be considered when selecting software used during the learning and feedback processes.

Furthermore, the Gartner Hype Cycle(Gartner, 2022) could explain the discrepancies among specific software, such as IWB, ManageBac and Kognity, in this case. The GHC shows the maturity, acceptance, and applicability of technologies and applications to help assess the viability of new technologies that make big claims. The GHC's technique demonstrates how a technology or application would evolve, providing valuable knowledge for controlling its deployment. The GHC stages comprise the technology trigger, peak of inflated expectations, trough of disillusionment, enlightenment slope and productivity plateau. For example, technology usage in the case of ManageBac and Kognity might fall somewhere between the enlightenment slope and the productivity plateau (see Figure 5.2).

Figure 5.2

Possible Gartner Hype Cycle for ManageBac, Kognity and IWB



Note. Adapted from Gartner (2022).

Figure ***5.2***

shows a hypothetical chart based on the data findings of this study, adapted from Gartner (2022). The chart is showing a probable hype cycle of the ManageBac, Kognity, and IWB actual adoption timeline at the case school. The cycle began with the innovation trigger phase, during which the school decided to deploy the technology (ManageBac, Kognity, and IWB) for the claimed benefits. Then the technologies went through a period of inflated expectations, while the school, teachers, and students were enthusiastic about the technology and spoke highly of the technology's affordances and impact. Then the technologies fell into the abyss of disillusionment when teachers and students started using them much less. Moreover, the school realised how expensive it was and how the technology was not doing what the company promised it would do and decided to discontinue the technology when it reached the bottom, which is the case of Kognity. Until teachers and students realised the affordances and constraints of the technology, they demanded to keep it and work with it by generating solutions around it. Teachers and students suggested ways of using Kognity to the school which accepted the recommendations and decided to give it another opportunity.

In the case of ManageBac and IWB, the school, teachers, and students were required to utilise them and develop strategies that allowed share-ability and save-ability in the case of ManageBac, collaboration and participation in the case of IWB. The observation confirmed that the IWB is used by all teachers in daily teaching practices due to the lengthy implementation and adoption time, as discussed above. However, utilising technology for formative assessment and feedback varies depending on the teachers' skills and attitudes. While ManageBac is still on the slope of the enlightenment phase, there is more potential for communication and collaboration affordances. It is worth mentioning that ManageBac has been used in the case school for less than ten years, and several teaching and assessment features have just been improved.

Another factor determining integration of technology and utilisation of various software programs at the case school is the demand for performance improvement. The school is going through a restructuring phase, implementing digital transformation in teaching and learning as a part of the restructuring. The difficulty appears that teachers and school professionals could not transfer the functionality of the technology into innovatively enhanced practices and advanced instructional technologies. For example, they implemented numerous technologies and software, such as ManageBac, Kognity, and IWB. Still, the use of its formative assessment and feedback functions was not reflected in the classroom practices. According to Herodotou et al. (2019) and Orr et al. (2019), to reap the benefits of educational technologies, teachers must develop and implement a software-specific pedagogy, which would take some time. In their study, Herodotou et al. (2019) explored new forms of pedagogy for the 21st-century interactive world. They argued that learning is a science that needs to test its interventions and teaching approaches before its application in the classroom. It should be required to enhance learning outcomes and meet the expectations of a constantly evolving digital culture. They recommended more significant interaction between researchers and practitioners and highlighted the need for evidence-based professional development to inform and improve teaching.

5.4 Varying Levels of Students’ Engagement and Autonomy

The current study data analysis identified a theme of technology as a tool for ownership and autonomy. It appeared that students could access a wealth of information and learning opportunities through available educational resources on the Internet during classroom activities. Observations showed that a well-established learning environment was provided in some classrooms by merging the Internet, hardware technology, and mobile technology. As reported in Chapter Four, some teachers, including the humanities group, encouraged students to use all types of technologies and formal portals to look for information and not to rely on teachers only for formative assessment and feedback while teachers were monitoring students' activity and development from their desktops (Sadler, 1989). As Sadler reported as far back as 1989, self-assessment and learning monitoring teaches students to choose and use superior learning strategies to reach their goals.

The interviews conducted also support the view that technology could be an excellent aid in students’ engagement and autonomy and could help them to become self-sufficient and accountable. As one of the students told me, students perceive technology as enabling them to depend on themselves and as a support during their learning process. Indeed, when students actively participate in the learning process, they achieve learner autonomy (Aldon & Dempsey, 2016; Benson, 2006). Teachers 6 and 7 also emphasised the notion that students’ autonomy supports students in reinforcing the information, reduces teachers’ workload and balances the time and effort spent in the classroom. Sadler (1989, 2010) reported that using technology in formative assessment and feedback assists and improves students' learning and allows them to develop into autonomous and self-regulated learners.

The findings revealed that the methods used emphasised the significance of students' understanding of learning objectives. For example, almost all teachers and students reported in the survey and interviews that utilising technology facilitated formative assessment and feedback levels, as was used in sharing learning objectives and assigning learning assignments, fostering productive classroom discussions, and completing learning tasks. The method used also anticipated performance and the critical role of teachers' feedback in allowing students to improve their performance, as highlighted in the supporting teaching and learning subtheme and was also confirmed by Hattie and Timperley (2007), James and Pedder (2006), and OECD (2008). In addition, this study revealed in the technology as a tool for ownership and autonomy theme that most teachers used technology for assessment and provision of feedback. That approach would enable the students to control their learning process through self-monitoring, a critical component of the assessment process that supports learning, as reported by Clarke (2014), Hargreaves (2005), Hattie and Timperley (2007), and McCallum et al. (2010).

The findings showed various advantages to using technology in formative assessment and feedback to facilitate learner autonomy; without a doubt, these phenomena of students' engagement and autonomy are related to the self-regulation level of feedback. Similar to my claim, Woo et al. (2010) and Zhao et al. (2012) reported a link between self-regulation and lifelong learning autonomy. I should stress that these affordances allowed the students to connect their learning with the self-regulated assessment process to monitor their learning progress easily. Thus, I conclude that technology helps students to plan their learning process, benefit from different resources, monitor their progress, instantly share resources with their peers, access peers' work, and reflect on their learning which appears to motivate their engagement, collaboration, self-regulation, and, therefore, autonomy.

5.4.1 Engagement

Technology as a tool of engagement theme in my study indicated that technology worked as an engagement tool for students inside and outside the class and that integrating technology-aided formative assessment and feedback into classroom teaching and learning increased interaction and engagement between teachers and students and amongst students. Observations showed that, with technology such as Google applications inside and outside the classroom and social media outside classrooms, shareability affordances aided students in demonstrating good attitudes toward agentic engagement, as seen by their willingness to take the initiative to participate in classroom activities and improve the quality of their learning. Many teachers were proactive; the technology offered teachers access to student performance data and allowed them to modify instruction to maintain interaction and interest. For example, Teacher 8 said technology facilitated timely feedback for students and afforded engagement.

My observations showed that students in technology-aided classrooms (specifically the humanities group) also were not passive but made a positive contribution to the learning process by attempting to enrich the learning experience rather than simply accepting it passively as a given. For example, in humanities group classes, students worked in pairs or small groups, sharing their work via Google Documents or PowerPoint presentations to facilitate classroom discussion and feedback. Communication, class discussion, and peer engagement fostered positive relationships through technology, with students performing the majority of assessment and feedback work with the teacher serving as a facilitator (see vignette). In the literature, students' participation was regarded as an essential factor in formative assessment and feedback (Black & Wiliam, 1998; OECD, 2008) and in technology-aided formative assessment (Boyles & Klein, 2018; Gibson, 1977). In addition, students' connectivity and engagement in technology demonstrated their motivation and self-efficacy (Goldhammer et al., 2016; Willey & Gardner, 2010), which positively contributed to the learning process.

I observed an example of such use of technologies when teachers shared and projected the groups' slide presentations on the IWB for assessment and feedback. Both students and teachers gave and received feedback during this task. The IWB was utilised to convey class objectives and directions for exercises, exams, and other assignments to students. It was also used to present films, graphics, enticing words, and conversation questions. During the interviews, both teachers and students also stated that technology creates an interactive environment that makes assessment and feedback processes more dynamic, which helps to develop confidence, enhance engagement, and thus improve student achievement. This finding was consistent with other research about the benefits to students of technology in their studies (Aldon & Dempsey, 2016; Sheard, 2012; Sheard et al., 2012). For example, Black and Wiliam (2009) noticed that classmates engaging in social interactions enhanced confidence and a sense of knowing one another, which led to knowledge construction, as reported by Banks and McCormick (2006). Thus, as Stiggins (2002) argues, creating a learning environment where students can collaborate to develop peer connections is critical for formative assessment.

Based on the current study findings and results of other studies, interaction and engagement promoted collaboration, generated a feeling of community, built social capital, and supported knowledge generation. The research literature also reports the benefits related to ownership, autonomy, and engagement when students use technologies outside of the classroom. For example, Aidinopoulou and Sampson (2017) argue that students who collaborate actively outside the classroom, for example, as part of a flipped learning approach, experience deeper learning, increased confidence, and increased achievement. However, in my study, most teachers' online engagement outside of the classroom was limited to monitoring submissions and providing summative feedback, excluding the lockdown time.

Three teachers, observed and interviewed in the current study, indicated a relatively low level of involvement in formative assessment and feedback procedures. The English and mathematics teachers were hesitant about incorporating technology into their lessons and beyond the classroom. They could not conduct technology research for suitable technologies in certain activities or topics due to their low use of technology in their disciplines, which resulted in a decline in formative assessment processes such as peer and self-regulated assessments. Marshall and Drummond (2007) discussed how teachers' beliefs affect formative assessment practices. According to Drummond’s findings, teachers whose classes reflected the essence of formative assessment were more inclined to accept responsibility for success and failure in promoting pupil autonomy. As a result, those teachers had a sense of agency and wanted to use it to overcome learning difficulties. In the current study, it was found that the lack of technology-aided formative assessment and feedback in classrooms negatively affected the formative assessment and feedback practices. This resulted in low student engagement levels and, therefore, reduced learner autonomy, which is at the heart of formative assessment, as Black and Wiliam (2006, 2009) argued.

In general, the findings showed that technology in formative assessment and feedback could increase teacher and student engagement when used properly. For instance, technology can assist teachers in becoming more efficient by expediting and changing the instruction plan in response to feedback received. In addition, students can benefit from technology by accelerating their knowledge acquisition and improving their knowledge retention. I should stress, though, that my analysis focused on specific formal assessment technologies used in and outside the classroom, such as Kognity, Kahoot and Quizlet, and research tools such as Encyclopaedia Britannica. Additionally, the technology eliminates barriers between teachers and students and between students themselves, increasing student engagement and allowing students to work outside of the classroom, such as at home. Technology can also foster cooperation, access, and connection and expose students to diverse people, ideas, and resources. Moreover, it enables educators to arrange projects to match the unique needs of each student. Each student can work alone and at their own pace on various assignments in a well-equipped classroom. This contributes to ensuring that all students may learn in a setting that is optimally suited to their requirements.

5.4.2 Learner Autonomy

A salient point of my study is that technology helps students to develop self-regulation and, therefore, ownership of their own learning process. They no longer rely on teacher-centred learning and instead embrace technology-based autonomous learning. It appeared to me that as teachers adapt to technology in formative assessment and feedback practices, the focus of teaching in the classroom shifts from teacher-centred to student-centred. Furthermore, in my study, students clearly perceived collaborating with other students as an advantage to learning. In the literature, Wilson et al. (2015) and Willey and Gardner (2010) reported that collaborative learning and receiving peer feedback via technology had been shown to promote autonomous learning and motivation for lifelong learning. Boud and Falchikov (2007) also found that encouraging students to self-regulate through collaborative investigation and assessment would nurture the student's learning independence and autonomy, shifting the teaching paradigm to a student-centred learning approach.

Nevertheless, the same students can behave in different ways when learning different subjects. The observation revealed that the learner’s autonomy was shown much more in the humanities disciplines group than in the STEM or languages group. That could also be due to the teaching and learning environment, as technological-aided and facilitated classrooms afford collaboration, engagement and follow-up between teachers and students and students themselves and, therefore, support feedback strategies, while the opposite is true in less technological classrooms.

In their mixed methods study, Lahdenperä et al. (2022) found that the learning environments are different based on a factor that measures lack of regulation and that not following students' tasks makes it challenging to set goals and stay motivated. On the other hand, what aided regulated learning was the co-regulation of learning through scaffolding and a strong interpersonal environment (Vygotsky & Cole, 1978). It might be also that in high-technology classrooms, students are given the option by their teachers to choose the type of technology that they find beneficial to their learning, which supports their learning autonomy. According to Benson and Lamb (2020), the choice is a crucial component of learner autonomy; nonetheless, it is a significant point in the technological era and the abundance of resources available.

In STEM subjects, students were able to assess others' assignments and compile work to determine how effectively their learning progressed. In some classrooms, such as chemistry, the students were given guidelines on completing learning activities, while the teacher went around assisting them when needed. However, the guidelines were general and could not be applied to every context the students chose, and the teacher was not always available to assist students individually in and outside of school. Interestingly, the teacher did not use technology to facilitate and monitor students' classroom practices. Thus, students' collaboration, self-regulation and autonomy were not facilitated by technology in this classroom.

An explanation for this difference between various disciplines could be due to the nature of the skills required. As Moir (2016) argued, technology is unlikely to be helpful when students need to gain higher-order abilities such as problem-solving, creativity, and critical thinking, which can be found more in STEM disciplines. Moir (2016) further states that a wiki or similar task requires pupils to collaborate, which is competence rather than higher-order skills. However, technology might not be needed due to the nature of the targeted skill, as some skills depend on the individual students following required steps rather than acquiring aid from others or other resources. Retnowati et al. (2016) believe that when students are required to solve a problem and are provided with a step-by-step solution, an individual learning technique is found to be more effective than a collaborative learning strategy. Maybe that is the reason for the chemistry teacher not supporting collaboration and self-regulation in that particular class. Thus, students' collaboration, self-regulation and autonomy were not facilitated by technology in this classroom.

Another reason for the disparities of students’ autonomous behaviour among disciplines could be related to the teachers' capabilities and competencies. In the current study, the technological capacity and the self-regulated capacity of teachers and students appeared to create complexity and confusion. It appears that the use of technology offers new complexity. The technology used in the current school is thought by some students to cause overreliance on self-study and independence instead of the teaching staff, which could harm learning outcomes, as some students reported during the interviews. Thus, I argue that the right balance of implementing the self-regulation strategies with teachers’ support and monitoring is needed. It might be that students do not clearly recognise the difference between requesting help as an instrumental (hint) strategy in self-regulation, and executive (answer) help seeking . Many types of help-seeking behaviour could be deemed self-regulation, according to Hattie and Timperley (2007). Their study differentiated between instrumental (hints), and executive (answers) aid seeking and reported that higher degrees of instrumental help seeking lead to self-regulation feedback, whereas executive help seeking relates to task and processing levels. Moreover, teachers need to understand that emotional aspects influence instrumental help-seeking behaviour, as sometimes students do not request assistance due to low self-esteem or fear of social humiliation (Hattie & Timperley, 2007; Karabenick & Knapp, 1991; Newman & Schwager, 2015).

On the other hand, there will always be problems while using advanced technologies in learning because simply placing sophisticated technologies in educational settings would not ensure successful and autonomous learning. Teachers need to explore the implications of strengthening students' capacities to participate in a technological environment on their sense of autonomy and ownership as they progress through their education. In this regard, in their review of the significance of teachers' self-regulation capacity in adopting self-regulated learning practices, Peeters et al. (2014) concluded that teachers' self-regulation abilities are a critical predictor of self-regulated learning implementation in schools. Self-regulated teachers adapt their teaching style to their students' self-regulated learning capacities, get a better grasp of self-regulated learning processes, and become more effective at encouraging self-regulated assessment.

One more salient point of my study is that with technology, education is no longer restricted to classrooms and school hours; it could occur anywhere at any time. When students have control over their learning, they may choose when, where, and what to utilise in their learning process, as well as with whom they want to work or receive feedback, even in disciplines that use traditional ways to complete tasks in the classroom. I found that students used various types of technology for formative assessment and feedback; formal, informal, inside and outside the classroom; all this software was downloaded onto their smartphones and personal devices. As discussed previously, the students indicated in the interviews that while they worked on the activities, they used social media to communicate with their peers for feedback and group and peer projects, exchanging multimedia and documents. Regarding learning autonomy, students stated that they return to their social media accounts to check for comments provided by other students and reflect on their learning. In contrast, students who worked on their assignments or tasks individually could not receive such feedback even when they were experiencing learning difficulties.

Furthermore, learner autonomy offered by technologies makes students feel more confident about producing better learning output. Other studies report that many meta-cognitive techniques, processes, and skills are involved in the self-regulated learning process, including self-assessment, goal setting, planning and implementation, monitoring, and support (Butler & Winne, 1995; Carlos Núñez et al., 2017; Lee et al., 2019; Schunk, 1989; Schunk & Zimmerman, 2011; Zimmerman, 2010). However, it should be noted that while using social media and informal portals may boost learner autonomy, it minimises the teachers' role and monitoring. The lack of official monitoring of students’ learning activities and development may negatively affect the teachers' role in correcting and assuring the knowledge is transmitted and acquired.

Another advantage offered by technology, as reported in the interviews by students, is that students can review other students' work and receive feedback, which allows students to learn from these processes and aids in their learner autonomy. In this sense, students could be inspired to finish their assignments or see flaws in their own work and subsequently fix them. The students' learning behaviour of using the available software for exchanging feedback, self-assessing themselves by taking notes, recording, using resources, and sharing functionalities would arguably result in a better learning output quality. However, during the interviews, some teachers voiced concerns that technology, in this sense, could be used as a tool for cheating and plagiarism. Other teachers believed technology is a distraction, as it is mostly used for socialising rather than learning or receiving feedback, as already discussed earlier. Indeed, while rapid communication and ease of access were considered important by the student respondents to receive immediate feedback, frequently checking for feedback could be considered a constraint since immediate correction can negatively impact students learning to develop a particular skill, as Hattie and Timperley (2007) argue.

5.5 Differences Between the Results of the Interviews, Observations, and Surveys Regarding Technology-aided Formative Assessment and Feedback Affordances and Constraints

The data collection methods included the survey, interviews, and observations, and the findings revealed several inconsistencies between the results of these three modes of data collection concerning technology-aided formative assessment and feedback affordances and constraints. For example, although teachers reported in the interviews that technology aided learning in providing immediate feedback, they were observed spending most of the time providing face-to-face feedback. This can be explained by the evidence I found that technology aided teachers in serving automated quizzes to gauge how students were learning and seeking comments from the students, which helped teachers to assess students' strengths and weaknesses, which is what formative assessment is about, as reported by Black and Wiliam (2009). In this way, technology possibly allowed teachers to concentrate on the weak points to improve the class's overall performance by providing face-to-face feedback on the complicated challenges.

Another example of the differences is that between the survey and observation. While only two teachers among all the teachers and students reported in the survey that they provided feedback through IWB, observation confirmed that many teachers incorporated the IWB into classroom teaching and assessment practices. For instance, in humanities classrooms, the IWB seemed to be a useful tool for the students in the digitalisation of instructional materials and multimedia integration and feedback, where students appeared to be active, collaborative, and engaged learners. Moreover, in geography class, students managed the tasks online in pairs on Google Slides live sharing tool and shared their work with their peers and the teacher on the IWB, engaging in discussions and providing feedback to each other.

Without a doubt, I attribute these variances in the data I obtained to the differences between the three methods of data collection I used: interviews, observations, and surveys. Due to the nature of this mixed methods study and the low sample size of the survey participants, the study benefited from the observation and semi-structured interviews. It served as a triangulation of methods for a deeper understanding of participants' perceptions and use of technology-aided formative assessment and feedback (see 3.6.5). It also aided in spotting discrepancies and variances in this matter. Somewhat similar differences between data collection methods have been discussed by other researchers. For example, Hoebel et al. (2014) reported that findings vary by data collecting methods because often the same participants respond differently when different tools of data collection are used, with the most striking difference between the interviews and surveys. Furthermore, Stokes and Bergin’s (2006) evaluation of focus groups and in-depth interviews revealed that social pressures lead to a consensus perspective, as the focus group method can obscure beliefs, attitudes, and motivations. Studies that explored group pressures confirmed that group opinions might differ from personal views (Bloom, 1989; Fern, 2001).

Group pressures also seemed to play a certain role in my research, and I concluded that the obtained data related to group settings in this, and other studies of a similar nature, should be interpreted cautiously in conjunction with data obtained by other collection methods. First, it should be noted in this regard that in this study, there is no information about how the participants responded to the survey, as they could be answering survey questions either individually or in a group setting. Moreover, the low sample size issue could be why the survey may not have given valid information. Then, my research demonstrated a challenge in recognising consensus beliefs formed by groups, as respondents seemed oblivious of contradictions between their views and group ownership. Individual in-depth interviews are free from group influences and can reveal crucial attitudinal data (Gaskell, 2000). In the current research, I did not conduct focus groups, although I had some informal conversations with the teachers and students during classroom observations.

During the interviews, it occurred to me that teachers might be sensitive about the question about their own behaviours or their students' behaviours regarding technology use. On one occasion, I asked a teacher about ManageBac, which was reported in the survey as used by both teachers and students. However, I observed that ManageBac had some communicative functionalities that were not used for formative activities and feedback. When questioned, this teacher immediately became defensive and diverted the answer by saying, "students do use it; they have recorded all the CAS (Creativity, activity, service Module) in ManageBac". The teacher also commented that they were unsure what the students were telling me in this regard. That response did not answer my question, but I assumed the teacher wanted to demonstrate their professional self-perception and personal pride in their work environment of the case school that supports technology. I attribute this episode and apparent sensitivity of the teacher to the influence of the work environment, especially in that the case school is going through transformation and assigning considerable budget to it. According to Holland (1997), the work environment promotes the development of competencies, stimulates people to engage in various activities, and rewards people for displaying values and attitudes. The high technological environment and support at the case school were noticeable during the study. Therefore, the environment could influence personal and professional self-perceptions, competencies, attitudes, abilities, and values. Therefore, I believe this teacher showed pride in the school's technological environment and practice and became defensive when I asked my question, which may have been understood as a criticism. However, it did appear at times teachers gave responses that were inconsistent with what I observed first-hand about technology use.

5.6 Perception and Attitude of Teachers and Students Toward Technology-aided Formative Assessment and Feedback

It was not surprising that both teachers and students agreed that technology was an effective tool for education. However, students and teachers seemed to have different explanations for this usefulness. Based on the survey and interviews, students found the technology useful since it made it easier to communicate with teachers and peers. They employed technology to get their work done and submit it to their teachers and fellow students. Teachers use technology to impart instructions and provide feedback and assessment during the learning process. This finding aligns with previous studies reporting that the technology was helpful in improving communication (Duch et al., 2001) and aids in educational endeavours (James, 2006; James & Pedder, 2006; Timmis et al., 2016).

A number of authors (e.g., Armstrong & Llorin, 2015; Spector et al., 2016; Spector, 2014; Spector, 2016b) have argued that technology provides resources, facilitates independence and timely feedback, and helps people better understand their strengths and weaknesses, which agrees with the findings of the current study. As demonstrated under the perceived usefulness theme, in the interviews, technology was perceived as supportive of teaching and learning by teachers and learning by students through boosting the quality of work, reducing instructors' workload, and allowing for students' self-determination. Teacher 8 even reported that technology supports teaching of challenging and uninteresting topics because students are more likely to engage with those subjects that use technology as it would introduce novel ways to learn, such as in humanities subjects. These technologies worked as empowerment to the students' self-directed learning. Student 8, for example, described how these technologies make assessment and learning more dynamic and interactive. Importantly, the students recognised that technology made it easier to do their academic assignments by keeping everything they needed at hand, allowed multitasking (as Student 2 mentioned), and made formative assessment possible.

Based on the survey and interviews, most of the students believed that the formative assessment was more beneficial than traditional assessment approaches. With the availability of technology in the case school, students from a specific discipline kept track of their progress, researched, and presented and shared the results of their studies with their teachers and fellow students. Notably, the students also said that this improved their motivation and engagement in studies. Similarly, Wiliam (2013, 2014) highlighted that students' performance improved because they received feedback during the learning process.

Given the findings presented above, it is not surprising that most teachers and students had a positive outlook toward the use of technology. Expectedly, students considered technology an essential part of their lives and quickly accepted new technologies. At the same time, the remarks made by the teachers during the interviews, for instance, "The technology seems to be very normal to them" (Teacher 9) and "Students have technology anywhere they turn. Let's face it" (Teacher 4). Teachers were relatively less comfortable with the technology than the students. Survey data supported this notion, wherein only 46 % of teachers said they were excited about using technology in future. Also, most teachers admitted that if they got stuck when utilising technology, they would need help from someone or need to consult a resource. Interestingly, most students also said the same.

Despite teachers' and students' positive perceptions of technology's usefulness, ease of use, behavioural intentions, and supportive conditions, participants perceived low levels of self-efficacy. Some other studies demonstrate similar findings. In a meta-analysis, Uerz et al. (2018) found that instructors, particularly those in higher education, had low self-efficacy regarding technology. According to Yildiz Durak (2019), technological self-efficacy was the most significant aspect of technology-based teaching. Thus, in this study, though the teachers and students agree that it would be beneficial to use technology for educational purposes, their capacity to do so was inadequate.

This gap needs to be addressed to accrue the full benefit of technology in education; for example, study participants may need technology-aided formative assessment and feedback training. Importantly, despite this gap, I observed positive uses and practices of the technology-aided formative assessment and feedback in the case school. I should note that the school provided an enabling environment for using technology by providing devices like Desktops, Laptops, IWB, Soundsystem and scientific equipment. They made available a variety of portals and software, such as ManageBac (ManageBac, n.d.), Kognity (Kognity, n.d.), and (Kerboodle, n.d.). Subscriptions to multiple formal websites were also provided, such as Encyclopaedia Britannica and CodeAcademy. Formative assessment was integrated within the process using technology like Kerboodle.

However, surprisingly, many of these technologies were primarily utilised by the teacher rather than students. In available technologies and their user's theme, the teachers reported that they mostly use formal technology implemented by the school and that ManageBac is mandatory in IB schools for assigning tasks, submitting them, reporting grades, and providing feedback. The students mostly preferred using personal devices and informal websites. The school allowed personal devices such as laptops, tablets, and smartphones, and provided online access to informal websites and apps such as YouTube and Microsoft applications, which were perceived as beneficial by the students. This could be due to that these technologies provide easy access to new knowledge, as it showed considerable change in the teaching and assessment of the students in the institution. This confirms the research reports of the significant changes in teachers' instruction and assessment processes of student learning outcomes in the education field that Aidinopoulou and Sampson (2017), Aldon and Dempsey (2016), and Panero & Aldon (2016) reported.

Besides, the majority of student participants noted that technology supports self-learning. They believed they could get new knowledge and feedback by using online technology. They acknowledge that the availability of online portals and software such as YouTube tutorials would widen their academic research and equip them with knowledge of specific practices and technical aspects among different subjects. This research corroborates the findings of Aidinopoulou and Sampson (2017), Aldon and Dempsey (2016), and Panero and Aldon (2016), who established that online use aided students in sharing materials for a group task, which increased their self-directed learning. From the participants' perspectives, technology allows them to access information through search engines such as Google and Google Scholar, electronic sources such as E-Books, and school portals such as ManageBac. This finding is consistent with prior research indicating that technology has a crucial role in supporting students in their continuous assessment for learning and, consequently, their final test, which has a beneficial effect on their performance (Gerard et al., 2010).

5.7 Differences Between Perceptions of the Students and Teachers Related to Feedback

There were gaps identified between the perceptions of the teachers and students, as demonstrated by the analysis of the results of the surveys, interviews, and observations. For example, the teachers' responses to students' regularity of delivering self-regulating feedback levels question items in the survey were inconsistent with the students' responses. While 90% of the teachers believed that they provided feedback that supports students' self-regulation, only 50% of the students reported receiving this kind of self-regulative specific feedback from their teachers, although, importantly, students reported that technology aided them in self-regulative feedback. This difference in the perceptions regarding the feedback given and received could be explained by the fact that students did not recognise this particular feedback because it was not clear to them that it was related to self-regulation. It is very likely that the teachers did not point out that this kind of feedback would help the students with self-regulation before the final grading. As the findings showed in the "*Technology and feedback levels*" theme, the examples provided by Teacher 1 (see **Figure *4.27*** and **Figure *4.28***) are all for grading and final assessment purposes. There were no data available regarding whether this rubric or feedback was provided to the students formatively while teaching and learning. Other explanations are that students may tend to ignore this self-regulative feedback, or they indeed did not receive it.

Yet, it is interesting that teachers reported they make efforts to support students in a certain way, whereas the students did not report the same level of support. This issue needs more attention, as there are insufficient data in the findings regarding why students do not share similar self-regulation perceptions. This discrepancy would negatively affect the delivery of feedback via technology, especially from experienced teachers such as the participants; experienced teachers' confidence in delivering self-regulation feedback might not make them aware that students are not receiving it or at least not perceiving it. Importantly, some studies demonstrate that there is an association between the experience that teachers have and pedagogical views and behaviours. According to Black and Ammon (2016), Huberman (1992), and OECD (2008), teaching experience is indirectly associated with pedagogical views, self-efficacy, and behaviours. Furthermore, teachers' views on constructivism and sense of efficacy become more robust with more teaching experience, as Berger et al. (2018) implicated in their paper regarding teaching experiences and teachers' beliefs. Therefore, in my study, more experienced teachers may assume they have already given self-regulative feedback; as a result, they stop being explicit about the feedback to the students.

Furthermore, this study revealed varying teachers' practices, which could be related to discrepancies in the beliefs about the formative assessment and feedback objectives and perceptions among the teachers. According to the observation and interviews, some teachers in this study used technology in formative assessment and feedback to assist and improve learning and performance, while others used the same formative assessment and feedback technology to manage time and effort. Teachers in the STEM and humanities groups said they spent much time as a subject group discussing the knowledge gap in each group's instructional objectives, learning purposes, and success criteria. These factors influenced the technological selections, while some teachers claimed that students' tastes also had a role. The learning progression detailed the expected growth and improvement of students' learning based on formative assessment (Wiliam et al., 2010). As a result, the timely constructive approach in which teachers respond to and evaluate information would aid students' progress in studying a subject area. The interesting point is that the literature such as (Faber et al., 2017; Faber & Visscher, 2018; Panero & Aldon, 2016; Sheard & Chambers, 2014; Vásquez et al., 2017) confirmed slight benefits of technology use in formative assessment and feedback. However, it did not show that they appear separately or that the benefits are associated with the use objective.

One possible explanation is that the role of technology differs among teachers who are more familiar with a teacher-centred setting from the teachers with learner-centred views. In the current study, observation showed that some teachers, who were incorporating technology for assessment and feedback in their instruction, such as in classrooms 2, 3, and 11 (see Table 4.28 and Vignette in Appendix 7-15), exhibited more of a teacher-centred approach; they benefited from technology in managing the time of teaching more than enhancing students' autonomy and ownership. While teachers who allowed students to use the technology encouraged online research and group work and gave sufficient time to search and work in groups or pairs in their classroom, such as in classrooms 10 and 12, showed more student-centred settings in teaching and learning. This could be linked to culturally entrenched, difficult-to-change teacher-oriented views reported by Jacobs et al. (2014). In their study about teachers' conceptions of learning and teaching, teachers' experiences with observing and evaluating students' learning processes appear to be more difficult in challenging students to apply alternative learning and thinking strategies such as self-regulating and autonomy, which was evident in the classroom observation. One explanation is that the way teachers utilise technology in their classroom depends on their perception of it, along with their deep-rooted beliefs regarding teaching and learning, as Jacobs et al. (2014) explained. For example, teachers with a teacher-centred approach perceive technology as helpful in managing time, and therefore they utilise it on that basis. On the other hand, teachers with a learner-centred approach perceive technology to enhance students' autonomy and ownership; therefore, their utilisation is based on their approach or even belief.

Thus, I conclude that with some teachers and subjects in this study, both teaching and feedback approaches were more teacher-centred than formative or student-centred, limiting the usefulness of both feedback and technology in increasing student self-assessment, technical abilities, and learning autonomy. Despite teachers' belief in the importance of feedback tailored to students' requirements, some teachers remained committed to assisting students in closing knowledge gaps they face when students do not know how to complete a task, rather than allowing students to self-regulate their learning. Although some teachers said during the interviews that their feedback was formative, which was supposed to encourage students to actively participate in closing the gap between their current and targeted proficiency levels, as reported by Shepard (2005), most teachers, such as in classroom 1, 5, 6, 7 and 8 (see Table 4.28
) did not appear to take this approach according to the observation findings. The impact of this inconsistency on their classroom feedback approaches was evident during the observations, as teachers did not always aid students' autonomous learning effectively. However, Black and Wiliam (2009) argue that teachers should limit their assistance while applying scaffolding principles to educate students on their following learning stages.

There is also a discrepancy related to the feedback providers in terms of the involvement of the students' parents in the feedback process. The findings showed that one teacher reported that students always receive feedback from their parents, five teachers chose 'sometimes', and five reported that parents are rarely or never involved in the feedback process. At the same time, 15 student respondents said that parents seldom or never engage in the feedback process, and only five students receive feedback from parents. However, no student in the interviews mentioned parents as a provider of feedback, while one student mentioned private tutoring. Students in the interviews consistently reported self-autonomy and per-assessment; they also reported that teachers are the sheet anchor whenever it gets difficult while learning and the classroom observation also confirmed that.

This finding is interesting, as 50% of the teachers believe parents are more involved in their students' assessment and feedback than they are. It is difficult to explain this result, but it might be related to teachers' communication or perception of communication with students and parents, particularly with all the technologies that teachers perceive and use as communication facilitators. Interestingly, Gibson (1977) has a different view in his technology affordance theory. He reported that affordances are fundamentally the link between perception and action and are directly perceived and intrinsic to items, regardless of whether persons are aware of them. The technology in this situation did not afford sufficient communication or data regarding the assessment and feedback providers of their students.

There are, however, other possible explanations, such as that students are showing good progress founded on their autonomy and ownership using the technology-aided formative assessment and feedback. This may lead teachers to believe that students have help from their parents or outside the school. In the findings chapter, the *technology as a tool of engagement* theme, the findings demonstrated that technologies allowed students to have immediate conversations about learning and receive feedback from peers, primarily through social media applications. Some participants perceived it vital to empower student autonomy, especially in accessing, sharing, and reflecting on their learning. This finding corroborates the ideas of McCaslin and Good (1996), Ryan et al. (2001) and Zimmerman (1998, 2011), who confirmed the association between the use of technology and the development of self-regulation skills.

A salient point here is that the role of parents in the presence of technology could be marginalised, especially since technology facilitates access to unlimited Internet resources, peers via social media, and teachers via email at anytime and anywhere. Patrikakou’s (2016) paper about technologies and parents’ involvement in their children’s learning discussed how technology advancement and online media have negatively impacted parents' interactions with their children and influenced parental involvement in their children's learning. The paper recommended an adaptation of ten principles that would enhance the parent-student interaction and parents’ involvement.

One more discrepancy between the students' and teachers' perceptions and use of feedback is that most students perceive social media apps as an aid for feedback and learning. In contrast, teachers do not use these apps at all. For example, in the interviews, WhatsApp was perceived by students as more beneficial than formal portals such as ManageBac. This is not surprising since students can access social media anytime and anywhere and can playback the corresponding content. Furthermore, as Bower (2008) identified, media affordances, such as WhatsApp in our study, have the characteristics of readability and write-ability in texts, speak-ability and listen-ability in audio functionality, accessibility (anytime and anywhere via online), and record-ability functions within group work and teams. The concepts offered by Bower within the various affordances categories are characterised as abilities, stressing the action possibilities they offer users. Snapchat was also popular among the participants, arguably because of the platform's speak-ability, listen-ability, and accessibility functions. Mao (2014) reported in a mixed methods study about high school students learning and social media affordances that students relied on social media in their daily lives for leisure and social connections. The study found that, although informally, students use it constantly for educational purposes and self-learning, which agrees with the current study findings. It is very interesting that still, after five years, students use WhatsApp for group work and Snapchat for instant peer feedback.

In contrast with my results, though, Mao (2014) found that teachers intermittently used social media for classroom teaching and learning. In this study’s case, after five years of Mao's study, teachers are adhering only to the formal technologies. A possible explanation is privacy issues related to school regulations. It might also be related to teachers' workload, especially since there will be open communication between teachers and students anywhere and anytime. Another possible explanation is that social media do not provide evidence of teachers’ extra work, mainly when the school carefully monitors technology for accountability and performance evaluation reasons. Unfortunately, I found insufficient data to support or dismiss these assumptions.

The most interesting explanation supported by the data I obtained would be how teachers perceive social media and informal technology in general. The current study revealed that teachers perceived smartphones and online connections as distracting. Several teachers voiced how it is difficult to control what could distract the students once the students are logged in to their devices. In contrast, Mao (2014) recommended that this kind of informal learning resulting from social media "need to be regarded as the ultimate aims for creating future learning environments" (Mao, 2014, p. 222). Mao's rationale was that the technology itself is insignificant, but the user, teachers and students are the significant actors. It is now clear that five years after Mao's study, this recommendation has not been fulfilled.

One could argue that a generation gap could also explain the previous findings: indeed, teachers and students reported multiple times that the students' generation (Gen Z) are more competent and accustomed to technology than teachers. Nevertheless, this explanation is debatable, as the observations revealed that teachers who used technology in their daily practice showed more skilfulness and competence than students, as students jumped from one technology to another, looking for more straightforward and specific functions. In this sense, teachers', and students' beliefs regarding the usefulness of a particular technology shape the technology's affordances and constraints. However, there is ample research (Cheng & Xie, 2018; Ding et al., 2019; Ertmer et al., 2012; MacArthur & Malouf, 1991) that confirms the relationship between teachers' beliefs and technology integration, but little if any, regarding the relationship between perception, beliefs, and technology affordances. At the same time, teachers' and students' self-efficacy beliefs also affect technology use and its affordances.

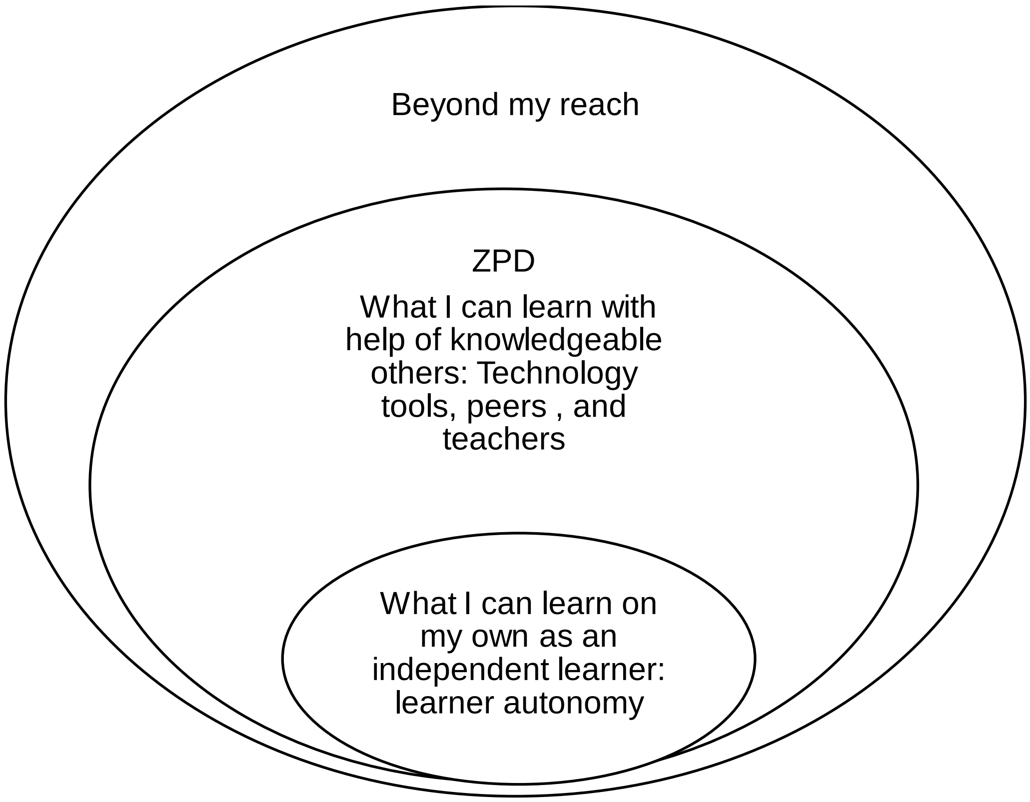
Hence, the role of the teacher is significant in the ZPD, where skills get complicated for the student to master autonomously unless a teacher assists. As discussed in the literature review, Chapter 2, Vygotsky (1978) defined the ZPD as:

The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers. (p. 86)

This ZPD concept is illustrated in Figure 5.3, where the learner's independent capability for development is increased through the help and guidance of knowledgeable others. In Vygotsky's day, these knowledgeable others were limited to parents and teachers (or other adults) and peers; however, today the learner can also be assisted to advance through autonomous learning with the affordances of technology and tools. In this sense, technology added another layer to Vygotsky's concept. The intersection of technology and ZPD in the 21st century has led to digital personalised learning experiences which can be implemented for student learners or for teachers using technology to support and enable scaffolded growth (Jacobs & Usher, 2018; Polly & Byker, 2020). Additionally, knowledge and learning are considered under the ZPD to be socially constructed, and students and teachers are part of their social environment and society. They consistently connect, interact and get influenced by their digital culture and all the knowledge is rooted in this interaction (Gredler, 2009; O'Donnell, 2014; Verenikina, 2010; Vygotsky, 1978), which Keengwe et al. (2009) found is just too important to be overlooked.

Figure 5.3

Zone of Proximal Development with Technology



During the observations, I saw some teachers using different assessment and feedback levels with their students depending on whether they were high- or low-progress students (see Appendix 7-15). Some teachers decided to work one-on-one with students who struggled with the assignments. In contrast, the remainder of the students completed technology-assisted tasks in groups, with peers, or independently. I also observed that some teachers use real-time sharing technologies like Google Docs to offer immediate input to low-progress students. Others used the same programme to provide personalised, comprehensive comments afterwards. At the same time, some teachers employed the same setting in teaching, disregarding the needs of the low-progress students. Thus, while substantial differences in learning were observed in classes between high- and low-progress students, different learning strategies and developments were possible, as demonstrated by some teachers.

Using technology to facilitate engagement and collaboration in assessment and feedback practice would raise students' progress and bridge the gap between low- and high-progressing students. Vygotsky and Cole (1978) argued that cognitive growth occurs first on a social level and then on an individual level. Moreover, social knowledge creation helps people to relate to the environment and other people, therefore all knowledge is rooted in their interactions with society (McCormick & Paechter, 2006) and develops with the help of "more knowledgeable other" (Vygotsky,1978, p. 86). Hence, dialogue develops community, builds social capital, and facilitates knowledge generation. Freire (1972) pointed out that the social aspect of knowledge implies that discussion promotes knowledge.

It can be argued that inconsistencies in teachers' formative assessment and technical knowledge and abilities may slow students' growth, as reported by Kafyulilo et al. (2016) and Torrance (2012). The method utilised by some teachers with low skill levels may widen the gap between low and high performers in the class. It is worth noting that some teachers responded to formative feedback by engaging face-to-face individually in classroom teaching and learning activities to bridge the gaps in learning, rather than providing this feedback to all students in classroom using technology-assisted approaches. In the findings, I reported how I observed some students checking their answers using YouTube while the teacher was circulating around the classroom addressing student challenges individually. At the same time, some students in the current study were playing online games and others were engaged in a conversation with their peers, which the teacher was unable to control while being otherwise engaged.

This could be explained positively as students who do not have low skill levels get the capacity to learn independently and conduct self-assessment by gaining the ability to use technology and conduct self-assessment while the teacher is engaged with low skill levels students. Black (2007), Boud and Falchikov (2007), James (2006), and James and Pedder (2006) found that students might learn independently and undertake self-assessment by learning how to utilise technology. Alternatively, this form of teacher's strategies could be slowing the adoption of technology since there was no clear framework for the technology-aided formative assessment and feedback, as students are showing variation in their response to assessment practices. Some were playing, waiting for the teacher to proceed, and some were seeking help in the way they find it suitable for them (online or peer). McFarlane (2010) described how traditional methods of assessing students appeared to retard the uptake of technology-enabled classroom activities.

In the findings, teachers emphasised technology functions, such as sharing, monitoring, tracking, saving, and recording, that are fundamental in managing instruction, learning time, and effort. Some teacher participants used these functions to bridge the gap between high and low-progressed students but in different variations. For example, in social science classes, teachers utilised these functions in their daily instruction and formative tasks performed by students to achieve more advanced results, including instant managing and monitoring students' learning, indicating positive affordance. This finding is compatible with incorporating technology by practitioners' experiences and the notion that affordances result from users' interactions with technology rather than the technology itself (Volkoff & Strong, 2017).

Teachers' practices and knowledge significantly impact how education technology enhances student learning as well as professional development. In this study, I explored some educational tools such as IWB, Google applications, Quizlet and Kognity that are incorporated, sometimes together, while teaching to enable teachers to engage in new formative assessment and teaching methods, which provides empirical evidence for the instructional options given by this technology (see the Vignette Appendix 7.15). Teacher 1, for example, stated that these feedback technologies improve the learning process by allowing teachers to tailor their instruction to meet the requirements of individual students and by providing for new ways to learn. In technology as a tool of engagement, from both teachers' and students' perspectives, the use of technology in the classroom allows for more dynamic and interactive assessment methods that can be shared instantly, recognise the diverse skills of students, and allow students to work at their own pace.

Additionally, the interviews with the participants highlighted more individual disparities in how different teachers perceive affordances. What one teacher considers to be affordances, such as in biology and humanities subjects, may not be the same for another (English and maths) due to variances in teacher disciplines, practices, and perspectives, as seen in the one size does not fit all theme. This supports the argument that teachers' perception, intention to use and competence are necessary for the affordances to be actualised (Davis, 1989). Direct perception limits teachers' personal use and understanding of teaching, learning and assessment technological tools, therefore, their professional development (Volkoff & Strong, 2017).

To sum up, in this study, direct perception differs among teacher subject-groups, indicating the reasons for use, low use and lack of use among teacher groups. Table 5.4 below shows that motivation, subject-specific/teacher-led software and assessment and learning advantages are key factors in the use of technologies among the humanities and STEM groups, which explains the utilisation of technologies in their practices. At the same time, language teachers do not adopt similar perceptions; on the contrary, they perceive technology as a distraction and cheating tool. Consequently, teachers' adoption of technology influences students' use; in assessed FA and feedback classes, students fully engage with teachers' practices. In non-technology-assessed subjects, students use technology based on their perceptions of its usefulness and ease of use and what they perceive as a facilitator and support to their FA and feedback processes.

Table 5.4

Teachers' Perceptions and Uses

Actors (Teachers)	Perceived Usefulness	Perceived Ease of use	Uses and adoption	Direct perception
Humanities Group	✓	✓	✓	Motivation Teacher-led software Engagement Autonomy FA and feedback levels facilitator
STEM Group	✓	✓	Partly	Motivation Engagement Autonomy Feedback levels FA and feedback facilitator Subject-led software
Languages Group	✓	✓	✗	Subject-led software Distraction Plagiarism

5.8 Differences in Technological Self-efficacy Between Participants

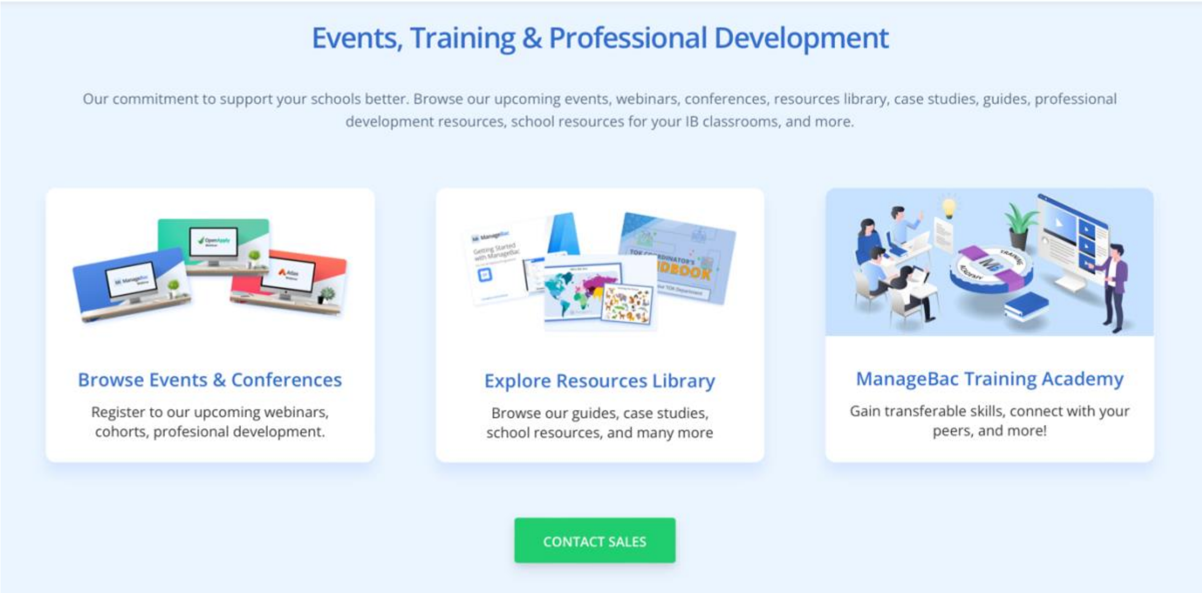
Based on the survey data from the technology acceptance model, participants' attitudes toward assessment technologies in education and learning were positive, and the participants expressed a desire to continue using assessment technologies in the classroom. I should note, though, that teachers showed lower confidence than students, with more than half of the teachers surveyed reporting poor technological self-efficacy. Furthermore, although students had a favourable opinion of assessment technologies as a learning aid, they expressed concerns about the facilitated learning condition and technological self-efficacy. Interestingly, the findings of the current study do not support the previous research. Scherer et al. (2015, 2019) reported that participants who believe they lack the required technological competencies and knowledge to use these technologies often have negative intentions and attitudes toward utilising technologies in the classroom. Moreover, Rohatgi et al. (2016) demonstrated a positive association between learner self-efficacy and educational technology utilisation which was not observed in the current study. This could be related to insufficient training on the new technological applications, as it seems that the school is up to date with new ones.

Educational institutions, such as the case school, are trying to boost their capabilities to deliver high-quality education programmes. However, this could be overwhelming, especially for teachers who must keep up with all the newly implemented programmes. Learners' self-efficacy could undermine a helpful programme if not identified and addressed in advance (Chao, 2003). In an investigation regarding the effect of educational technology on English as a foreign language (EFL) teachers and learners self-efficacy, Zhang (2022) reported that learner self-efficacy can be increased by boosting learners' dynamic mindsets, online interaction, self-assessment, knowledge, and positive affectivity. Furthermore, providing an encouraging environment can aid in developing learners' self-efficacy in technology-supported education. To follow

Zhang's recommendation for increasing self-efficacy both teachers and students will need extra time and less workload. In this respect, the training would be financially costly, and even if the institution provides training to incorporate new technologies into teaching, learning, and formative assessment processes, teachers and students would still face workload and time constraints. For example, ManageBac, an LMS system, offers online training and professional development (see Figure 5.4) with extra cost.

Figure 5.4

ManageBac Professional Development



During the interviews, some students expressed scepticism about technologies and how they are being used, stating that they use technology that they perceive to be simple. Also, when the technology functions become complicated, they look for new technology that performs the same role more straightforwardly. Teachers expressed similar views as students. For example, in one of the interviews, an English teacher said they do not use all the functionalities provided since they do not have time to learn how to use them.

One of the students also stated some difficulties in their typing skills which affected their intention to use technology. A surprising finding is that both interviewees reported a positive perception of the usefulness of these technologies. Possibly, this is because teachers and students do not spend time exploring and learning new functions in technology, as was indicated above, but jump from one tool to another, seeking ease of use. It also implies that at school, there is insufficient training conducted on newly implemented technologies for both teachers and students, especially considering that no participant mentioned any kind of formal training regarding all the technologies implemented.

Poor technological self-efficacy discussed above and in the findings chapter can be explained by the factors that the participants faced, such as that technology has become overwhelming as it develops and needs specific skills and training that can be time-consuming and inconvenient to both students and teachers (Gil-flores et al., 2017; Levy-vered et al., 2015). Furthermore, the participants could suffer from a lack of training. Bevan (2017) reported that the absence of training was a primary reason their participants did not fully utilise technology-based assessment in the participants’ view of STEM-Rich Making, an emerging form of educational practice involving digital tools that claims to produce a form of science teaching and learning. Teachers and students in Bevan’s (2017) study agreed that learning new technology takes time and effort, which are not always available, while in the current study, teachers and students prefer to use new technology rather than receive training or learn about the existing one that they found difficult to use.

Thus, the availability of digital tools is not always enough; new technologies need sufficient time and training to be adequately implemented, as also supported by the previous studies. For example, Gil-Flores et al. (2017) found that Spanish schools have adequate ICT but poor classroom ICT utilisation, given the availability of technology. In this review, 3,339 instructors from 192 secondary schools were sampled, and the results showed that training materials and practices, teamwork, and self-efficacy were needed. Teachers in Gil-Flores et al. (2017) valued training more than infrastructure and hardware. Moreover, Zimmerman et al. (2008) reported that sufficient time is required to master skills.

As discussed previously in the theoretical framework discussion (see 2.5.9), it was argued that teachers' and students' perception of technological affordances of new software or application, such as Kognity, Quizlet or even Snapchat in the student case, is governed by their perceived usefulness and ease of use. These factors determine whether they will utilise technology or specific functions in the technology. Concurrently, direct perception is the process of acquiring or gaining software-related information, therefore, this knowledge affects perception. For example, whether the teacher or student will perceive the new software as peculiar, unnecessary and complicated, or useful, and easy to use. Moreover, the software is more likely to be judged as easy to use, useful, and ultimately adopted if it is located within the teacher's or student's ZPD.

Therefore, teachers' skills and knowledge regarding technology, formative assessment, and feedback are vital for students’ development by using the suitable tool. Polly and Becker (2020) emphasised the significance of using suitable scaffolds when implementing ZPD. ZPD is based on the notion that a learner must be supported and scaffolded by a more knowledgeable individual or even other scaffolding. If the scaffolding and support reduce the rigour, the learner will not engage in creative challenge, which may prevent them from learning from profound experience. Consequently, scaffolds and the work of more competent persons cannot achieve all students' work but will aid their development. For example, Teacher 14 used a word cloud generator. It incorporated technology-based activities by raising questions and providing stimuli to assist students' ideas and discussions, and they increasingly engaged in higher-level thinking. In the technology-aided activities, the scaffolding and peer assistance under the teacher's guidance significantly enhance the experience and support the ZPD concept of scaffolding learning experiences through *social constructivism*.

5.9 Summary

The key findings of this study were that there is a positive attitude towards assessment technologies in teaching and learning, and both teachers and students intend to use technologies in the future. The findings also highlighted differences in technology-aided feedback perceptions among teachers and students. Although student participants showed a positive perception of assessment technologies in learning, they reported some perceived difficulties. Nevertheless, the findings showed differences in technological self-efficacy between participants; more than half of all surveyed teachers negatively perceived their technological self-efficacy.

The findings revealed plenty of uses of technology-aided formative assessment and feedback among participants, although there were differences in technology use between the different disciplines. The findings also showed differences in the outcome of using different technologies as formative assessment tools and varying levels of students' engagement and autonomy. Low adoption or failure to use technology in formative assessment and feedback in some subjects can be attributed to subject-specific instruction having special technological requirements in terms of formative assessment and feedback. There is also no personalised feedback or adaptive evaluation that identifies individual differences, and there is a need for a more technology integration framework.

Chapter 6. Conclusion

This study aimed to explore and investigate the role of technology in formative assessment and feedback in a UK secondary school academy from the perspectives of teachers and students. With the new formative feedback tools and the use of complementary technologies in the classroom, little progress was made in modifying traditional pedagogies. It remains unclear whether technology-based formative assessment influences the learning of teachers and students, what helps teachers provide better and more detailed formative assessments and feedback to their students, and whether assessments and feedback are beneficial to student learning. The present study critically examined the role of technology in formative assessment and feedback. It seeks to comprehend teachers' and students' perceptions, attitudes, and utilisation of the technology-aided formative assessment procedure; furthermore, to understand the impact of this adoption on teaching and learning. The study aimed to develop a theoretical and conceptual argument and make recommendations to improve the quality of instruction and student learning with formative assessment and technologies.

The study was built on existing literature on learning, formative assessment and feedback, and educational technologies fields. The role of technology in assessment practices remains somewhat understudied. The intrinsic social nature of these processes makes it impossible to be conceptually evaluated within a single theoretical domain. As argued in the theoretical framework (see section 2.5), it is not practical to theorise the technology-aided assessment simply as an affordance of the technology without considering technology acceptance, as perceptions play a critical role in the adoption of technology and could hinder it. Moreover, formative assessment practices promote knowledge construction (Black & Wiliam, 2009), which can be viewed through a *social constructivist* theory of learning. The constructive nature of the learning process may lead to different perceptions of technology-aided assessment practices. Therefore, this study attempted to develop a comprehensive theoretical framework that acknowledges these factors' significance and integrates them to enable a comprehensive analysis of the assessment process.

A mixed methods, qualitative and quantitative methodology was utilised to collect and analyse the data. A survey collected quantitative data regarding available technologies, assessment and feedback use, and technological acceptance perceptions. It intended to gain a general grasp of the case and its context and to identify potential areas for further investigation. For further investigation, semi-structured interviews and observation were used to collect the qualitative data. The data analysis disclosed differences and variations in the utilisation and perception of technology-aided formative assessment and feedback among participants and discipline groups. It also revealed variations in the technology affordances and constraints based on the data method used, along with students' level of engagement and autonomy resulting from using these technologies. A mixed methods study was employed for around 6 months to answer the research questions. The following section summarises the findings in response to the research questions:

How do teachers and students use technology-aided formative assessment and feedback? What are they using? In what context? And in what way?

Regarding technology utilisation, the first question aimed to critically assess how teachers and students are using formative assessment feedback in the teaching and learning they are doing in the school environment. The findings revealed that teachers and students used various devices, software, and websites for learning, assessment, and feedback. Devices varied from portable to non-portable and for personal and academic use. Findings also revealed differences in technology use between different disciplines. Although the school funds all the assessment and learning applications demanded by each subject group, the languages group and maths subject does not use subject-specific software or websites. Moreover, the findings were discussed considering the following key considerations. That when technology is incorporated into the classroom and used simultaneously with teachers' teaching, it solves the issue of students' learning pace in classrooms by enabling them to become active learners while enhancing classroom engagement. At the same time, it reduces students' dependence on their teachers' feedback and supports their autonomy. Moreover, students’ access to online and offline tools and software affords resources and feedback that allows students to keep up with their peers. The findings highlighted the reason for low adoption or failure to use technology in formative assessment and feedback in some subjects, which can be attributed to:

1- Subject specialist teaching has distinct needs in terms of the technology used, as one or two kinds of software are insufficient for all formative assessment and feedback activities for teachers who use technology.
2- The lack of automated personalised feedback or adaptive assessment that identifies personal differences.

3- The lack of a technology integration framework.

How does technology provide formative assessment and feedback? How does this affect the teachers' teaching and the students' learning? What are its affordances and limitations?

The second question is intended to critically assess how teachers and students are adopting technologies to facilitate feedback generation and how it affects learning. The findings demonstrated many benefits and affordances of using technology in formative assessment and feedback to increase learner autonomy, engagement, and self-regulation inside and outside the classroom. The deployment of technology delivered active learning environments which promote student-teacher interaction and a learner-centred environment. Nevertheless, the findings also revealed some constraints in the usability of these technologies. The results demonstrated that teachers and students do not use the formal technologies' formative assessment and feedback functions to the fullest, if at all, in everyday teaching, learning, and assessment practices. The data also disclosed differences between teachers' and students' use of formative assessment technologies. However, the differences in use varied by subjects and users (teachers and students). The results were discussed in relation to the technology usability and user experience as reasons for the highlighted constraints. The findings yielded mixed results among interviews, observations, and surveys evaluating technology-aided formative assessment and feedback.

How do teachers and students perceive technology-aided formative assessment and feedback for teaching and learning, and what are their attitudes about it?

This question aimed to examine teachers' and students' attitudes and perceptions towards adopting the technology-aided formative assessment in their teaching and learning process to develop a theoretical and conceptual argument about how to harness the potential for improved learning in formative assessment and technologies in the school environment. The results indicated that teachers and students had positive direct perceptions and attitudes towards utilising technology in their formative assessment and feedback activities. They perceived it as useful and easy to use, yet teachers and students appeared to have various reasons for this usefulness. Moreover, the findings revealed concerns regarding the facilitated learning condition and technological self-efficacy; teachers' self-efficacy and what they perceive as easy to use may have influenced their instructional and assessment strategies, while both participants' self-efficacy may have influenced their technological choices. The findings demonstrated differences among data collection methods between teachers' and students' perceptions of feedback, indicating the complex relationship between the technology affordances in assessment and feedback practices. This finding is novel; it was not identified in previous research, as studies reported that participants who lack technical skills and expertise generally have opposing views regarding using technology in the classroom.

6.1 Limitations of the Study

The current study had some limitations relating to time, context, and methodology. While the methodological limitations have been discussed in the methodology chapter (see section 3.8), it is crucial to highlight the most significant constraints of this investigation. Although the current study is based on the pragmatic perspective, as mixed methods allow the results to be generalised or applied to a broader population, it is worth noting that the study does not strive to test hypotheses or generalise the results, rather it seeks only to transmit them.

Since both qualitative and quantitative data were collected from a single school, the sample size for the quantitative survey was small, comprising of 11 teachers and 25 students from a single school or a total of 36 participants. Even though the survey sample represented 30% of the teacher population and 59% of the student population, it is important to note that due to the small sample size the study should not be generalised. Moreover, it is acknowledged that a larger sample size would have boosted the likelihood of generating a broader range of conclusions and perspectives regarding the study for more comprehensive results. It is also worth noting that this study did not include school administrators in the sample investigated, due to time constraints, which would have offered an additional perspective to the study. Further, my initial plan was to collect teachers' and students' data logs of the formative assessment and feedback technology in terms of times and duration of access to each technology. Having had a meeting with the IT department for this reason, however, they were unable to provide these data for unspecified reasons. Data logs would have helped analyse activity and identify trends quantitatively.

The second limitation would be the specific context, as the case school is an academy in the UK sponsored by a foreign governmental entity for the international and Islamic community. While it is still subjected to Ofsted inspections, this IB academy follows the same rules as state schools, though it does not follow the national curriculum, and the teacher population is similar to any state school in the UK.

The final and most significant limitation was timing. The study was conducted during the ongoing period of the COVID-19 pandemic from early 2020 to the mid of 2021.The exceptional and unpredictable conditions produced by the COVID-19 pandemic created difficulties in data collection that limited the ability to interview a more significant number of participants. Similarly, collecting quantitative data from a larger population was not achievable. However, during the pandemic, teachers and students tended to use technology to impart instructions and feedback as classroom learning and face-to-face teaching had been disrupted. Consequently, the participants were better positioned to respond to the survey and the interviews. As the data were collected in an environment wherein the use of technology for teaching purposes and feedback was a fundamental aspect of the education system, there was greater reliance on technology. While the pandemic posed many obstacles and limitations, it also presented some important opportunities to reveal more about the interface between technology and humans in an education context. Consequently, participants in this study were able to provide insightful information based on their experiences and increased focus on the utilisation of technology-assisted learning.

6.2 Contribution to Knowledge

The study contributes to a greater understanding of the reasons for the slow adoption and integration of technology in teaching and learning with a focus on formative assessment and feedback. Accordingly, the findings could be beneficial and transferable to other educational settings where comparable aspects influence the adoption of technology-aided formative assessment and feedback by teachers and students. I contend that the results of the current study can be applied to other schools with comparable policies, applications, and social and cultural contexts. The results revealed that the case school had *digitised* formative assessment and feedback practices to transform data, documentation, and processes from pen-and-paper to digital form. However, not all teachers in the case school could *digitalise* teaching, learning and assessment practices by leveraging digital technology to facilitate their assessment and feedback practices for more efficient outcomes. The reasons were interpreted in terms of perceptions, beliefs, utilisations, affordances, and constraints.

In the study, many discrepancies existed between what teachers claimed they were doing and what actually occurred relating to using technology in instruction, feedback, and formative assessment. Moreover, there were discrepancies between what teachers reported students were doing with technology and what students were actually doing. In their learning-with-technology practices and platform utilisation, students appeared unstructured; there was no unified or consistent strategy for their development. Moreover, teachers were sensitive when questioned or probed about these areas of discrepancy, which showed that, despite their seeming satisfaction with the school's technological transformation and successes, they may have been overly protective when analysing the effectiveness of the technology-aided formative assessment implementation. Similarly, the students appeared to lack a consistent learning strategy based on a school-wide norm, as they preferred to move around in the digital world with few limitations on their freedom of choice.

This study started with the notion that technology implementation is facilitating the shift from traditional pedagogy into an untraditional one and how traditional pedagogy is resistant to change (see section 0). Furthermore, interactive online technology can enhance the transfer of power from teacher-centred to student-centred classrooms and allow students to practise learning at their own pace by empowering them to be accountable for their learning and reducing their dependence on teachers (London et al., 2010; Shank & Cotten, 2014; Spooner, 2015). This technological growth aligns with instructional changes, thus increasing formative assessment strategies to provide students with additional feedback in a technology-enhanced pedagogy (Lo et al., 2018). The study adds a different perspective and sensemaking by exploring, reporting, and analysing this phenomenon regarding technology-aided formative assessment and feedback from teachers and students with different perspectives from different disciplines.

This study contributes to understanding the role of technology in formative assessment and feedback in a secondary school context in the UK in terms of the reasons behind the inconsistencies revealed in technology-aided formative assessment and feedback perceptions, utilisation, and practice, and whether the study can inform future research. As discussed in Chapters 1 and 2, there is a lack of understanding regarding the role of technology in formative assessment and how emerging technologies facilitate the transition to formative assessment as part of the learning process. Likewise, there is a demand for more examination into how these technologies aid teachers in assessing students learning efficiently and providing personalised feedback that would otherwise require more time and effort. Additionally, there is a need to investigate the intersected aspects of technology, teaching, learning and formative assessment in an educational setting to explore what influences teachers' and students' adoption of technology-aided formative assessment and feedback in the classroom. The points and topics needed to be examined and explored have been achieved and unravelled in this research.

The study significantly addresses the utilisation of technology-aided formative assessment and feedback, which has revealed what is utilised, the ways of utilising it, and the factors influencing the low adoption. It highlighted differences in utilisation among teachers and students along with different disciplines. The finding confirmed previous studies, such as Gikandi et al. (2011), Roskos and Neuman (2012), and Vásquez et al. (2017), in which when technology is integrated into the classroom and utilised in tandem with teachers' instruction, it speeds up students' learning and increases classroom engagement; it decreases students' reliance on teacher feedback and promotes autonomy. Online and offline, and formal and informal tools and software give students resources and feedback to keep pace with classmates. The novel concept this study is contributing to is that although technology was highly accepted among all participants, there was a pattern of low utilisation or inability to employ technology in formative assessment and feedback in several disciplines. It was interpreted in the light of teachers’ software-specific pedagogy requirement of specific needs concerning technology, such as personalised feedback or adaptive evaluation that detects individual variances, sufficient time and training assigned to the integration, and technology integration framework (e.g., TPACK, SAMR). Moreover, the overcomplexity of a technology such as the LMS used in the case school would hinder the user experience and prevent teachers and students from using its functions regularly in assessment and feedback activities to develop and implement a software-specific pedagogy.

The study also highlighted the complexities of technology's affordances and limitations concerning formative assessment and feedback. What is an affordance for teachers may be a limitation for students, and vice versa. Teachers viewed the monitoring and tracking functionality as beneficial to their assessment practices and activities, whereas these affordances were interpreted as a hindrance that prevents students from utilising most of the essential functionalities of formal technologies. On the other hand, social media facilitates communication, collaboration, and peer and group feedback among students, while teachers view it as a distraction. In addition, certain technologies are fully integrated into assessment procedures. However, they are not seen as technology-assisted formative assessments such as IWB, whilst others perceived as related to assessment practices are not entirely integrated, such as Kognity or ManageBac. The differences were explained by referring to the Gartner Hype Cycle (Gartner, 2022); the Cycle helps examine the viability of new technologies that make huge claims by showing their maturity, acceptance, and applicability (see

Figure ***5.2***

). The differences in perception could be related to the technology stage of implementation. The Cycle's technique shows how a technology or application would evolve, helping with implementation. Technology triggers the peak of inflated expectations, a trough of disillusionment, an enlightenment slope, and a productivity plateau.

6.2.1 Contribution to Theory

The study also contributes to the adoption and integration of technology and theorising the role of technology in an educational context. It provides a framework for theorising the role of technology in education by developing a theoretical framework that combines *affordance theory*, *TAM* from information systems research, and *social constructivism* as a learning theory with *pragmatic* lens. The study contributed by unfolding different aspects of complex phenomena and improving students' and teachers' understanding of the role of technology in formative assessment on individual and group levels.

It offers future researchers theoretical tools allowing them to assess factors affecting technology affordances on formative assessment and feedback and establishing the link between agency and technology affordance. The interpretation of the results highlighted that perception of usefulness and ease of use, affected teachers' and students' direct perceptions on technology choices and utilisation and, therefore, technology affordances. Self-efficacy as an external variable did not affect the PU and PEU, although it appeared to influence the direct perception. Direct perception was a key factor in why certain technology, or certain of its functions were used, not used or substituted with another technology for teachers and students. Almost all teachers and students were highly positive in their attitude and intention to use technology-aided formative assessment, and they perceived it as useful and easy to use. But not all of them had positive technological self-efficacy and direct perception towards these technologies and their role in students' development through utilising appropriate scaffolds for ZPD.

Regarding the direct perception, as shown in Table 5.1, teachers were divided into three groups based on their subject-discipline. The three groups varied in their technology adoption: highly utilised, partially utilised, and non-utilisation. The highly utilised group (humanities) perceived technology-aided formative assessment and feedback as support, motivating and subject-led; the non-utilised group (languages) perceived it as distraction and not beneficial or related to their subjects and time consuming; while the medium utilising group (STEM) had varied views based on the topic taught; some perceived it as a support and motivator although it is not suitable to all topics (not teacher-led subject-led). This unveils the relationship between direct perception that is related to technology adoption.

6.3 Implications and Recommendations

My study also has several important political and practical implications. It challenges schools, which could be outdated or modern, in terms of accepting and including new technologies on formative assessment and feedback in the curricula and training of teachers. A list of such applications and the corresponding possibilities for the teachers should be developed and regularly revised and updated. School funding should be directed to support the most successful formative assessment and feedback technologies, which have passed the ‘Gartner Hype Cycle test’.

The results of this study also question whether schools should be purchasing new technologies every year instead of working on the proper implementation of the existing software approved by teachers and students. To accrue the full benefit of technology in education, teachers and students need technology-aided formative assessment and feedback framework that include standardised both general and subject-specific technologies, clear assessment strategies and related training. This process should be supported top-down by the school authority and stakeholders, and bottom-up by the teachers and students.

In the study's case, the technology framework could aid the implementation and adoption of these technologies by developing and analysing their application in teaching, learning, FA, and feedback contexts. Additionally, rather than implementing "one-size fits all" as a single software for all subjects and departments, having one software per subject group maybe be better to regulate the students' use and learning. Generally, youth are known for going astray in the Internet's possibilities maze if they are permitted to pursue their interests instead of being guided to follow a consistent pathway. To guarantee fair and efficient use of their study and learning time at this level in their education, students require more specific, tighter direction and monitoring. I appreciate that "one size fits all" thinking may not be the solution, but if there are too many options and freedoms, it seems unlikely that a single-system approach can ever be successful.

The various stages of ZPD can act as a structure for developing the students' learning and supporting their independence. In the current study, I acknowledged that there are limits to implementing technology-aided formative assessment and feedback when teachers perceive the technology as useful. The awareness that technology-aided formative assessment requires a continuum of developments and learning opportunities to address the intersection of technologies, pedagogies, and assessment serves as the basis for this notion. Therefore, educational technology professional developers cannot operate alone. Their work is continually improved when they collaborate with and gain input from pedagogy and content specialists.

This study stresses the importance of teachers and students receiving appropriate technology-aided formative assessment and feedback training and developers focusing on subject-specialist pedagogy-based software and continually updating and supporting it. This study highlighted various requirements for technology-aided formative assessment use in the classroom. I suggest that professional development and a congruent framework can address some of these requirements. Professional development does not always result in the anticipated outcomes. The characteristics of sufficient professional development in using technology-aided formative assessment and the design, implementation, and evaluation of a framework require additional study. It is important to emphasise that technology-aided formative assessment and feedback are essential and highly required in schools.

Although the findings highlighted several technology affordances to formative assessment and feedback, they also implied the need of slowing down other emerging technologies' implementation and utilisation and focusing on the available technologies. More studies need to investigate and identify more affordances and constraints of each technology in relation to each discipline, including proposing relating hypotheses, theories, and frameworks to implementing technology-aided formative assessment and feedback. This would include collecting and analysing data to inform improvements in formative assessment strategies and teaching and learning in everyday practice. I recommend that the software developers focus more on subject-specialist pedagogy-based software. Furthermore, I stress the importance of supporting the technologies that teachers and students favour. Thus, it is critical to introduce a better feedback process between the technology developers and education providers. Moreover, a better understanding and rules regarding the use of social media in the classroom should be established within the schools. The school management should accept that one size does not fit all and that the subjects and even individual teachers have different requirements regarding the formative assessment and feedback tools used.

One of the most noteworthy observations was that the employment of technology in schools was driven by technology rather than pedagogy. It meant that teaching was adopted and adapted to correspond to the software's specifications while it should have been the other way round. One recommendation for schools is to have a clear pedagogical plan for handling feedback, either within a department or throughout the school. First, the school may need to establish some broad principles, and each department should determine its aims for providing feedback. Then, the school should look for software that would assist them in meeting their educational requirements.

The finding also showed that technology-aided formative assessment and feedback is not limited to classrooms and school day; it extended the teaching and learning process to beyond. It aided in making the learning process a continuous process that can be done everywhere and anytime. It also boosts students’ communication and engagement. Even if teachers are not involved students tend to get feedback via technology from any available source such as peers and online sources. This could have negative impact on students learning as students will be more reliant on these external technologies which would inferior the attention in the classroom and limit their classroom engagement and questioning since they have other different resources to go to. It also causes the variation in teaching and learning pace in classrooms.

Schools and teachers need to be aware of the negative impact of technologies on their teaching and learning. They need to focus more on more collaborative tasks strategies that utilise a variety of assessments assigned to their students within a digital portal. The collaborative functions within the formal portal could be more useful in engaging all students in a collaborative learning that would develop wide range of skills among diverse achievers. School policies need to be more focused on several strategies that fits the used technologies and offer a framework with sufficient coaching that guide their facilitation to achieve the targeted assessment and learning goals that satisfies students' needs.

The finding revealed that subject-group teachers are the ones who decide on the used technologies based on their needs, which is a challenging task. Teachers are accountable for making the difficult choice of which technologies will help them realise their objectives for improving learning. Although teachers' and students' technology usage for learning should be considered when making tool-related choices, there should only be some responsibilities. There are different factors to consider in guaranteeing transformational and ongoing impacts on the students' learning. The choice should involve collaboration with different parties, such as school administration, instructional designers and technology coaches, teachers, and students. Those parties should consider the grade-level curriculum, content requirements, classroom and outside-classroom use, their compatibility with the curriculum and material, assessment needs, management choices, security features, tool performance, and cost. Instructional designers and technology coaches can assist in enhancing the experience of each student and teacher through a comprehensive strategy that emphasises the use of technology in formative assessment and feedback to allow for individualised learning and connected and efficient classrooms. Teachers must be continuously trained and supported by resources for professional development.

6.4 Future Research

This study was grounded in perspectives of affordance theory and constructivism which focused on how technology-aided formative assessment affected teaching, learning, and the attitudes of teachers and students toward the use of technology. Though the present study provided a fair account of these aspects, there is considerable room for further exploration. In this context, future researchers should consider examining the effect of standardisation of specific technologies, subject-related frameworks, standardising school technology framework training, and support such as instructional designers on the performance of the teachers and students and the effectiveness of the formative assessment. Researchers should also study the reasons for the lack of technology self-efficacy among the teachers and students in regard to formative assessment and feedback practices. That may confirm or disagree with the reasons identified in this study, for example, that technology was not subject-specific or teacher-led, software was overwhelming, and there was lack of time to implement the technology. These are all factors that should be investigated further to reveal answers and enable the most appropriate methods of integrating technology in future formative assessment and feedback practices.

6.5 Personal Reflection on the Research

Before graduate school, I was an educator at the Saudi Arabian Ministry of Education for almost 14 years. I have worked as a teacher in three different regions among Saudi: western, southern and central with diverse cultural backgrounds and some of rural areas. I have also worked as deputy head in one of the few secondary schools that applied a newly reformed system CS. CS is a specialised path-based framework; natural sciences and social sciences, assessed mainly on projects, essays, portfolio and exams through the course. My primary duty as deputy head was supporting, supervising, and monitoring students' progress and outcomes. I was also responsible for the professional development of the faculty and the implementation of new technologies. Moreover, I worked for four years as school governor in the UK. Throughout my years, I have experienced the challenges and difficulties that most students, teachers, and school administrations face. They spend much time and effort on teaching, learning, and assessment practices. The assessment process, educational technology choices, and implementations were among the big challenges that schools faced. I have lived their ambitions, struggles and disappointments. Thus, with my background, I began the PhD research project journey with a wealth of experience and insight, inexhaustible desire, and natural curiosity. I wanted to develop my abilities to conduct solid research and investigate answers to complicated challenges while furthering my academic career as a researcher. My central aim was to become well-equipped to conduct and complete exhaustive studies on relevant teaching and learning issues that I am passionate about; however, I gained much more than that during this journey.

My professional experience has equipped me with important competencies, such as problem-solving, flexibility, systematic planning and execution, time management, and interpersonal and communication skills. These attributes have helped me improve my contributions to the quality of learning and teaching in Saudi Arabia. I also gained experience in spotting the gaps in the educational system, and by joining the PhD programme, I have sought to find ways to fill these gaps as much as possible. With my PhD experience, I have recognised that each development stage has its methods, procedures, and challenges in a structured methodology, which also applies to me as a researcher.

My past experiences as an educator and knowledge of broader issues in education influenced my desire to explore technology-aided formative assessment and feedback topics in this new age of digital teaching and learning. As a researcher I was acutely aware that, when interviewing both teachers and students for this study, I needed to stay neutral and objective, put aside my own opinions and feelings, and listen from a researcher's unbiased perspective. However, due to my background and personal views, it was difficult for me to be completely objective and to avoid any bias. Yet, I believe each researcher of human behaviour must struggle with this tendency and overcome it in their own way, as I did in mine.

I started my PhD confidently, but the four years of intensive research experience have humbled me. I gained the most significant skill or ability: humility, specifically, intellectual humility (IH). McElroy et al. (2014) defined IH as how much a person knows or how much influence they have intellectually. It implies being aware of the limits of one's knowledge, which is shown by being open to new ideas. In my case, IH assisted me to control intellectual arrogance and preconceived notions in presenting my ideas in a way that was not offensive, while enabling me to accept different ideas without losing perspective, even when faced with opposing points of view. In one of the last meetings, I remember telling my supervisors how the PhD journey made me aware of how little I knew.

During my study, I frequently rethought and reflected upon my views. For example, I was often consciously aware of my subordinate status as a PhD candidate after the many years of enjoying higher status as a senior educator and administrator. These feelings sometimes led to self-doubt and apprehension about my capability to succeed alone in this daunting task. However, in retrospect, these feelings were all self-inflicted, as everyone around me was incredibly supportive of my work. The support of my university, my supervisors, the case school, and the participants gave me confidence to overcome doubt and misgiving. However, on reflection, this sense of uneasiness encouraged me to also be self-critical and to raise questions that an established scholar may have been less eager to ask or answer. This was not a sign of any ignorance about interview methods and dynamics; rather, my incisive approach to gathering data was influenced by my position as a mother and teaching professional who listens carefully and values the views of young people and the opinions of my colleagues. Asking the penetrating questions was key to gaining the rich, in-depth data I wanted. Moreover, because I was an engaged, empathetic, and compassionate listener, I was able to establish the rapport and mutual trust with the participants necessary for openness and honesty during interviews. I felt responsible and that I needed to reassure them of confidentiality and how much I felt about their struggles and successes.

I was extremely grateful and privileged to have the opportunity to hear their voices, listen to their ambitions and worries, and gain insight into their challenges and how they dealt with them, which they needed to communicate. Listening to them empowered them, boosted their self-esteem, and enhanced their comprehension of technology-assisted formative assessment and feedback. My experiences in this research have convinced me that there are not enough opportunities for teachers to reflect on their teaching and students to talk about their learning in our schools. While students and teachers were talking to me about their lived experiences, I often found their stories relevant to my own beliefs and experience of the educational process. Although I used to believe that the challenges of incorporating formative assessment and technologies in daily practices would be solved with basic training in digital literacy or formative assessment strategies. An awakening discovery that there is no one-sided or easy straightforward answer, especially with education.

The benefit was mutual; the participants were very welcoming, honest, and open in communicating the reality of their lived experiences. I felt my interpersonal and communication skills were boosted. I sensed I was becoming more effective in relating to participants' experiences and interacting with them. I could tell by the responses that my communication improved as my self-awareness increased; I could communicate more effectively and establish trust. Both teachers and students were hesitant initially to be open, but through conversation, they opened up freely and expressed their worries and experiences; they even offered to help and sit again with me if needed.

The participants could offer a unique perspective because they had personally experienced the rewards and difficulties. At the same time, their perspectives made me re-assess my own previous perceptions and beliefs as an education professional in the public sector and emphasised for me the importance of listening to the teachers' and students' voices. I used to believe that including staff, teachers, and students in decision-making is enough to support any implementation; they would feel involved when their perspective is solicited. However, some may feel excluded since the school administration did not choose their ideas or solutions. Every teacher and student have specific teaching and learning needs; if the school's solutions do not meet their needs, they will seek an alternative digital solution or even a non-digital one. I learned that anyone involved in a transformation should clearly understand the concept and its purposes, such as why using specific technology for formative assessment and feedback and what the expected outcomes should be. Moreover, any implementation should be facilitated by coaching that helps individuals acquire the skills necessary to adapt to change. That would foster team unity and goal orientation since everyone would work together, and there would be constant communication between teachers, students, and school management.

Chapter 7. Appendecies

7.1 Appendix 7-1: Introductory Section

The Role of Technology in Formative Assessment (Students' Survey)

Dear Student,

My name is Ahoud and I am a PhD student. I would like to invite you to take part in my study as your participation is vital to this project. Please take the time to read the following information carefully.

The study aims to explore the role of technology in formative Assessment from Students' and Teachers' Perspectives. Formative assessment is defined as: "The process used by teachers and students to recognise and respond to student learning in order to enhance that learning, during the learning."Bronwen Cowie & BeverleyBell, (1996,1999).

The project attempts to seek information about teachers' and student's perception of the role of technology in formative assessment and feedback practices in teaching and learning.

All responses collected online are completely anonymous. And any personal data shared will be stored securely on a password-protected device. To assure anonymity all participants will be referred to by numbers. As a researcher, I may refer to the results of this survey when writing an article, constructing a project, or presenting at a conference on this topic. As a respondent, you have the option of withdrawing your participation at any point in the questionnaire.

By submitting the answers, you understand the voluntary nature of answering this survey, confirming your participation in this study, and agreeing to the use of your responses as the collected data. I will be glad to answer questions via email: aa807@exeter.ac.uk (mailto:aa807@exeter.ac.uk).

* Required

7.2 Appendix 7-2: Teachers' Survey

* Required

Background Information

Please answer the questions and choose the box that is most relevant to you. The name and email address is necessary for the follow-up interviews, if you don't prefer to provide the email you can use N/A.

1. What is your name? *

2. At what email address would you like to be contacted?

3. What grade are you teaching? *

You can choose more than one answer. If you choose "other", please tell us about it.

- ☐ IB1
- ☐ IB2
- ☐ Year 10
- ☐ Other

4. What subjects are you teaching for this year? *

You can choose more than one answer. If you choose "other", please write them down.

- [ ] English Language
- [ ] Arabic
- [ ] French
- [ ] Maths
- [ ] Visual Arts
- [ ] Information Technology
- [ ] Business Management
- [ ] Biology
- [ ] Computer Science
- [ ] Chemistry
- [ ] Physics
- [ ] Psychology
- [ ] History
- [ ] Geography
- [ ] Other

Access to and Use of Technology

5. What type of device do you use at school? *

You can choose more than one. If you choose "other", please tell us what you use

- [ ] Smartphones
- [ ] Tablets/iPad
- [ ] Desktop
- [ ] Laptop
- [ ] Chromebook
- [ ] ____________

Other

6. What kind of technology do you use for schoolwork? *

You can choose more than one. If you choose other, please tell us what do you use.

- [ ] Google Forms
- [ ] Kahoot
- [ ] Social media
- [ ] Microsoft Forms
- [ ] Interactive Board
- [ ] Social media Apps
- [ ] ManageBac
- [ ] Microsoft Teams
- [ ] Plickers
- [ ] PupilAsset
- [ ] Google Classroom
- [ ]

Other

7. What type of device do you use at home for teaching purposes? *

You can use more than one. If you choose other, please tell us what you use

- [ ] Tablet/ iPad
- [ ] Desktop
- [ ] SmartPhones
- [ ] Chromebook
- [ ]

Other

8. How often do you use the following electronic devices? *

	Always	Very frequently	Occasionally	Rarely	Never
Interactive whiteboard	○	○	○	○	○
Desktop computer	○	○	○	○	○
Laptop computer	○	○	○	○	○
Tablet computer (e.g. iPad, Samsung Galaxy)	○	○	○	○	○
Chromebook	○	○	○	○	○
Digital camera	○	○	○	○	○
E-book reader (e.g., Kindle, Nook)	○	○	○	○	○

9. How do you access the internet? *

You can choose more than one answer. If you choose "other", please tell us what do you use.

- [ ] From school
- [ ] From Home
- [ ] Both school and home
- [ ] On my portable device
- [ ] Public internet
- [ ] All of the above
- [ ]

Other

10. How often do you use educational technologies in following facilities? *

	Always	Very Frequently	Occasionall y	Rarely	Never
Classroom	◯	◯	◯	◯	◯
School library	◯	◯	◯	◯	◯
Labs	◯	◯	◯	◯	◯
School hall	◯	◯	◯	◯	◯
Dining hall	◯	◯	◯	◯	◯
Computer suite	◯	◯	◯	◯	◯
Playground	◯	◯	◯	◯	◯
Home	◯	◯	◯	◯	◯
Cafe	◯	◯	◯	◯	◯
Public library	◯	◯	◯	◯	◯
Bus/Car/Train	◯	◯	◯	◯	◯

Assessment and Feedback Practices

This section explores the feedback practices in education (Formal and informal/ written and verbal/ in school and out of the school)

11. What kind of technology do you use for providing feedback? *

Feedback regarding tests, quizzes, assignment, project, etc. You can choose more than one. If you choose other, please tell us what do you use.

- ☐ Google Forms
- ☐ Kahoot
- ☐ Microsoft Teams
- ☐ Microsoft Forms
- ☐ Plickers
- ☐ Interactive Board
- ☐ Social media Apps
- ☐ ManageBac
- ☐ Kognity
- ☐ Other

12. How often do you think your students receive feedback regarding their schoolwork from the following? *

- Assessment refers to the wide variety of methods or tools that educators use to evaluate, measure, and document the academic readiness, learning progress, skill acquisition, or educational needs of students. - Student self-assessment is evaluating your own work and learning progress. Through self-assessment, students can: identify their own skill gaps, where their knowledge is weak. - Peer assessment is when student/s judge the performance of their peer/s and it can take different forms.

	Always	Very Often	Sometimes	Rarely	Never
Teachers Assessment	◯	◯	◯	◯	◯
Parents Assessment	◯	◯	◯	◯	◯
Peer-Assessment	◯	◯	◯	◯	◯
Self - Assessment	◯	◯	◯	◯	◯

13. How often do you provide the following feedback to your student with technology? *

This section explores the feedback levels in eduction (Formal and informal/ written and verbal/ at school and out of the school)

	Always	Very Often	Sometimes	Rarely	Never
Grades/marks	◯	◯	◯	◯	◯
Pointing the errors	◯	◯	◯	◯	◯
Correcting error	◯	◯	◯	◯	◯

Comments to provide connections between ideas.	◯	◯	◯	◯	◯
Comments for identifying errors	◯	◯	◯	◯	◯
Comments for learning how to explicitly learn from mistakes.	◯	◯	◯	◯	◯
Comments helping students to identify feedback themselves and how to self-evaluate.	◯	◯	◯	◯	◯
Providing opportunities and awareness of the importance of deliberate practice and effort.	◯	◯	◯	◯	◯
Developing confidence to pursue the learning	◯	◯	◯	◯	◯
Praise feedback (e.g, great, excellent, good job, well done).	◯	◯	◯	◯	◯

This section is about technology acceptance.

This section explores the technology acceptance in eduction (Formally and informally/ written and verbal/ at school and out of the school).

14. Overall, I am keen on using technology in my teaching. *

Choose the most relevant number to you.

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

15. Please tick the most relevant box to you. *

	Strongly Agree	Agree	Disagree	Strongly disagree	Neutral
Using technology will improve my teaching.	○	○	○	○	○
Using technology will help my teaching to be more effective.	○	○	○	○	○
I have a wider task option when I use technology.	○	○	○	○	○
I find technology to be useful in my work.	○	○	○	○	○

I find it easy to get technology to do what I want it to do.	◯	◯	◯	◯	◯
Using technology does not require a lot of mental effort.	◯	◯	◯	◯	◯
I find technology easy to use.	◯	◯	◯	◯	◯
The technology makes teaching more interesting.	◯	◯	◯	◯	◯
Teaching with technology is fun.	◯	◯	◯	◯	◯
I look forward to those aspects of my work that require me to use technologies.	◯	◯	◯	◯	◯
I can complete a task using technology if I could call someone for help when I get stuck.	◯	◯	◯	◯	◯

I can complete a task using technology if I only had a book to guide me.	◯	◯	◯	◯	◯
I can complete a task using technology If someone demonstrates how to use it first.	◯	◯	◯	◯	◯
I will use the technology in future.	◯	◯	◯	◯	◯
I plan to use the technology often.	◯	◯	◯	◯	◯
Whenever possible, I intend to use computers for teaching.	◯	◯	◯	◯	◯
Learning to use the computer takes up too much of my time.	◯	◯	◯	◯	◯
Using the computer involves too much time.	◯	◯	◯	◯	◯
It takes too long to learn how to use	◯	◯	◯	◯	◯

7.3 Appendix 7-3: Students' Survey

Background Information

Please answer the questions and choose the box that is most relevant to you. The name and email address is necessary for the follow-up interviews, if you don't prefer to participate you can use N/A.

1. What is your name? *

   Please write your assigned number/code.

2. What grade are you in? *

   Please elaborate when choosing "Other".

   - IB1
   - IB2
   - Year 10
   - Other

3. What subjects are you taking for this year? *

You can choose more than one. Please elaborate when choosing "Other".

- [ ] English Language
- [ ] Arabic
- [ ] French
- [ ] Maths
- [ ] Visual Arts
- [ ] Information Technology
- [ ] Business Management
- [ ] Biology
- [ ] Computer Science
- [ ] Chemistry
- [ ] Physics
- [ ] Psychology
- [ ] History
- [ ] Geography
- [ ] Other

Access to and Use of Technology

4. Do you have access to the internet? *

Please elaborate when choosing "Other".

- ○ Yes
- ○ No
- ○ Other

5. How do you access the internet? *

You can use more than one answer. If you choose "other", please tell us what do you use.

- ☐ From school
- ☐ From home
- ☐ Both school and home
- ☐ On my portable device
- ☐ Public internet
- ☐ All of the above
- ☐ Other

6. What type of device do you use at school? *

You can use more than one answer. If you choose other, please tell us what do you use.

- [ ] Smartphones
- [ ] Tablets/iPad
- [ ] Desktop
- [ ] Laptop
- [ ] Chromebook
- [ ] Other

7. What type of device do you use for educational purposes out of the school? *

You can use more than one. If you choose other, please tell us what do you use.

- [ ] Smartphones
- [ ] Tablets/iPad
- [ ] Desktop
- [ ] Laptop
- [ ] Chromebook
- [ ] Other

8. What kind of technology do you use for schoolwork? *

You can use more than one. If you choose other, please tell us what do you use.

- [ ] Google Forms
- [ ] Kahoot
- [ ] Social media Apps
- [ ] Microsoft Forms
- [ ] Interactive Board
- [ ] ManageBac
- [ ] Microsoft Teams
- [ ] Plickers
- [ ] PupilAsset
- [ ] Emails
- [ ] WhatsApp
- [ ] Other

9. How often do you use the following electronic devices for educational purposes? *

	Always	Very frequently	Occasionally	Rarely	Never
Interactive whiteboard	◯	◯	◯	◯	◯
Desktop computer	◯	◯	◯	◯	◯
Laptop computer	◯	◯	◯	◯	◯
Tablet computer (e.g. iPad, Samsung Galaxy)	◯	◯	◯	◯	◯
Chromebook	◯	◯	◯	◯	◯
Digital camera	◯	◯	◯	◯	◯
E-book reader (e.g., Kindle, Nook)	◯	◯	◯	◯	◯

10. How often do you use education related technology devices in the following facilities? *

	Always	Very Frequently	Occasionally	Rarely	Never
Classroom	◯	◯	◯	◯	◯
School library	◯	◯	◯	◯	◯
Labs	◯	◯	◯	◯	◯
School hall	◯	◯	◯	◯	◯
Dining hall	◯	◯	◯	◯	◯
Computer suite	◯	◯	◯	◯	◯
Playground	◯	◯	◯	◯	◯
Home	◯	◯	◯	◯	◯
Cafe	◯	◯	◯	◯	◯
Public library	◯	◯	◯	◯	◯
Bus/car/train	◯	◯	◯	◯	◯

Assessment and Feedback Practices

This section explores the feedback practices in education (Formal and informal/ written and verbal/ in school and out of the school)

11. What kind of technology do you use for receiving feedback? *

Feedback regarding tests, quizzes, assignment, project,etc. You can choose more than one. If you choose other, please tell us what do you use.

- [ ] Google Forms
- [ ] Kahoot
- [ ] Microsoft Teams
- [ ] Microsoft Forms
- [ ] Plickers
- [ ] Interactive Board
- [ ] Social media Apps
- [ ] ManageBac
- [ ] Google Doc
- [ ] Kognity
- [ ]

Other

12. How often do you receive feedback regarding your schoolwork from the following? *

- Assessment refers to the wide variety of methods or tools that educators use to evaluate, measure, and document the academic readiness, learning progress, skill acquisition, or educational needs of students. - Student self-assessment is evaluating your own work and learning progress. Through self-assessment, students can: identify their own skill gaps, where their knowledge is weak. - Peer assessment is when student/s judge the performance of their peer/s and it can take different forms.

	Always	Very Often	Sometimes	Rarely	Never
Teachers Assessment	◯	◯	◯	◯	◯
Parents Assessment	◯	◯	◯	◯	◯
Peer-Assessment	◯	◯	◯	◯	◯
Self -	◯	◯	◯	◯	◯

13. How often do you receive the following feedback from your teacher through technology? *

This section explores the feedback levels in education (Formal and informal/ written and verbal/ at school and out of the school)

	Always	Very often	Sometimes	Rarely	Never
Grades/marks	◯	◯	◯	◯	◯
Pointing the errors	◯	◯	◯	◯	◯
Correcting error	◯	◯	◯	◯	◯
Comments to					

Comments to provide connections between ideas.	◯	◯	◯	◯	◯
Comments for identifying errors	◯	◯	◯	◯	◯
Comments for learning how to explicitly learn from mistakes.	◯	◯	◯	◯	◯
Comments helping students to identify feedback themselves and how to self-evaluate.	◯	◯	◯	◯	◯
Providing opportunities and awareness of the importance of deliberate practice and effort.	◯	◯	◯	◯	◯
Developing confidence to pursue the learning	◯	◯	◯	◯	◯
Praise feedback (e.g, great, excellent, good job, well done).	◯	◯	◯	◯	◯

This section is about technology acceptance.

This section explores the technology acceptance in eduction (Formally and informally/ written and verbal/ at school and out of the school).

14. Overall, I am keen on using technology in my teaching. *

Choose the most relevant number to you.

0	1	2	3	4	5	6	7	8	9	10

Not at all likely Extremely likely

15. Please tick the most relevant box to you. *

	Strongly Agree	Agree	Disagree	Strongly disagree	Neutral
Using technology will improve my teaching.	◯	◯	◯	◯	◯
Using technology will help my teaching to be more effective.	◯	◯	◯	◯	◯
I have a wider task option when I use technology.	◯	◯	◯	◯	◯
I find technology to be useful in my work.	◯	◯	◯	◯	◯

my work.

I find it easy to get technology to do what I want it to do.	○	○	○	○	○
Using technology does not require a lot of mental effort.	○	○	○	○	○
I find technology easy to use.	○	○	○	○	○
The technology makes teaching more interesting.	○	○	○	○	○
Teaching with technology is fun.	○	○	○	○	○
I look forward to those aspects of my work that require me to use technologies.	○	○	○	○	○
I can complete a task using technology if I could call someone for help when I get stuck.	○	○	○	○	○

-

I can complete a task using technology if I only had a book to guide me.

I can complete a task using technology If someone demonstrates how to use it first.

I will use the technology in future.

I plan to use the technology often.

Whenever possible, I intend to use computers for teaching.

Learning to use the computer takes up too much of my time.

Using the computer involves too much time.

It takes too long to learn how to use

7.4 Appendix 7-4: Pilot Interviews Example

Teachers' Interviews:

Q1: How do teachers and students perceive the benefits of technology-based formative assessment for teaching and learning?

Examples of questions:

- Describe the assessment process in your classroom and in your subject area.
- Do you use technology with students? In what way?
- How do you use technology in the classroom, how do you use technologies for helping you to administer student grades, etc?
- ~~Do you provide your students with feedback?~~
- ~~How do you feel about the feedback process?~~
- Do you provide feedback largely on the outcome of your evaluation or grading, or do you also give students input about their learning processes?
- Can you give me an example of learning process feedback that you give?
- Can you give me an example of outcome focused feedback that you give?
- Do you use technology to provide feedback? How so? What is the technological feedback like versus conventional feedback you gave in the past (or were given yourself as a student)?
- ~~What kind of feedback do you most like as a teacher?~~
- ~~Do you use the feedback in your teaching? Do you incorporate the feedback in your teaching practices? How so?~~

Microsoft Office User
Usually Teachers cover most of the questions mentioned below in this part

Reply

RQ2 How does technology-based formative assessment influence teachers' learning regarding their instruction and how does technology afford that, from their perception? How do teachers respond to or adapt this technology for use?

Examples of Questions:

- How do you think that feedback influences your teaching?
- Describe how you adjust your lesson plans for each group of students and the pace of different students.
- Describe what feedback is like for a student who is exceling or who is exceptional.
- Describe what feedback is like for students who are struggling.
- ~~How do you work formative assessment into your daily lessons?~~

Microsoft Office User
Some questions are common sense and usually teachers cover them with the above questions

- How do you work formative assessment into your overall assessment of each student?
- What further improvements do you think technology could make in the classroom or in your teaching practice?
- Are there aspects of technology that are not being used? (Not being taken full advantage of?) Or is there something negative about using technology that you see worsening or becoming more of an issue in the future?
- Is there something about formative assessment you find unhelpful or not useful?
- ~~What are some things in the classroom that should or could happen, but that are not happening?~~
- How else could technologies be used to improve your teaching?
- How else could technologies be used to improve the learning processes for students?

Students’ Interviews:

Q1: How do teachers and students perceive the benefits of technology-based formative assessment for teaching and learning?

Examples of questions:

- ~~Do you use technology with your schoolwork? In what way?~~
- How do you use technology at school, how do you use It at home to do tasks related to school?
- When you face a difficulty in a given task what do you do in order to overcome It? Do you ask the teacher, parent, friend, google …?
- Do you ask your peers for feedback? How do you do that?
- In a group project how do you communicate with your peers? Do you use technology? In what way? How do you find it or feel about it?
- ~~Does your teacher provide you with feedback?~~
- How do you feel about the feedback your teachers give?
- ~~Do you ask for your friends’ feedback? In what way? How do you perceive it?~~
- Describe the kinds of feedback that you get from your teachers.
- Do they also give you input on your learning process? Give an example.
- Do you feel like your teacher is accessible for you?
- ~~Can you give me an example of learning process feedback?~~

MO Microsoft Office User
Repetition
Reply

MO Microsoft Office User
unclear
Reply

MO Microsoft Office User
Repetition
Reply

MO Microsoft Office User
Mentioned in the survey
Reply

MO Microsoft Office User
Repetition
Reply

MO Microsoft Office User
Repetition

- ~~Can you give me an example of outcome focused feedback?~~
- Does your teacher use technology to provide feedback? How so? What Is the technological feedback like?
- What kind of feedback do you most like? Do you incorporate it in your learning practices or study practices? How so?
- ~~Do you use the feedback?~~

Microsoft Office User
Irrelevant
Reply

Microsoft Office User
Repetition
Reply

Q2) How does technology-based formative assessment influence students' learning in different disciplines (Maths, Sciences, English), from both teachers and students' perception? What are students' perceptions on the affordances of the technology for their learning? How do students respond to or adapt this technology for use?

Examples of Questions:

- ~~In what subjects do teachers provide you with feedback?~~
- ~~What subjects provide the most feedback?~~
- Are you provided feedback by your teachers in all subjects? If not specify the subjects you do get feedback, and which provide the most
- ~~Do you like the feedback you get from your teachers? Why or why not?~~
- Is the feedback helpful? How so? If it is not helpful, please explain why?
- How is feedback different for different subjects you are learning?
- Do you get feedback on your learning process or just the outcomes?
- Does the teacher use technology to provide you feedback?
- Is technology more helpful in some subjects than others? Explain.
- ~~What kind of technology do you use in your learning (formal and informal)?~~
- ~~In what ways do you use the feedback in your own learning processes?~~
- Do you use technologies to do your classwork or homework?
- ~~Do you use technologies to do your homework?~~
- ~~What other ways can technologies be used in the classroom?~~
- What other ways can technologies be used to help you with your homework?
- ~~How else could technologies be used to improve your learning?~~
- What is your perception on the affordances of the technology for your learning? What is the role of technology in learning?
- How do you respond to or adapt this technology for use?
- What are the affordances of technology in learning that you should or could benefit from but is not happening in regards to your learning on a specific subject and overall

Microsoft Office User
unclear
Reply

Microsoft Office User
this is unnecessary because its the same as the previous two questions
Reply

7.5 Appendix 7-5: Example for Interview Questions

Teachers' Interviews:

Q1: How do teachers and students perceive the benefits of technology-based formative assessment for teaching and learning?

Examples of questions:

- How do you use technology in the classroom, how do you use technologies for helping you to administer student grades, etc?
- Do you provide feedback largely on the outcome of your evaluation or grading, or do you also give students input about their learning processes?
- Can you give me an example of learning process feedback that you give?
- Can you give me an example of outcome focused feedback that you give?
- Do you use technology to provide feedback? How so? What is the technological feedback like versus conventional feedback you gave in the past (or were given yourself as a student)?
- How do you perceive the support of technology-based formative assessment for your teaching? Please give examples and elaborate.

Q2 How does technology-based formative assessment influence teachers' learning regarding their instruction and how does technology afford that, from their perception? How do teachers respond to or adapt this technology for use?

Examples of Questions:

- How do you think that feedback influences your teaching?
- Describe how you adjust your lesson plans for each group of students and the pace of different students.

- Describe what feedback is like for a student who is excelling or who is exceptional.
- Describe what feedback is like for students who are struggling.
- What further improvements do you think technology could make in the classroom or in your teaching practice?
- Are there aspects of technology that are not being used? (Not being taken full advantage of?) Or is there something negative about using technology that you see worsening or becoming more of an issue in the future?
- Is there something about formative assessment you find unhelpful or not useful?
- How does the technology-based formative assessment differ from each topic to another? Please give examples and elaborate.
- What are the challenges of the USED technology from your perception? Please elaborate and give examples.
- What is your perception of the affordances of the technology for your teaching and learning? And how do you respond to or adapt this technology for use?

Students' Interviews:

Q1: How do teachers and students perceive technology-based formative assessment for teaching and learning?

Examples of questions:

- How do you use technology at school, how do you use it at home to do tasks related to school?
- When you face a difficulty in a given task what do you do in order to overcome it? Do you ask the teacher, parent, friend, Google …?
- Do you ask your peers for feedback? How do you do that?

- In a group project how do you communicate with your peers? Do you use technology? In what way? How do you find it or feel about it?
- How do you feel about the feedback your teachers give?
- Describe the kinds of feedback that you get from your teachers.
- Do they also give you input on your learning process?
- Do you feel like your teacher is accessible for you?
- Does your teacher use technology to provide feedback? How so? What is the technological feedback like?
- What kind of feedback do you most like?
- Do you use the feedback? Do you incorporate it in your learning practices or study practices? How so?
- How do you perceive the support of technology-based formative assessment for your learning in different subjects? Please give examples and elaborate.

-

Q2) How does technology-based formative assessment influence students' learning in different disciplines, from students' perception? What are students' perceptions on the affordances of the technology for their learning? How do students respond to or adapt this technology for use?

Examples of Questions:

- Do you get feedback on your learning process or just the outcomes?
- How is feedback different for different subjects you are learning?
- Is technology more helpful in some subjects than others? Explain.
- Is the feedback helpful? How so? If it is not helpful, please explain why.
- In what ways do you use the feedback in your own learning processes?
- Does the teacher use technology to provide you feedback?

- Do you use technologies to do your classwork?
- Do you use technologies to do your homework?
- What other ways can technologies be used in the classroom?
- What other ways can technologies be used to help you with your homework?
- What are some things in the classroom that should or could happen, but that are not happening in regard to your learning on a specific subject like (give examples).
- What are some things in the classroom that should or could happen, but that are not happening in regard to your overall learning?
- How else could technologies be used to improve your learning?
- How does the technology-based formative assessment differ from each subject to another? Please give examples and elaborate.
- What are the challenges of the USED technology from your perception? Please elaborate and give examples.
- What is your perception of the affordances of the technology for your learning? And how do you respond to or adapt this technology for use?

7.6 Appendix 7-6: Information Sheet

Project Title: Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK
Start and end dates: 15/02/2020
Information sheet for

My name is Ahoud Alshaikh, and I am inviting you to take in part in my research project, "Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK". My dissertation looks at how teachers provide feedback on the learning processes of students, especially in terms of how they use technologies to provide that feedback (a process we call a formative assessment). I am interested in the opinions and perceptions of both teachers and students on the use of technologies to provide feedback on student work.

Who is carrying out the research?
I am a PhD candidate at Exeter University, and this research is necessary to complete my dissertation thesis. My supervisors are Dr Judith Kliene-Staarman-J.Kleine-Staarman@exeter.ac.uk and Dr Taro Fujita-T.Fujita@exeter.ac.uk. Any organisation does not fund this research. I am also a school governor at Isleworth Town Primary but do not work for the Isleworth council nor funded by them.

I very much hope that you would like to take part in this research. This information sheet will try to answer any question you might have about the project, but please do not hesitate to contact me if there is anything else you would like to know.

Why are we doing this research?
The main research question for this project looks at how technology-based formative assessment influence teachers' teaching and students' learning in an International Baccalaureate school's context. This research is important because it will help us to understand how students and teachers are using assessment technologies to improve student learning. It may help to develop recommendations for improving the use of technology so teachers can provide better or more useful feedback for students.

Why am I being invited to take part?
Both students and teachers are being asked to take part to understand how teachers are using the technologies and how they are helping to improve student learning. The participants should be teachers who use the technology in providing feedback to their students through technological tools or software, and all of their students.

What will happen if I choose to take part?

This research will take place over several months, and the researcher will conduct interviews and make observations about the use of technology and feedback at school and while doing homework. Teachers and students might also be asked to participate in focus groups. If you are a teacher, you will be asked questions about how you are using technologies to teach different subjects and how you are giving feedback to students. Students will be asked about their perceptions of the technologies and the feedback they receive from their teachers, whether they perceive it to be good or bad. Interview sessions should last about 30 minutes. Focus groups will be one-hour interactive sessions with other students or teachers. You are not required to participate in any activities if you do not wish to participate. The researcher will also be taking notes and making observations in other areas of the school, like the cafeteria or outside areas where students do homework or use technologies.

Will, anyone, know I am participating?

The data from the research will be made anonymous for all publishing and sharing purposes. It will not be possible to identify the particular class or the particular school from the published or public results. The only people who might be able to identify particular classrooms or the school are other students and teachers from the same institution who are not participating as they will be aware of the study taking place and they will know which classrooms and teachers are participating.

Could there be problems for me if I take part?

The nature of the research questions will be limited to the use of feedback and technologies in the classroom and in completing schoolwork. There is a minimal risk that the questions could cause trauma or harm students or teachers in any way. If at any time you feel uncomfortable, you are entitled to stop your participation at any point.

What will happen to the results of the research?

The results of this research will be used to present a dissertation thesis to the graduate school at the University of Exeter so that the researcher can earn their PhD. There will also likely be articles published in academic journals and conference papers derived from the research results. The final published work will safeguard the anonymity of the participants by using pseudonyms where appropriate. The raw data will be stored for ten years on a cloud server service that is password protected. After that time, it will be deleted from the server, and the only copy kept on a personal computer of the researcher that is also password protected.

Do I have to take part?

It is entirely up to you whether or not you choose to take part. We hope that if you do choose to be involved, then you will find it a valuable experience. If you choose not to take part, there will be no negative repercussions for you. It will not have any effect on students' grades or any professional implications for those where the research is linked to their employment.

Data Protection Privacy Notice

The Data Protection Act will hold your interview data. The information you provide will be used for research purposes, and your personal data will be processed under current data protection legislation, and the University's notification lodged at the Information Commissioner's Office. Your personal data will be treated in the strictest confidence and will not be disclosed to any unauthorised third parties. The results of the research will be published in anonymised form, and it will be aligned with the legal requirements about the storage and use of personal data as stipulated in the UK by the Data Protection Act (1998) and any following similar acts.

The data controller for this project will be the University of Exeter. The University of Exeter Data Protection Office provides oversight of Exeter activities involving the processing of personal data and can be contacted at dataprotection@exeter.ac.uk University of Exeter's Data Protection Officer can also be contacted at the same email. Further information on how the University of Exeter uses participant information can be found here: https://www.exeter.ac.uk/gdpr/

Whom can I contact for further information?

For further information about the research or your interview data, please contact:

7.7 Appendix 7-7: Technological Devices That Students and Teachers Had or Used in the Classroom

Subject	**Technological devices used by students in the classroom**			**Technological devices used by teachers in the classroom**
	iPad	**Laptop**	**Cell phone**	**Smartboard**
Chemistry (IB) HL/SL		•		•
Chemistry (IB1)				•
Biology				•
English A/ HL	•	•		
English B		•		
English		•		•
Geography		•		•
History		•		•
Humanities		•		•
Computer Science/ IT			•	•
Maths1				
Maths2	•	•		•
Individuals and Society				•

Note 1: the symbol indicates the observation of the attribute.

Note 2: English and in English (A / HL) students did not use their laptops or iPads.

7.8 Appendix 7-8: Uses of Technology in Formative Assessment According to the Classroom/laboratory (1/2)

Subject	Technologies (laptops, iPads, smartboards, platforms, apps, web apps) used for:								
	Feedback in the learning process			Peer to peer feedback			Task feedback		
	Email	Platforms provided by the school	Smartboard (slides)	Google Docs	WhatsApp	Google Classroom	Google Docs	ManageBac platform	Smartboard
Chemistry (IB) HL/SL	•			•	•		•		
Chemistry (IB1)									
Biology			•						
English A/ HL									
English B								•	
English									
Geography				•		•	•		
History			•						
Humanities		•		•			•		•
Computer Science/ IT									
Maths1									
Maths2			•						
Individuals and Society			•						
Note: the symbol indicates the observation of the attribute.									

7.9 Appendix 7-9: Uses of Technology in Formative Assessment According to the Classroom/laboratory (2/2)

Subject	Technologies (laptops, iPads, smartboards, platforms, apps, web apps) used for:							
	Do the task (Individually or in groups)			Search for information			Watch the teacher's presentation.	Take pictures of the information on the board.
	Educational platforms	Google	Computer and presentation programs	E-book	Google	YouTube	Laptop	Cell phone
Chemistry (IB) HL/SL			•					
Chemistry (IB1)								
Biology								
English A/ HL								
English B								
English								
Geography	•	•		•			•	
History		•			•			
Humanities	•	•	•					
Computer Science/ IT								•
Maths1								
Maths2				•	•	•		
Individuals and Society								
Note: the symbol indicates the observation of the attribute.								

7.10 Appendix 7-10: Specific Uses of the Smartboard Observed According to the Classroom/laboratory

Subject	Specific uses of the smartboard						
	Show a video	Show pictures	Slides /	Slides / to	Slides/presentation of the	Slides / task instructions	Writing
Chemistry (IB) HL/SL					•	•	
Chemistry (IB1)					•		
Biology	•			•	•	•	
English A/ HL							
English B							
English		•				•	
Geography					•		
History		•	•	•	•		
Humanities							
Computer Science/ IT				•			•
Maths1							
Maths2				•			•
Individuals and Society	•			•	•		
Note: the symbol indicates the observation of the attribute.							

7.11 Appendix 7-11: Classrooms, Where Motivation to Learn Was Observed According to the Technologies Involved

Subject	Technology involved		
	iPad	Laptop	Smartboard
Biology			•
Geography		•	•
History		•	•
Humanities		•	•
Maths2	•	•	•
Individuals and Society			•
Note: the symbol indicates the observation of the attribute.			

7.12 Appendix 7-12: Non-technological Resources Used in the Learning and Teaching Process According to Observed Classrooms/laboratories

Subject	Non-technological resources for learning			Non-technological resources used for teaching/ testing	
	Books	Notebook	Pen-and-paper	Quiz (paper / oral)	Whiteboard
Chemistry (IB) HL/SL		•			
Chemistry (IB1)		•			
Biology		•			•
English A/ HL				•	
English B	•	•	•		
English		•	•		
Geography					•
History		•			
Humanities					
Computer Science/ IT		•			•
Maths 1					•
Maths 2	•	•			•
Individuals and Society					
Note: the symbol indicates the observation of the attribute.					

7.13 Appendix 7-13: Field Note Guide Sheet

Exploring the Role of Technology in Formative Assessment: Case Study of a Secondary School in the UK (Observation Guide-Field notes)	
Classroom number:	
Subject:	
Year:	
Class:	
Number of students:	
Instruction: Check the box if the attribute is observed	
1. Organisation of students in the classroom	
Grouped	
In rows	
Separated	
(Comments)	
2. Conditions offered for the adoption of technologies	
The school has an Information Technology Department	
The school pays the licences of educational platforms.	
Platforms/educational tools: (Comments)	
3. Technological devices used by students in the classroom	
Laptop	
iPad	
Cell phone	
Other:	
(Comments)	
4. Technological devices used by teachers in the classroom	
Laptop	
Smartboard	

Other:		
Comments		
5. Formative Assessments Strategies		
Explanation of the exam criteria		
Presentation of the class objectives		
Assignment of learning tasks		
Classroom discussions		
Questioning		
Test		
Work teams		
The task was to prepare for a presentation and present it in front of the class.		
6. Feedback		
Learning process	Teacher checks understanding	
	The teacher supervises/ helps complete the task.	
	The teacher answers questions.	
Self-regulatory	Peer assessment	
	Self-assessment	
	Students complete their task as a group.	
	Complete their task with the help of a peer.	
	The student completes their task individually.	
Self	The teacher praises the students' work and responses.	
Task	Teacher assessment	
The teacher gives negative feedback.		
(Comments)		
7. Technologies (devices, platforms, apps, web apps) used for:		Comments

Teacher	Presentation of the objectives	
	Class lesson	
	Assignment of learning tasks	
	Check attendance	
	Tracking the timetable	
	Feedback in the Learning process	
	Task feedback	
Student	Tasks (individual or in a group)	
	Search for information	
	Peer to peer feedback	
Other:		
Comments		
8. Interaction and engagement		
Students are distracted by technology.		
Students are not engaged in completing the task.		
Students don't interact with each other.		
Students don't interact with the teacher.		
Students are engaged to complete the task.		
Students interact with each other.		
Students interact with the teacher.		
Comments:		
9. Traditional resources used for teaching/learning/testing		
Whiteboard		

Books	
Notebook	
Pen-and-paper	
Paper quiz	
Oral quiz	
Other:	
(Comments)	
Overall Remarks:	

7.14 Appendix 7-14:Field Note Sample

Exploring the Role of Technology in Formative Assessment: Case Study of a Secondary School in the UK (Observation Guide) Classroom number: 9 Subject: Humanities Year: Grade 10 Class: Classroom Number of students: 7 1. Organisation of students in the classroom	
Grouped	✓
In rows	
Separated	
Seven students are sitting in three groups.	
2. Conditions offered for the adoption of technologies	
The school has an Information Technology Department	✓
The school pays the licences of educational platforms.	✓
Platforms/educational tools: Encyclopaedia Britannica and Britannica Digital Learning platforms. One of the students complained that he could not log in; the teacher was very anxious when he heard that and ran to his desktop to check if the subscription is still working. A relieved sign was expressed as he told the student that it is still working, and he double-checked the student’s account and finally, the student is logged in. This would indicate a total reliance on online resources and proof of technology use in and outside the school. Also, it appears the teacher could check students' logs to these websites and provide feedback.	
3. Technological devices used by students in the classroom	
Laptop	✓
iPad	

Cell phone		
Other:		
All are using their laptops.		
4. Technological devices used by teachers in the classroom		
Laptop		✓
Smartboard		✓
Other:		
The Smart Board is showing slides.		
5. Formative Assessments Strategies		
Explanation of the exam criteria		✓
Presentation of the class objectives		
Assignment of learning tasks		✓
Classroom discussions		✓
Questioning		
Test		
Work teams		✓
The task was to prepare for a presentation and present it in front of the class.		
6. Feedback		
Learning process	Teacher checks understanding	
	The teacher supervises/ helps complete task.	✓
	The teacher answers questions.	✓
Self-regulatory	Peer assessment	
	Self-assessment	
	Students complete their task as a group.	
	Complete their task with the help of a peer	✓

	The student completes their task individually.	
Self	The teacher praises the students' work and responses.	
Task	Teacher assessment	✓
The teacher gives negative feedback.		
(Comments)		
7. Technologies (devices, platforms, apps, web apps) used for:		Comments
Teacher	Presentation of the objectives	
	Class lesson	
	Assignment of learning tasks	
	Check attendance	
	Tracking the timetable	
	Feedback in the Learning process	Britannica Digital Learning platform
	Task feedback	Slide share, laptop, smart board, Google Docs
Student	Tasks (individual or in a group)	Laptop, Google, Wikipedia, Britannica
	Search for information	
	Peer to peer feedback	Google Docs
Other:		

The task is time-limited, and the teacher seems to control the slides of each group on the students' laptops; by clicking on a button, the slides of each group are presented on the Smartboard, and the students stop working immediately (slide share). Students are live sharing the presentation and Google Docs while working, but the teacher is providing and checking face to face. There were teacher, peer and group assessment, and all levels of feedback were covered (self/task/process/self-regulation). The teacher is encouraging the students to research online, explore three resources or more and not to depend on just one. The teacher encourages them to use approved official online textbooks and websites such as Encyclopaedia Britannica and Britannica Digital Learning platforms which appears to be financed by the school since all students are subscribed to it. The teacher is emphasising the use of Britannica, not Google, but students tend to use Google or Wikipedia.	
8. Interaction, Enthusiasm and Behaviour	
Students are distracted by technology.	
Students are not engaged in completing the task.	
Students don't interact with each other.	
Students don't interact with the teacher.	
Students are engaged in completing the task.	✓
Students interact with each other.	✓
Students interact with the teacher.	✓
Students all were engaged in learning and working on the tasks with no exception. Both students and teacher are interacting smoothly and showing enthusiasm and passion. The teacher was encouraging the students to ask and inquire after each presentation.	
9. Traditional resources used for teaching/learning/testing	
Whiteboard	
Books	
Notebook	
Pen-and-paper	

Paper quiz	
Oral quiz	
Other:	
(Comments)	
Overall Remarks: In general, lessons seem much interesting, effective with efficient time management when technology is incorporated as usual practice. It looks that all teachers are worried about the final exam; at the end of the lesson, the teacher went through the rubric of the final external assessment and discussed how to raise the grades. It would be worth mentioning that this teacher did not participate in the survey, although the teacher participated in the interview.	

7.15 Appendix 7-15: Classroom Observation Vignette

CLASSROOM 1

SETTING:

- Equipped Classroom
- Ten students
- The students were sitting in two rows facing the board.

ORGANISATION, CLARITY, AND PRESENTATION

The lesson started with an introduction and clear objectives. The teacher is using the Smartboard to present the subject. This slide shows the primary or essential concepts in different colours—using videos as a source of ideas and discussion. The video showed an experiment, and students were interested. The teacher uses the slides to present the lesson. Questions were raised on the Smartboard. And one of the slides is to check students' comprehension and discussion, going back and forth with the slides to study the idea and knowledge, which is Bloom's taxonomy, one in the form of debate and two. Students are not using a laptop; there is no evidence of laptops or mobile phones.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

The level of interaction and enthusiasm was good. The students were engaged and disciplined, and the teacher was transitioning from point to point smoothly. There is a mention of the Kognity App in the class; it appears they're using it with the teacher. The teaching activates students as a learning source for one another (peer assessment and feedback/ group discussion).

The teacher is engineering practical discussion tasks and activities that elicit evidence of learning (different types/techniques of exercises and activities).

It is a well-planned lesson, using technology resources and various techniques for feedback and formative assessment.

OVERALL REMARKS

The use of technology seems to facilitate the covering of Bloom's taxonomy, as in half an hour, the teacher covered it all with full involvement of the students.

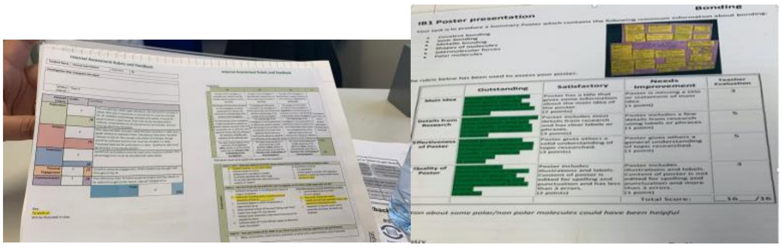
GENERAL REMARKS:

Although lots of technology is funded and supported by schools, no apparent technology integration frameworks are followed. When teachers were asked about the technology models they were following, they could not provide an answer.

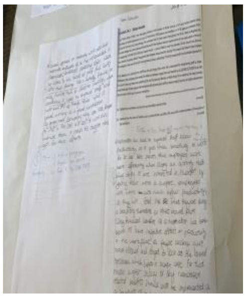
Students are the ones who are telling the teachers about the new technologies, teachers. On the other hand, teachers may choose to use it or not. Most IB is working on Google Docs and sharing their documents and assignments if it's group work or with their teacher to follow and check now and then their progress. ManageBac platform is always mentioned with the word "plagiarism" and " Turnitin", "IB." Teachers and students were showing reluctance and annoyance regarding the school’s decision not to renew the Kognity subscription license. Kognity is a platform that adapted the traditional textbook to digitally consumable text with video examples, 3D models and practice tests to make the content more interactive and engaging. The books are curriculum-aligned and are designed to enhance more in-depth learning.

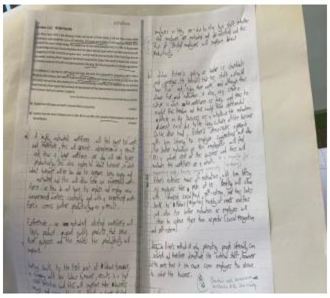
Kognity combines pedagogy and technology to take students' learning to the next level. Both students and teachers were talking about this platform with a great passion not observed regarding any other technology. At the same time, teachers did not incorporate any learning platforms in their teaching. However, they could access the media and monitor the students' access and activities.

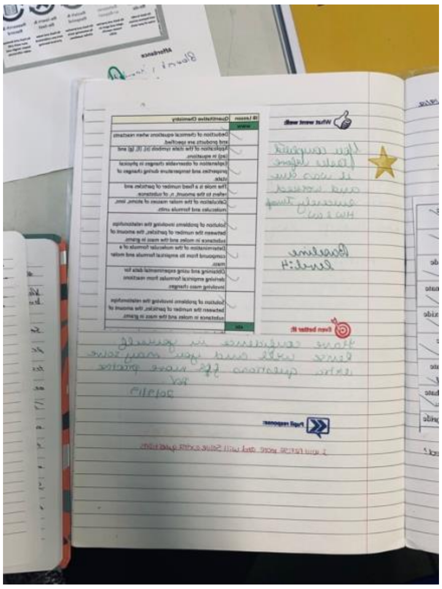
The teachers seem to be governed in their instruction by different elements. The final exam is the most noticeable since some teachers take considerable time revising and practising for the exam rather than teaching. I also noticed that some teachers are a bit stressed and feel that the students are unready or not prepared as some teachers keep reminding the students that the exam is close. Also, I’ve noticed that the teachers try to fulfil all Ofsted regulations by preparing evidence expecting inspection at any time. You can see how they depend on notebooks and handwriting as evidence of their work. (Below is a student notebook showing the teacher’s assessment) Although it was printed and could be sent by the ManageBac platform, the teachers asked the students to print and stick it in their notebooks.



The picture above is from a Chemistry class. It shows a student notebook. We can see the International Baccalaureate (IB) assessment criteria since the school system is IB; the teachers also are using a system of feedback in marking WWW and EBI (What Went Well, Even Better If) feedback based on Ofsted regulation (Ofsted, 2011). However, IB has a different assessment policy field (International Baccalaureate, 2018). The teachers in the school are following two types of policy at the same time (Ofsted and IB). There is also a school's policy regarding the digital learning environment, but it is not clear, specific, or standardised; there is a big budget and support for digitalisation, but there is no clear structure or regulation on the school's part. For example, I found the school in providing a generous budget for each subject department depending on the department's needs. For example, social science subjects use Encyclopaedia Britannica; STEM uses Kognity and other different platforms and apps where each teacher can access his students' accounts and monitor their activities and usage. At the same time, these learning platforms provide multiple interactive features that can be used to support learning and provide assessment and feedback. Still, the teachers are not using them in the classroom or even monitoring the students' progress and obtaining feedback for their instruction and that I believe is due to the school's unclear structure or policy. Students also use these learning platforms and apps depending on their preferences and convenience. The school appears to not have a clear vision of the technology tool usage in teaching and learning or the digitisation of the process.







CLASSROOM 2

SETTING:

- It is a big lab, and HL students were sitting in the front row with two empty chairs apart from each other. There was no evidence of technology use by any of the students. There was no sign of Chromebooks or laptops with the HL students, which may indicate that the teacher does not usually use technology-based platforms or applications while teaching.
- The Smartboard showed a slide of the objectives and an exercise.
- The use of the Smartboard was primary as no interactive features were used.
- The standard-level students sat at the back, working together using their laptops on their assignments.

ORGANISATION, CLARITY, AND PRESENTATION

The teacher seemed prepared for the students, but there was no clear presentation, introduction, or warming-up activities for the lesson. The clarification was one-to-one, depending on who asked for help or had a question. There were no transitions from topic to topic or any distinction made between points made by the teacher. Moreover, in the end, there was no summarising of the fundamental concepts or ideas.

The teachers' teaching methods were primary and traditional; there were no visual or vocal aids, and the teachers did not adapt the teaching pattern through gestures, voice level, tone, pace, or even writing on the board. There was not any group discussion or questioning or any integrated strategies such as handouts and media.

The teacher was giving the lesson to the HL students and using the Smartboard to present slides showing the exercises and later the answers. It was a traditional lesson; the lesson objectives were presented on the Smartboard, and students were copying (handwriting) from the Smartboard and the presented slides into their notebook. The teacher was asking and revisiting past information/knowledge, which covers scale1 (remembering) in Bloom's Taxonomy. One-to-one task level and self-level feedback were provided. The teacher spent a long time with one student explaining and providing feedback while doing the exercise, although there are only three students in the class. The teacher is asking the students to write down what is on the board and providing them with sufficient time to write.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

Teacher-Student had minimum interaction, and students had no peer interaction or discussion of any sort as each student sat on a chair, opened the notebook, and started writing. One of the students had no interaction with the teacher, even no eye contact. Students did not show any interest as their posture was bending on their desks and writing on their notebooks. However, the level of questions was a lower level that requires remembering, and they answer it right, and the teachers provide self-level feedback immediately "*very good*" and "*well done*". There was no apparent enthusiasm for the subject nor teaching from both teacher and students.

STANDARD LEVEL STUDENTS:

The class was divided into two; Higher Level (HL) and Standard Level (SL). The SL students were using Google Docs and life sharing their work for peer-feedback, later they mentioned that they also live share Google Docs and Excel with the teacher for monitoring and feedback. Students usually send emails to teachers for questions and feedback, but for fast feedback, students prefer peer feedback via the WhatsApp application.

OVERALL REMARKS

Although the school is fully equipped and providing sufficient budget for the new technologies such as (platforms, apps, and equipment), there is no sign of any instructional design or advanced use of technology in the classrooms such as interactive learning or flipped classroom. Although the apps and platforms provided by the school and supported by the same department could be used in the classroom to facilitate learning, assessment, and time efficiency. However, they still use the traditional way and even copy manually from the slides to the notebooks although teacher could save the lesson's time by sharing the slides and ask them to summaries. The survey results showed that almost 72 % of the teachers believe they are using educational technologies in both the classroom and home. In comparison, over 80% reported never using educational technologies in the school library and labs. Students, on the other hand, are using the technologies provided by the school on their own time, place, and pace. This can be confirmed from the survey as over 80% of student reported that they use educational technologies in both labs and libraries. They have also mentioned in the informal conversations, every student or group of students has their favourite app and platform, which they use for learning and feedback.

The interesting part is that the teacher showed a high keenness and positive attitude towards technology in teaching and learning in the survey. Furthermore, when asked how often do you use educational technologies in the following facilities? The teacher chooses the answer "*always*" in the classroom, Labs, and school library. The teacher also chooses "*always*" in using an interactive board and desktop.

CLASSROOM 2:

SETTING

- The same lab as Classroom1
- There is a Smartboard showing slides with the objectives.
- Thirteen students in the lab are preparing for an experiment.
- No evidence to technology in or outside the class rather than the slides presented
- The use of PupilAssist for Attendance

ORGANISATION, CLARITY, AND PRESENTATION

It was a practical, traditional lesson no evidence to technology in or outside the class rather than the slides presented. The teacher started by exploring the objectives, revisiting the exam's criteria, and explaining the task. There has been One-to-one feedback, Task feedback, and Ongoing feedback from peers and teachers. The teacher mentioned that notebooks are essential for Ofsted regulations.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

Since it was a practical lesson, several students who are working in pairs and groups. Students were more reliant on peers since the teacher goes one-by-one explaining, supervising, and providing feedback to individual students. The interaction and enthusiasm from both teacher and students were minimal.

OVERALL REMARKS

There was no evidence of technological aid or tool from both teacher and students. The teacher of this class is the same as Classroom1.

CLASSROOM 3

SETTING:

- Equipped lab
- The whiteboard shows the objectives and goals of the lesson.
- Students are not sitting close to each other; there is one-chair space between them which might indicate that they do not often work in a group.

ORGANISATION, CLARITY, AND PRESENTATION

The teacher started the lesson by explaining the objectives and then presenting the lesson in slides, going back and forth, and providing feedback linking to previous information and covering different scales of Bloom's taxonomy. A video is presented on the Smartboard to show the process and reinforce the information.

The teacher applied different techniques of discussion and questioning. The Smartboard shows the section intended activities and timeline. There is 10 minutes quiz (assessment) presented on the slides, and the students were asked to answer it in their notebooks.

After they finished, the teacher corrected the test with the students, and when a student said a correct answer or sound, the teacher praised them and explained to them what went well. Each student went on their elected microscopes to check everything they had learned about the seed (internal assessment. Nearly five levels of learning were covered- remembering, understanding, applying, analysing, and evaluating.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

There were a practical discussion and interaction between the students and the teacher; the teacher used technological tools to facilitate discussion. Also, different kinds of questioning methods were applied to refocus students' attention; a quiz was presented on the Smartboard and showed the section intended and the activities. Self-feedback, task feedback, and process feedback were provided, and both students and teacher were enthusiastic and engaged as the students interacted. There was no evidence of boredom as the teacher used various resources to reinforce the information. The teacher also encourages students' self-assessment and self-regulation, and the lesson benefited from technology but in a traditional way.

OVERALL REMARKS

The teacher was prepared, and the lesson was planned for, well presented, and well guided with the help of technology. With the critical use of technology, the teacher could support constant feedback and scaffolding learning by using multiple instructional techniques to transfer students gradually for deeper understanding and, eventually, better independence in the learning process.

Interestingly, although the same teacher mentioned using the educational platforms in the survey like Quizlet, Kognity and Google Forms, the quiz and the rest of the activities were presented on the board, and the students were still asked to answer in their notebooks.

It is worth noting that the teacher showed a high technology acceptance in the TAM survey, although they chose 6/10 in keenness to technology use in teaching. The teacher also mentioned that they *"Always"* use the interactive board without apparently using the interactive features.

CLASSROOM 4

SETTING:

- Four students are sitting apart, with two empty spaces between them.
- The students have their laptops and iPads with them.

ORGANISATION, CLARITY, AND PRESENTATION

There were no clear objectives or slides on the board. The teacher started by distributing quiz papers and allowed 10 minutes for the students to answer, and then the teacher began to ask the students to answer the questions orally. The teacher praises and justifies why she liked the answer by telling the right solution to the class(feedback). The type of questioning and feedback provided was task-level as the teacher graded and corrected the answers.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

There was a sort of interaction between students and the teacher but not amongst students, as they were encouraged to do their work individually. When the teacher heard two students discussing something, the teacher asked them not to discuss it with each other's as they should ask the teacher quoting *"the teacher knows best".* The teacher encouraged students to ask their supervisors and their teachers rather than their peers.

OVERALL REMARKS

Students informed the teacher that they were discussing issues regarding the TOK assignment since they could not reach the TOK supervisor because he was absent for days. The teacher asked them to wait until they became available and not try to solve anything alone. This would indicate that the teacher is not fostering peer-assessment, self-assessment, or self-regulation. The exciting part is that the teacher did not suggest emailing the supervisor, which may indicate that the school culture does not enable technological communication. There was no evidence for any technology such as Google Docs or any platform by students or the English teacher. However, since they have laptops and iPads, this might indicate some technology used in this subject. The teacher mentioned that she needs to start to look at Google Classroom since there might be a lockdown, which suggests that it was enabled in school for a while, but no one has used it, but they should start in case there is a lockdown; the teacher showed intention to use.

It is worth mentioning that the school is subscribed to G Suite, which includes Google Classroom, but not all teachers are using it. They were encouraged to use it since they will close the school and switch to online and distance learning during the COVID 19 crisis.

CLASSROOM 5

SETTING:

- The classroom is equipped.
- The tables are formed in groups.
- A student is using a laptop.
- The teacher uses her laptop to track the timetable, set the schedule, and take attendance.

ORGANISATION, CLARITY, AND PRESENTATION

There were no clear objectives discussed or presented on the board. A discussion started regarding students' assignments, and the teacher checked their writing while providing feedback on task-level (I love that, depressing handwriting, I like it, you did this and that). One student is working on a laptop while the teacher encourages the students to revise from the book, write notes, and ask them to gather information and write in their notebooks in the recent activity. Students asked the teacher to use their mobile phones to search for information, but the teacher refused.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

The students are working together and sitting close to each other.

OVERALL REMARKS

Students tend to depend significantly on notebooks and pen and paper, although the End of Year assessment is an e-assessment and assignment to be uploaded to the ManageBac platform.

CLASSROOM 6

SETTING:

- Nine students are sitting around tables in three groups.
- Each student has a laptop.
- The Smartboard presents a task.

ORGANISATION, CLARITY, AND PRESENTATION

There were no lesson objectives written on the board or even mentioned at the beginning of the lesson. The lesson started with pictures and asked the students to describe them while the teacher encouraged discussion. A reading activity started, and students worked individually on their notebooks. At this point, students are working individually and asking the teacher questions when needed. The feedback was on task-level, process level and self-regulation levels. The questions vary, covering several learning levels such as applying and analysing, followed by scaffolding strategies. The teacher provides comments to assess connections between ideas under process level feedback and provides words that help students to identify feedback themselves (self-regulate); her feedback was constructive.

The teacher provided a set of final exam questions, provided clarification, and asked the students to work on them and self-evaluate.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

Students interact and answer their peers' questions even when they are not asked, and the teacher encourages oral discussion. Both teacher and peer provided feedback.

OVERALL REMARKS

Although the teacher seems to consider the five Rs in feedback Redraft, Rehearse, Respond, Re-test and Record, technology is not involved. Although the activities were based on pen-and-paper, the lesson indicated planning and preparation, and the activities were time-restricted.

The teacher kept reminding the students of the test *“It is in a month”, “there is no time”.* Although the teacher was preparing the students for the exam, they were still working on pen and paper while the exam was E-assessment.

CLASSROOM 7

SETTING:

- Equipped Classroom.
- Thirteen students sitting in groups
- All students are using their laptops.
- The teacher uses the PupilAsset application to check the attendance of the pupils.
- The teacher is using the regular whiteboard with the Smartboard.

-

ORGANISATION, CLARITY, AND PRESENTATION

The target was to research online, and the students did that on Google Docs. The teacher presented the objectives on the Smartboard, and I noticed that the same presentation was also given on students' laptops. The teacher is consistently checking people's work and giving feedback. Task-level/ process-level/ Self-regulation. The teacher is encouraging students to use the Internet and look for information. He gave them time to search the web. The teacher encourages students not to use Google but to verify websites and platforms such as the Britannica Digital Learning platform, which the school is paying for its licence. The homework should be submitted in Google Docs; the teacher prefers Google Classroom. Most of Bloom's Taxonomy stages were covered.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

A student shared Google Docs with the teacher, and he also shared Google Docs with his friends. The teacher is sharing the presentations and Docs through Google Classroom. The teacher asked about Google Classroom homework and if they were still using the Kognity application. The teacher explained that he could provide feedback and make changes online. A student found all the books online and informed the teacher; the teacher was glad and relieved.

OVERALL REMARKS

The school's main subject is the loss of Kognity access; students and teachers seem to be upset and missing lots of resources and aides.

CLASSROOM 8

SETTING:

- Equipped classroom

- Students are all using their laptops.
- The teacher presented his presentation via Smartboard.

ORGANISATION, CLARITY, AND PRESENTATION

The teacher started by discussing the previous project and providing feedback; the teacher praised the students for an excellent job and gave them time to finish the last project. The teacher started the lesson by questioning and using the slides back and forth for reinforcement—well-presented and well-prepared formative assessment techniques using the standard, basic technology. The teacher gave them a task to Google/search information online, some were using Google Docs, and some students were using their notebooks and writing everything down. The teacher shared with the students the slides *"live sharing*" that showed the objectives, keywords, and some pictures.

The teacher was engineering practical discussion as evidence of learning with the help of technology and providing feedback that moves learners forward; he covered the 5Rs and most of the learning stages.

Some students were using notebooks. The teacher is engineering active discussions and encouraging critical thinking as evidence of learning. The teacher provides feedback that moves the learner forward; continuous feedback and assessment (all levels of feedback were covered).

INTERACTION, ENTHUSIASM AND BEHAVIOUR

The students were very active, engaged, and enthusiastic, and the teacher's teaching techniques were impressive; he was trying to cope with the students' pace and managed to keep it going with the help of technology.

OVERALL REMARKS

The students seem to be used to bringing their laptops and using them in class as they are using both laptops and notebooks. It might depend on the students' preferences, or they may have to present their notebooks as evidence to Ofsted. I noticed that while some students were discussing a point with the teacher that one of the students was Googling information.

CLASSROOM 9

SETTING:

- Equipped classroom
- Seven students sitting in three groups
- All are using their laptops
- The Smartboard is on showing slides.

ORGANISATION, CLARITY, AND PRESENTATION

The task was to prepare a presentation and present it in front of the class.

The teacher encourages the student to research online, explore three resources or more and not depend on just one. The teacher encourages them to use approved official online textbooks and websites such as Encyclopaedia Britannica and Britannica Digital Learning platforms which appears to be financed by the school since all students are subscribed to them. The teacher emphasises using Britannica, not Google, but students tend to use Google or Wikipedia.

The task is time-limited, and the teacher seems to control the slides of each group on the students' laptops; by clicking on a button, the drops of each group are presented on the Smartboard and the students stop working immediately (slide share). Students are live sharing the presentation and

Google Docs while working, but the teacher provides and checks face to face. There were teacher, peer and group assessments, and all levels of feedback were covered (self/task/process/self-regulation)

One of the students complained that he could not log in; the teacher was very anxious when he heard that and ran to his desktop to check if the subscription was still working. A relieved sign was expressed as he told the student that it was still working, and he double-checked the student's account and finally, the student was logged in. This would indicate a total reliance on online recourses and proof of technology use in and outside the school. Also, the teacher could check students' logs to these websites and provide feedback. Britannica Digital Learning Launch Packs Social Studies classroom learning platforms are integrated with Kahoot!, the learning games and trivia quizzes platform, which seems to be also used.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

Both students and teachers interact smoothly and show enthusiasm and passion. Moreover, students were all engaged in learning and working on the tasks, no exception. The teacher encouraged the students to ask and inquire after each presentation.

OVERALL REMARKS

In general, lessons seem exciting and compelling with efficient time management when technology is incorporated as practice. It looks like all teachers are worried about the final exam; at the end of the lesson, the teacher went through the rubric of the final external assessment and discussed how to raise the grades. It would be worth mentioning that this teacher did not participate in the survey, although the teacher participated in the interview.

CLASSROOM 10

SETTING:

- Equipped IT lab
- Five students
- The students were sitting in a group around a table in the middle of the lab bot at students' desktops around the class.
- The students were using their notebooks.

ORGANISATION, CLARITY, AND PRESENTATION

The lesson started with no clear objectives, written, or discussed. The teacher uses the Smartboard to present or project what he writes on a Word Doc; the teacher also uses the whiteboard to explain the exercise. The teacher works on the BlueJ platform using his desktop while all his work appears on the Smartboard to show the students how to design Java. The students are writing it down in their notebooks manually, and they are not using any technology, just a primary use of Smartboard. The level of questions was a lower level requiring remembering, and they answered them correctly, and the teachers immediately provided self-level and process-level feedback.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

The level of interaction and enthusiasm was low. The students were working individually on the exercises, and the teacher checked their work one by one. The students were struggling; they sought help from each other but asked the teacher; they just waited for the teacher to come by, check and lead them. There was no evidence of process-level or self-regulation-level feedback.

OVERALL REMARKS

A student was taking pictures of what was on the board from his mobile to copy them into the notebook as he could not see the board. Students tend to use technology whenever they face a problem.

CLASSROOM 11

SETTING:

- Equipped classroom, but the only whiteboard is used.
- All students do not have/use laptops or iPads

ORGANISATION, CLARITY, AND PRESENTATION

The teacher started by checking students' homework and discussing lesson objectives. The teacher presented an exercise on the whiteboard and gave the students six minutes to solve it. The teacher assesses and provides feedback while going around and checking their work. The teacher offers continuous one-to-one feedback, mainly using the five Rs. The teacher spent time with one student, although the student answered all the questions correctly. It is more of personal tutoring than a lesson as the teacher is dealing with each student as a case; half an hour passed with one student, and the rest are working on solving exercise problems individually with no sign of peer work.

INTERACTION, ENTHUSIASM AND BEHAVIOUR

The students seemed to be used to working individually on solving problems as they directly opened their notebooks and started copying as soon as the lesson began. The teacher appeared worried as the students did not interact with him when he asked questions. There was no student engagement with the class as all students had their heads looking down at their desks and did not show eagerness to participate, answer the teacher's questions, or be active.

CLASSROOM 12

SETTING:

- Equipped Classroom: Smartboard, Desktop for the teacher, Whiteboard, amplifiers. All students are using their laptops or iPads.
- Some of the students are using their laptops as a source of knowledge or aid while they're doing the exercise.
- Some are checking YouTube, and some are googling things.
- Some students use their laptops to open e-books.
- All students use their laptops for different reasons (aid/ looking up a way to solve an answer/resource such as e-book/games/ social media).
- Six students out of seven showed NO evidence of using Google share or monitored work. The engaged student is playing an online race game after he finished all the exercises and waiting for a new task.

ORGANISATION, CLARITY, AND PRESENTATION

It is an introductory, traditional lesson. The teacher uses the Smartboard as a regular board to write (for writing and presenting). I think because the whiteboard was full. The students are writing down in their notebooks what is on the board. The teacher is correcting using green colour. The teacher provides task-level feedback and no evidence of encouraging self-regulation or self-level.

The students were working on solving an equation individually, using the teacher guidelines (the teacher is using the board). His questions covered knowledge, comprehension, and application (Bloom's taxonomy). The teacher writes down exercise steps on the whiteboard after asking the students to answer the actions of the exercise. Afterwards, the teacher asked the students to write (what was on the board) in their notebooks.

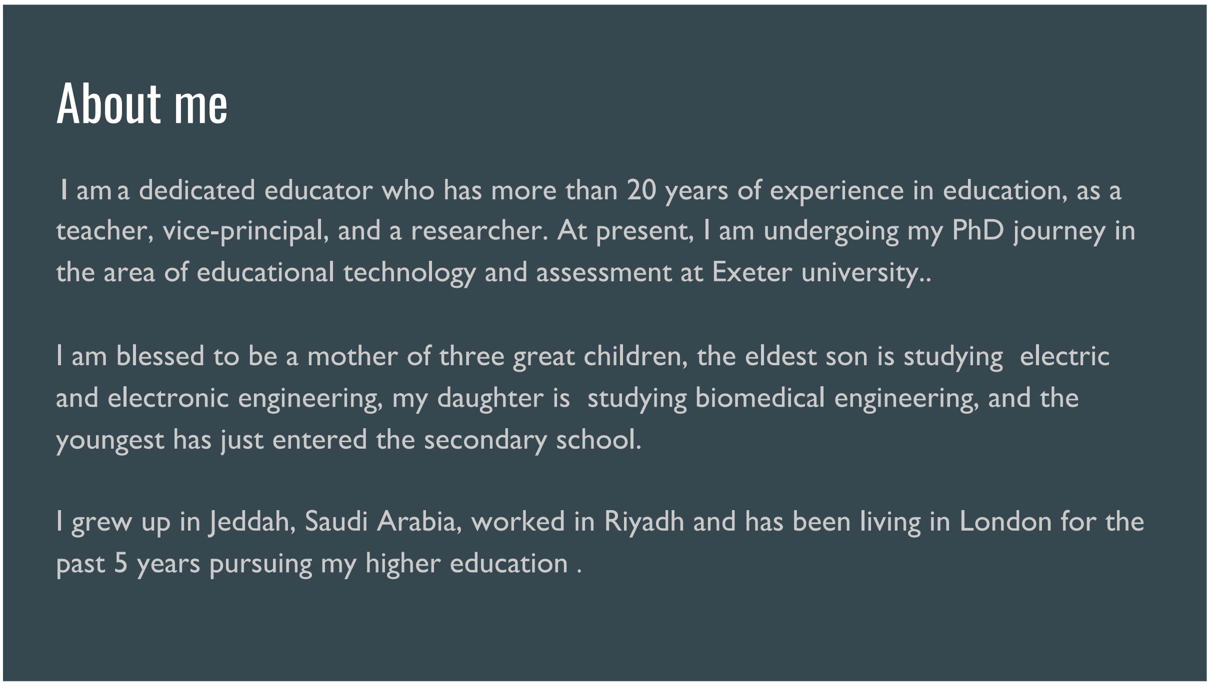
INTERACTION, ENTHUSIASM AND BEHAVIOUR

There are ten students, divided into five groups (all in two, one alone and three in one group). They're using their books and their laptops. Students are speaking to each other but are not sure about what. Students are checking their emails and sending emails while the lesson is on. Students seem to be watching YouTube while they are doing the exercise. Not everyone is engaged. Students exchanged notebooks; some students didn't ask for feedback from the teacher or peers. Some students who didn't ask for feedback asked their peers for feedback. Some students prefer to get peer assessments before the teacher checks their work. A group is checking their photos and discussing their looks (Side conversation) while they wait for the teacher to start explaining the exercise or writing down the answers. Some students are late in doing the activity and are talking the whole time, so they didn't ask or receive any feedback.

OVERALL REMARKS

The teacher, on many occasions, reinforces the idea of him being a substitute teacher (maybe an excuse for not presenting a well-prepared lesson, although it was not that bad). Still, there were a few comments from some students that “you are our teacher since the main teacher hardly attends/appear”. Given that he is a substitution teacher, I noticed that the students and teacher are used to each other and have a pattern/routine, which indicates that he

7.16 Appendix 7-16: Orientation Presentation



Why am I here today?

I am here to conduct a study about the role of technology in formative assessment

What is formative assessment?

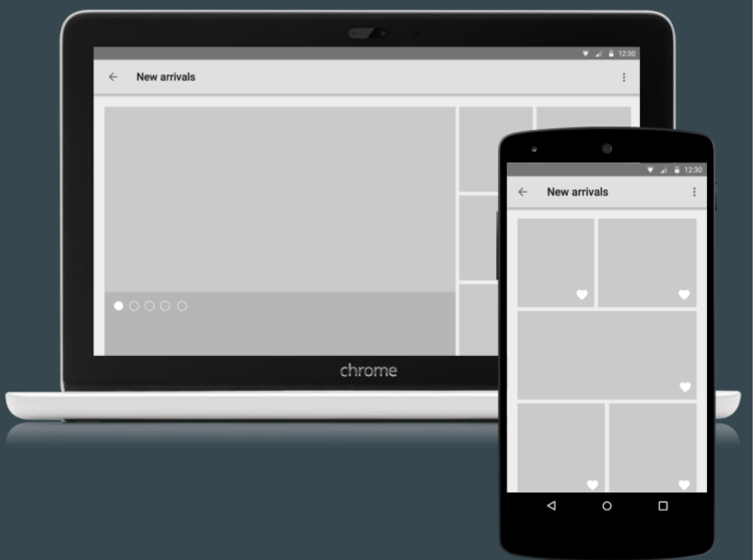
Formative assessment refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, or course.

What is formative assessment?

The general goal of formative assessment is to collect detailed information that can be used to improve instruction and student learning *while it's happening*. What makes an assessment "formative" is not the design of a test, technique, or self-evaluation, per se, but the way it is used.

Exploring the Role of Technology in Formative Assessment

It is case study of a secondary school that explores how teachers and students in various subjects from IB2, IB1 and Year 10 perceive the technologies they use in teaching and learning. Specifically, in formative assessment and feedback practices. This is to understand whether technologies are helping teachers in providing better and more comprehensive formative assessment for students or not. And how is that impacting teaching and learning.



What questions is the study suppose to answer?

How does technology-based formative assessment influence teachers' teaching and students' learning in a Secondary school in a UK context?

There are points that help to break down this large question :

Teachers and students perception of the:

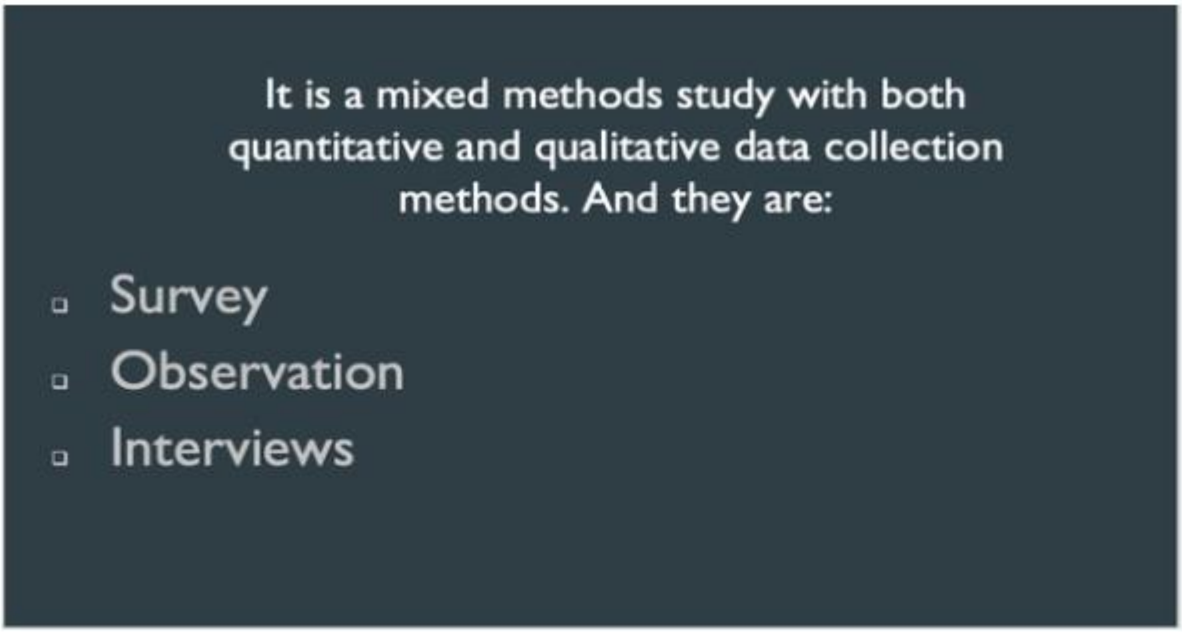
- The benefits of technology for teaching and learning.
- The support of technology to students' learning and teachers' teaching and learning regarding their instruction.
- The affordances of the technology for their teaching and learning.

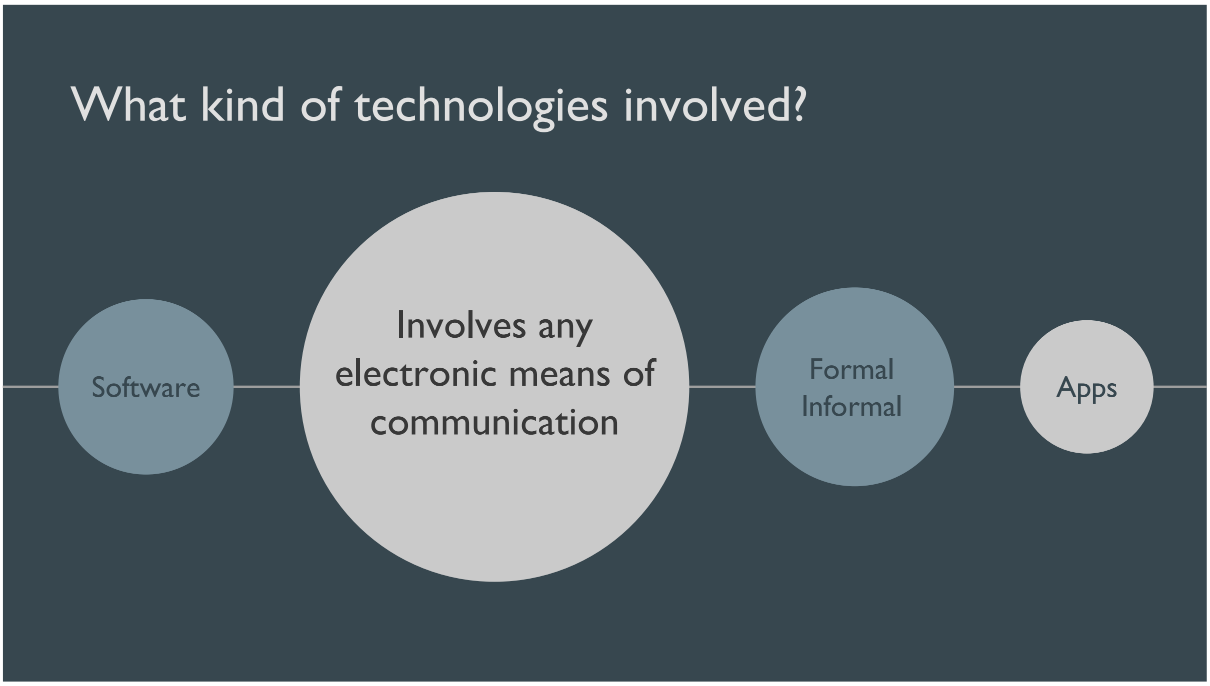
Teachers and students response to and adaptation of technology.

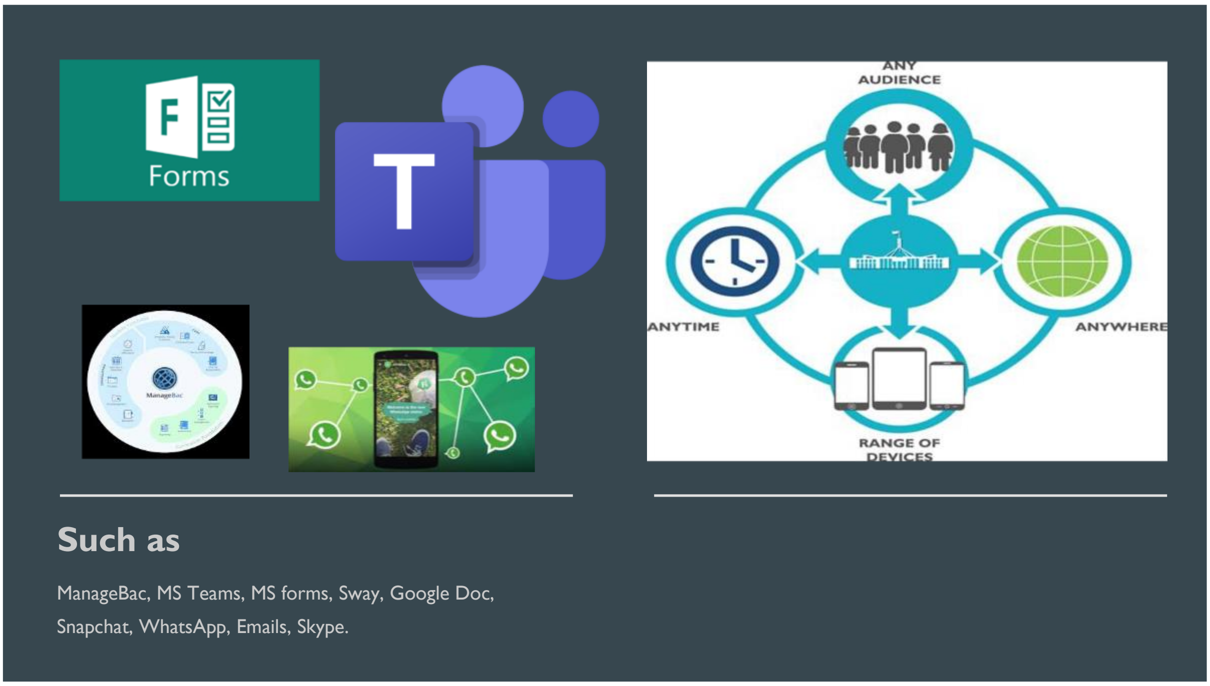
Who are the targeted participants?

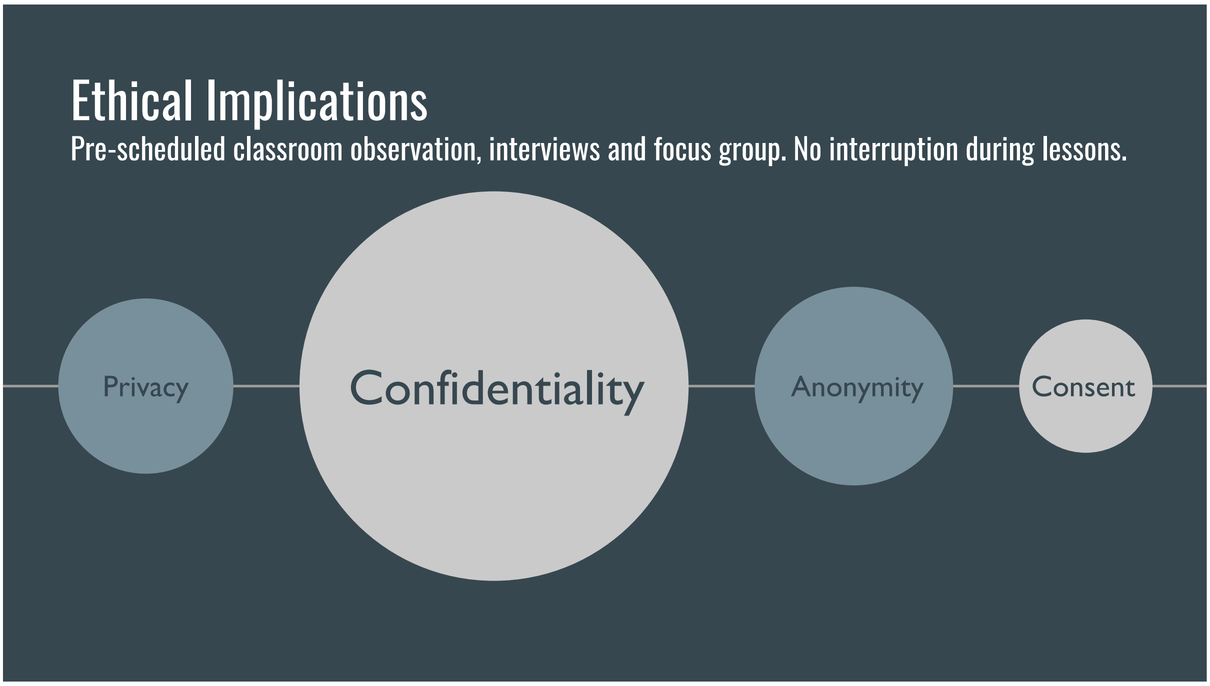
- Teachers and leaders from all subjects.
- IB2, IB1 and Year 10 Students

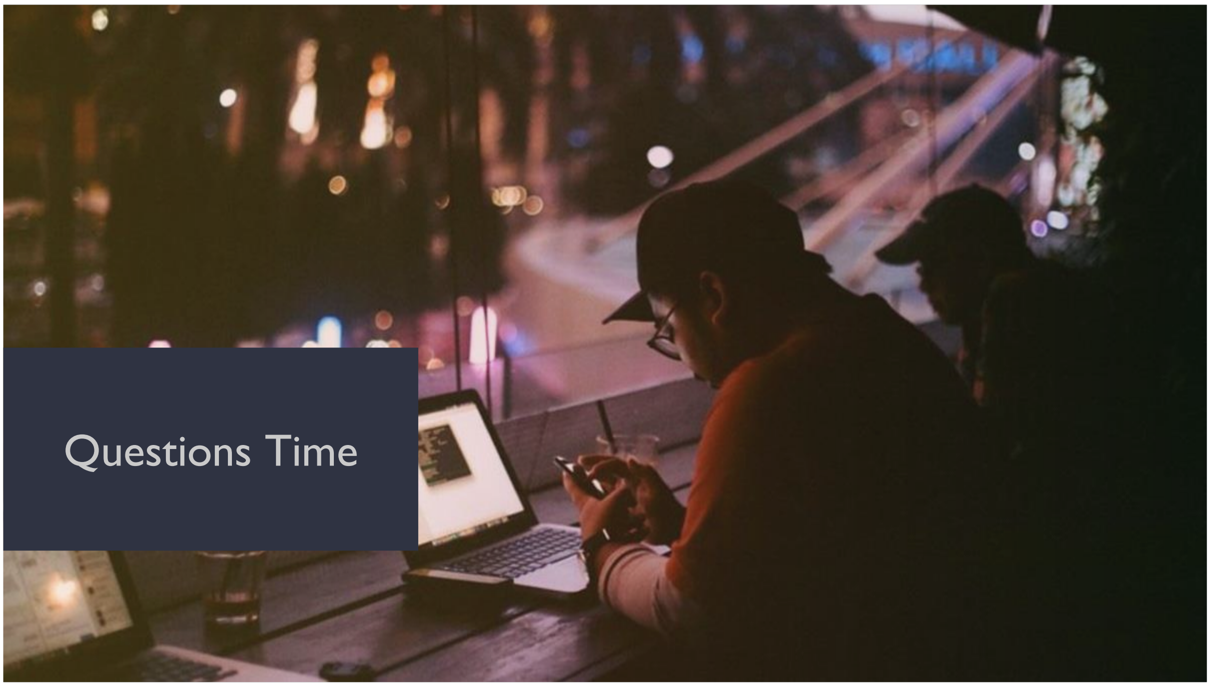
What does the study look like?


It is a mixed methods study with both quantitative and qualitative data collection methods. And they are:
Survey
Observation
Interviews


What kind of technologies involved?
Software
Involves any electronic means of communication
Formal
Informal
Apps


Forms
ANY AUDIENCE
ANYTIME
ANYWHERE
RANGE OF DEVICES
Such as
ManageBac, MS Teams, MS forms, Sway, Google Doc, Snapchat, WhatsApp, Emails, Skype.


Ethical Implications
Pre-scheduled classroom observation, interviews and focus group. No interruption during lessons.
Privacy
Confidentiality
Anonymity
Consent


Questions Time

7.17 Appendix 7-17: Consent Form

UNIVERSITY OF EXETER

Participant Identification Number:

CONSENT FORM

Title of Project:
Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK
Name of Researcher: Ahoud Alshaikh

Please initial box

1. I confirm that I have read the information sheet dated.................... (version no.............) for the above project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time. without giving any reason and without my legal rights being affected. ☐

3. I understand that relevant sections of the data collected during the study may be looked at by members of the research team and committee of the doctoral student at the University of Exeter, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I understand that taking part involves answering survey questions, participating in interviews, participating in focus groups, informal conversations with the researcher, and having my actions or behaviours observed by the researcher. ☐

5. I understand that my data will be used for the purposes of:
   - inclusion in the project data files for a period of up to 5 years. There will be a cloud stored copy online with a cloud storage vendor and a file on a personal password protected computer. ☐
   - reports published in an academic publication, project website, conference presentations, or media publication, or academic book. ☐

6. I agree to take part in the above study. ☐

______________________	______________________	______________________
Name of Participant	Date	Signature
Ahoud Alshaikh	______________________	______________________
Name of researcher	Date	Signature

When completed: 1 copy for participant; 1 copy for researcher/project file

7.18 Appendix 7-18: Information Sheet

Project Title: Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK
Start and end dates: 15/02/2020
Information sheet for

My name is Ahoud Alshaikh, and I am inviting you to take in part in my research project, "Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK". My dissertation looks at how teachers provide feedback on the learning processes of students, especially in terms of how they use technologies to provide that feedback (a process we call a formative assessment). I am interested in the opinions and perceptions of both teachers and students on the use of technologies to provide feedback on student work.

Who is carrying out the research?
I am a PhD candidate at Exeter University, and this research is necessary to complete my dissertation thesis. My supervisors are Dr Judith Kliene-Staarman-J.Kleine-Staarman@exeter.ac.uk and Dr Taro Fujita-T.Fujita@exeter.ac.uk. Any organisation does not fund this research. I am also a school governor at Isleworth Town Primary but do not work for the Isleworth council nor funded by them.

I very much hope that you would like to take part in this research. This information sheet will try to answer any question you might have about the project, but please do not hesitate to contact me if there is anything else you would like to know.

Why are we doing this research?
The main research question for this project looks at how technology-based formative assessment influence teachers' teaching and students' learning in an International Baccalaureate school's context. This research is important because it will help us to understand how students and teachers are using assessment technologies to improve student learning. It may help to develop recommendations for improving the use of technology so teachers can provide better or more useful feedback for students.

Why am I being invited to take part?
Both students and teachers are being asked to take part to understand how teachers are using the technologies and how they are helping to improve student learning. The participants should be teachers who use the technology in providing feedback to their students through technological tools or software, and all of their students.

What will happen if I choose to take part?

7.19 Appendix 7-19: Teachers' TAM Results

Teacher	PU				PEU			ATTIT			TSE			BI			TC		
	PU1	PU2	PU3	PU4	PEU1	PEU2	PEU3	ATTU1	ATTU2	ATTU3	TSE1	TSE2	TSE3	BI1	BI2	BI3	TC1	TC2	TC3
1	4	4	5	4	4	2	4	4	4	2	4	2	4	4	4	4	4	4	4
2	5	5	5	5	4	2	4	5	4	4	2	4	2	4	4	5	4	4	4
3	5	5	5	5	4	5	5	5	5	5	5	5	4	2	2	2	5	5	5
4	5	5	5	5	5	5	5	5	5	5	2	2	2	5	5	5	5	5	5
5	5	5	5	5	5	2	2	5	5	5	2	4	1	5	5	5	4	4	4
6	1	1	4	2	1	1	1	2	2	1	2	2	2	1	1	2	1	1	1
7	4	4	4	4	4	2	2	4	4	2	2	3	2	4	3	2	3	4	4
8	5	4	3	5	4	2	4	4	4	3	2	2	2	5	5	4	5	4	5
9	4	4	3	5	4	4	4	3	3	3	2	4	2	5	5	4	4	4	4
10	5	5	5	5	5	2	5	5	5	5	2	4	2	5	5	5	4	4	4
11	5	5	4	5	4	3	4	3	2	3	4	2	2	5	5	5	4	5	5

7.20 Appendix 7-20: Students' TAM Results

Students	PU				PEU			ATTU			TSE			BI			TC		
	PU1	PU2	PU3	PU4	PEU1	PEU2	PEU3	ATTU1	ATTU2	ATTU3	TSE1	TSE2	TSE3	BI1	BI2	BI3	TC1	TC2	TC3
1	5	5	5	5	5	5	5	5	5	5	1	5	5	5	3	2	5	5	5
2	5	5	4	5	5	5	5	3	3	5	1	1	1	5	5	5	1	1	1
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7	4	4	5	5	5	3	3	4	4	4	1	5	3	4	3	3	2	2	2
8	5	5	3	4	5	5	4	3	3	3	1	2	4	5	4	3	4	4	4
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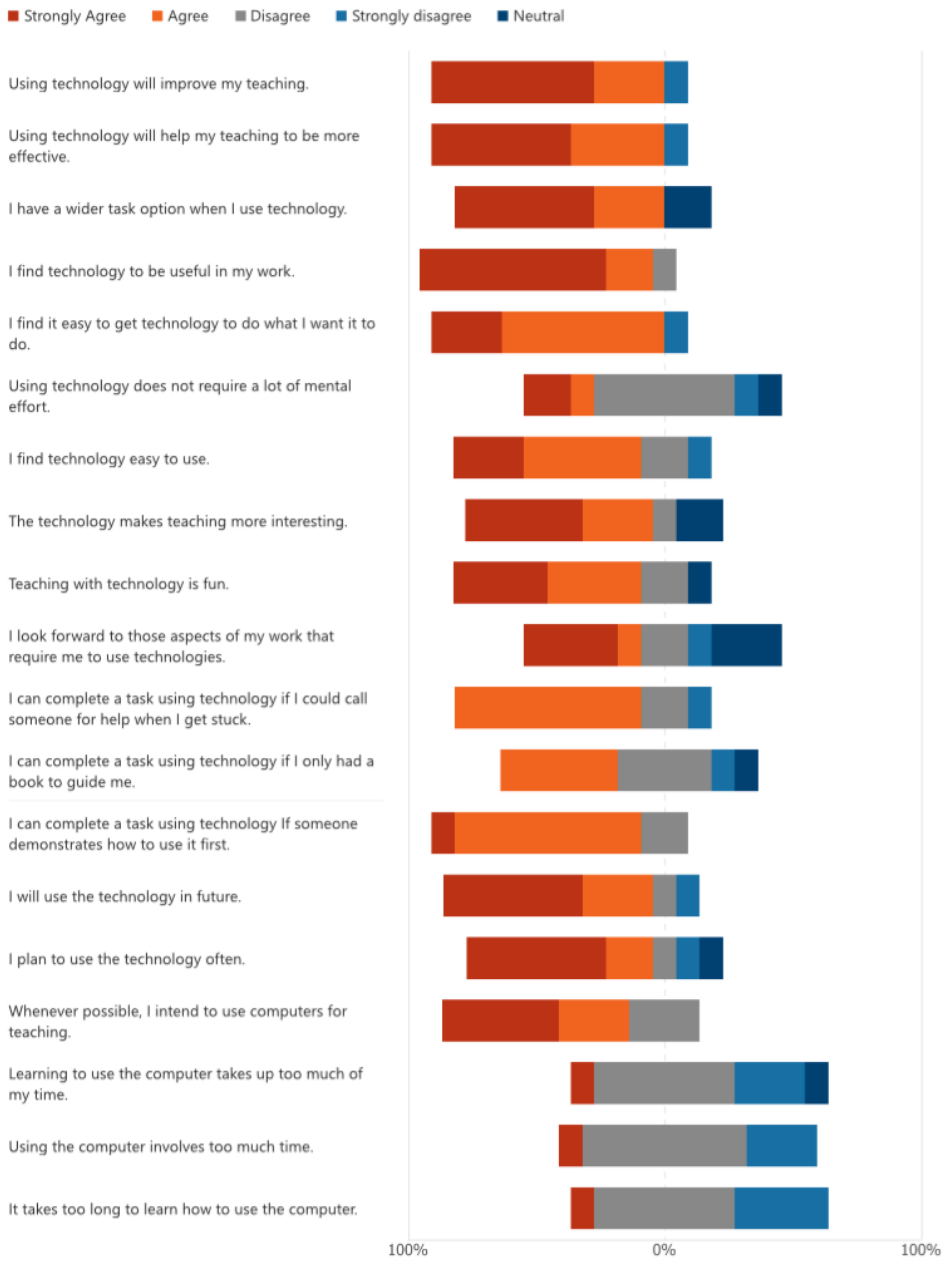
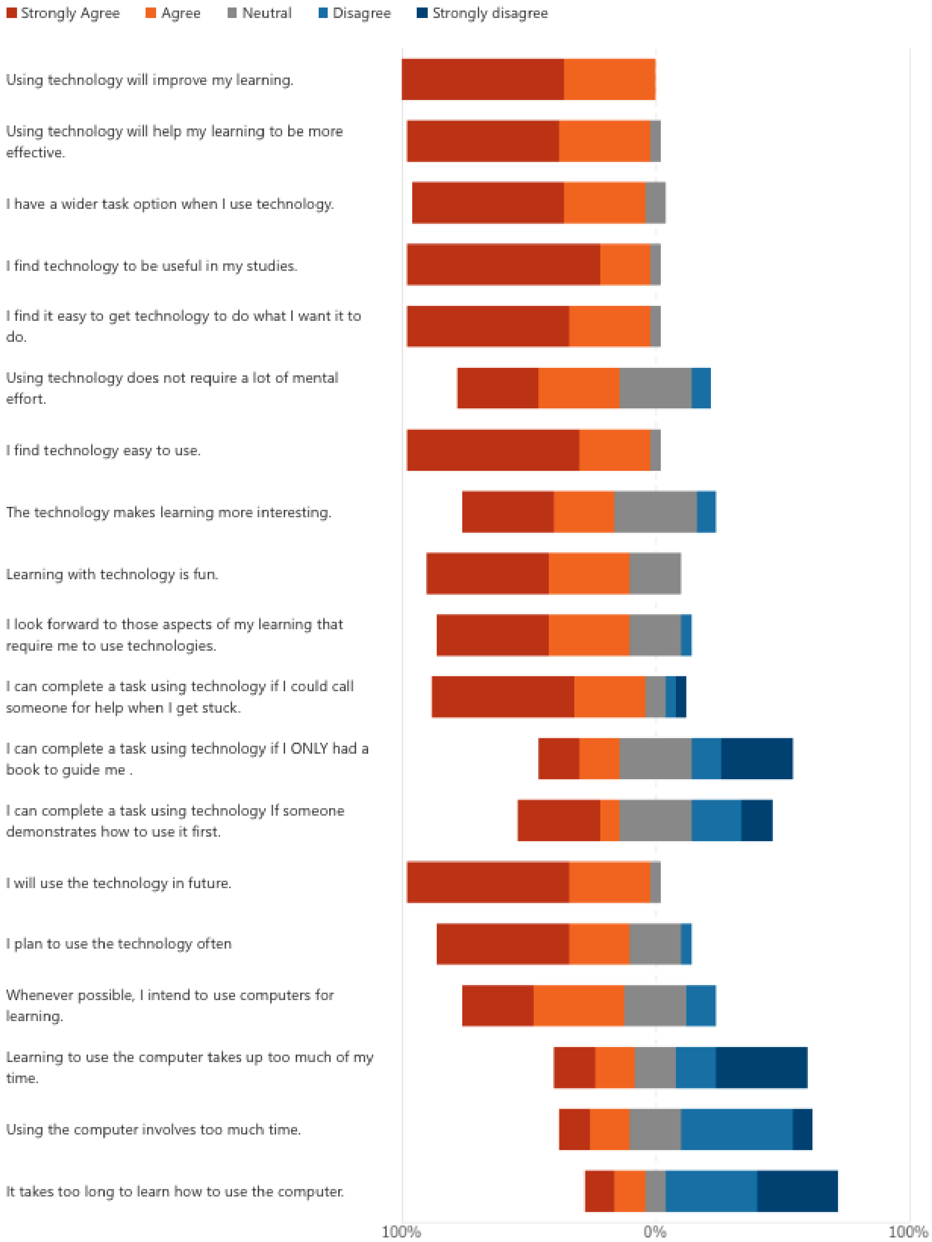
7.21 Appendix 7-21: TAM Survey (Teachers, *N*=11)



7.22 Appendix 7-22: TAM Survey (Students, *N*=25)



7.23 Appendix 7-23: Teachers' TAM Results

Teacher	PU				PEU			ATTIT			TSE			BI			TC		
	PU1	PU2	PU3	PU4	PEU1	PEU2	PEU3	ATTU1	ATTU2	ATTU3	TSE1	TSE2	TSE3	BI1	BI2	BI3	TC1	TC2	TC3
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2	5	5	5	5	4	2	4	5	4	4	2	4	2	4	4	5	4	4	4
3	5	5	5	5	4	5	5	5	5	5	5	5	4	2	2	2	5	5	5
4	5	5	5	5	5	5	5	5	5	5	2	2	2	5	5	5	5	5	5
5	5	5	5	5	5	2	2	5	5	5	2	4	1	5	5	5	4	4	4
6	1	1	4	2	1	1	1	2	2	1	2	2	2	1	1	2	1	1	1
7	4	4	4	4	4	2	2	4	4	2	2	3	2	4	3	2	3	4	4
8	5	4	3	5	4	2	4	4	4	3	2	2	2	5	5	4	5	4	5
9	4	4	3	5	4	4	4	3	3	3	2	4	2	5	5	4	4	4	4
10	5	5	5	5	5	2	5	5	5	5	2	4	2	5	5	5	4	4	4
11	5	5	4	5	4	3	4	3	2	3	4	2	2	5	5	5	4	5	5

7.24 Appendix 7-24: Students' TAM Results

Students	PU				PEU			ATTU			TSE			BI			TC		
	PU1	PU2	PU3	PU4	PEU1	PEU2	PEU3	ATTU1	ATTU2	ATTU3	TSE1	TSE2	TSE3	BI1	BI2	BI3	TC1	TC2	TC3
1	5	5	5	5	5	5	5	5	5	5	1	5	5	5	3	2	5	5	5
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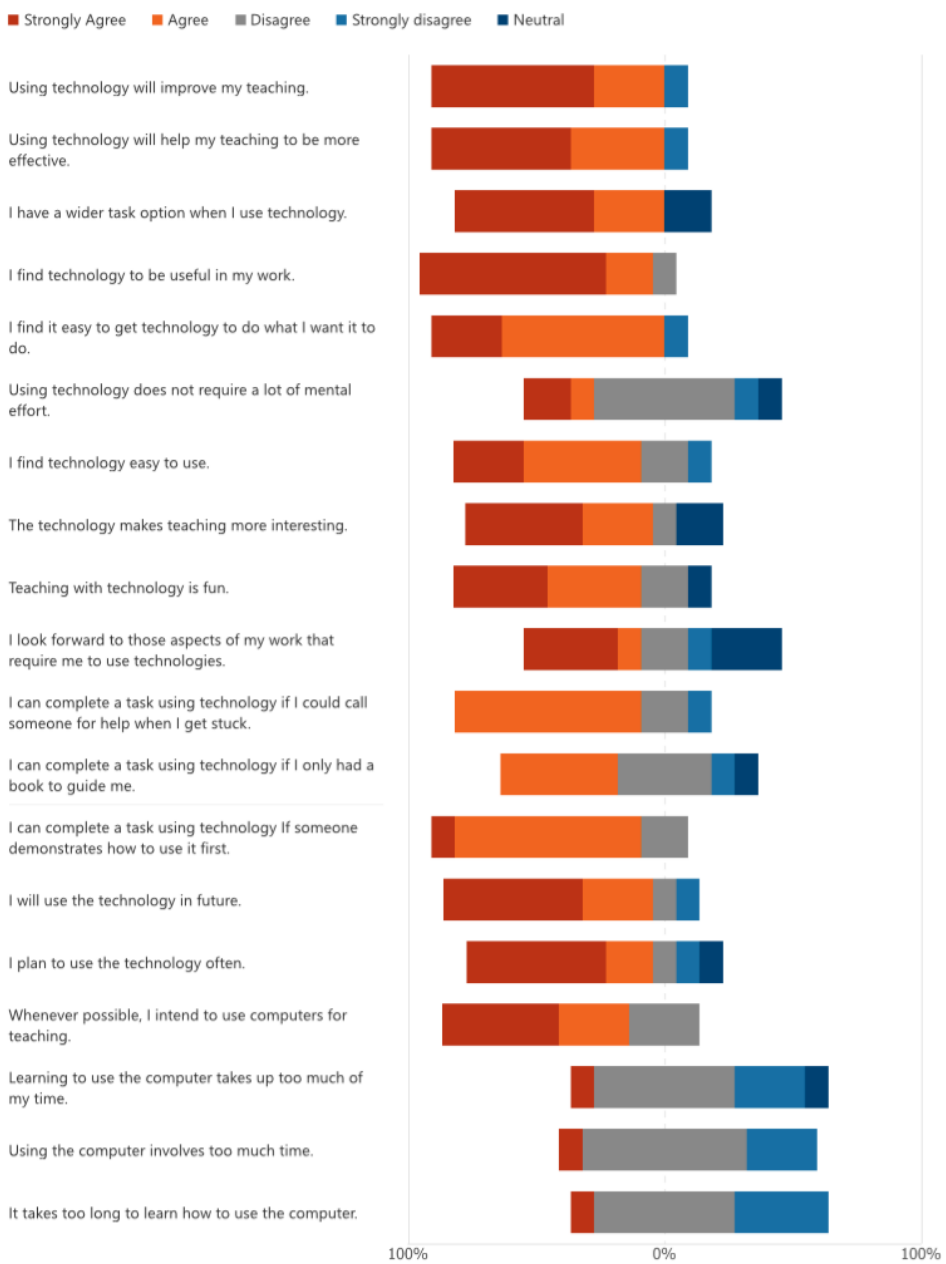
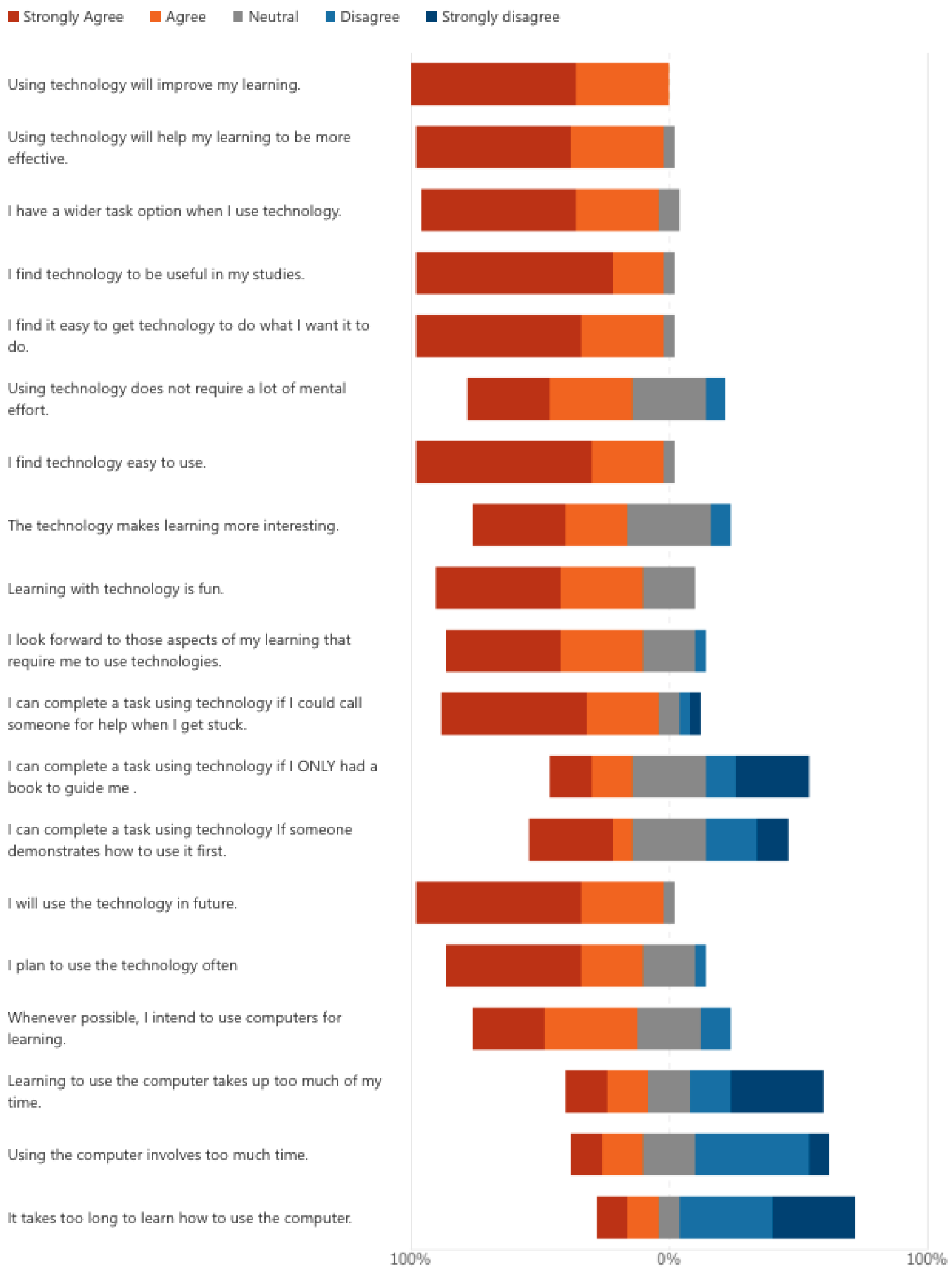
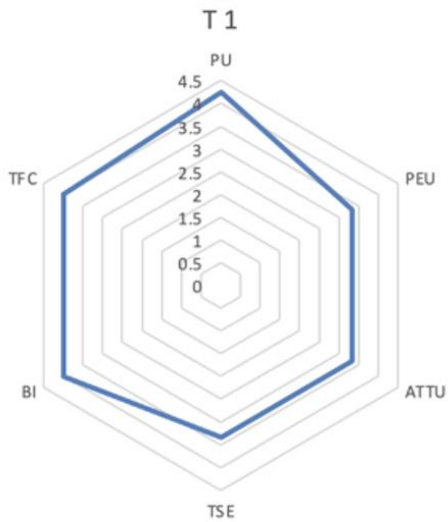
7.25 Appendix 7-25: TAM Survey (Teachers, *N*=11)

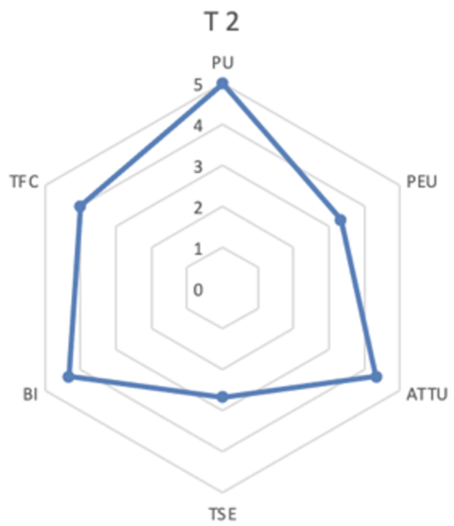


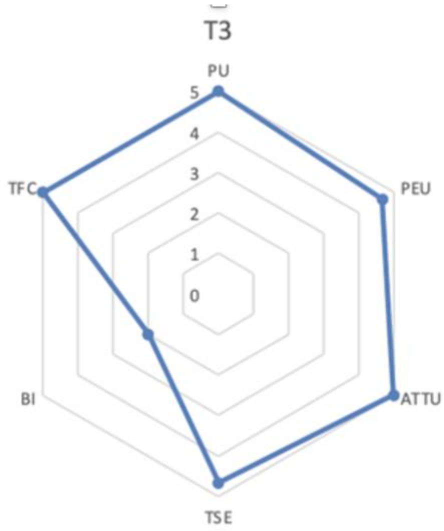
7.26 Appendix 7-26: TAM Survey (Students, *N*=25)

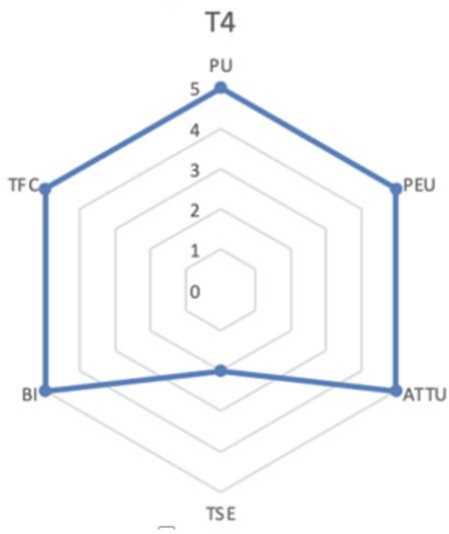


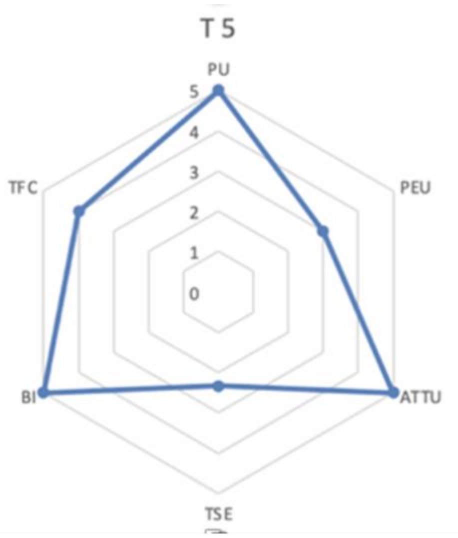
7.27 Appendix 7-27: Individual Teachers' Results Charts







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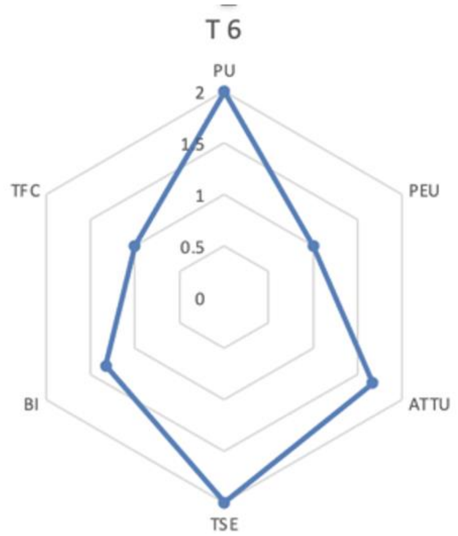
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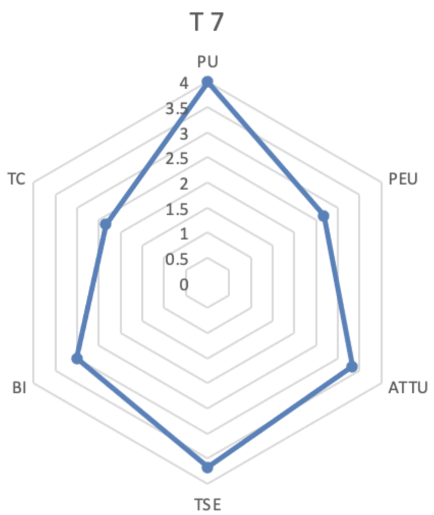
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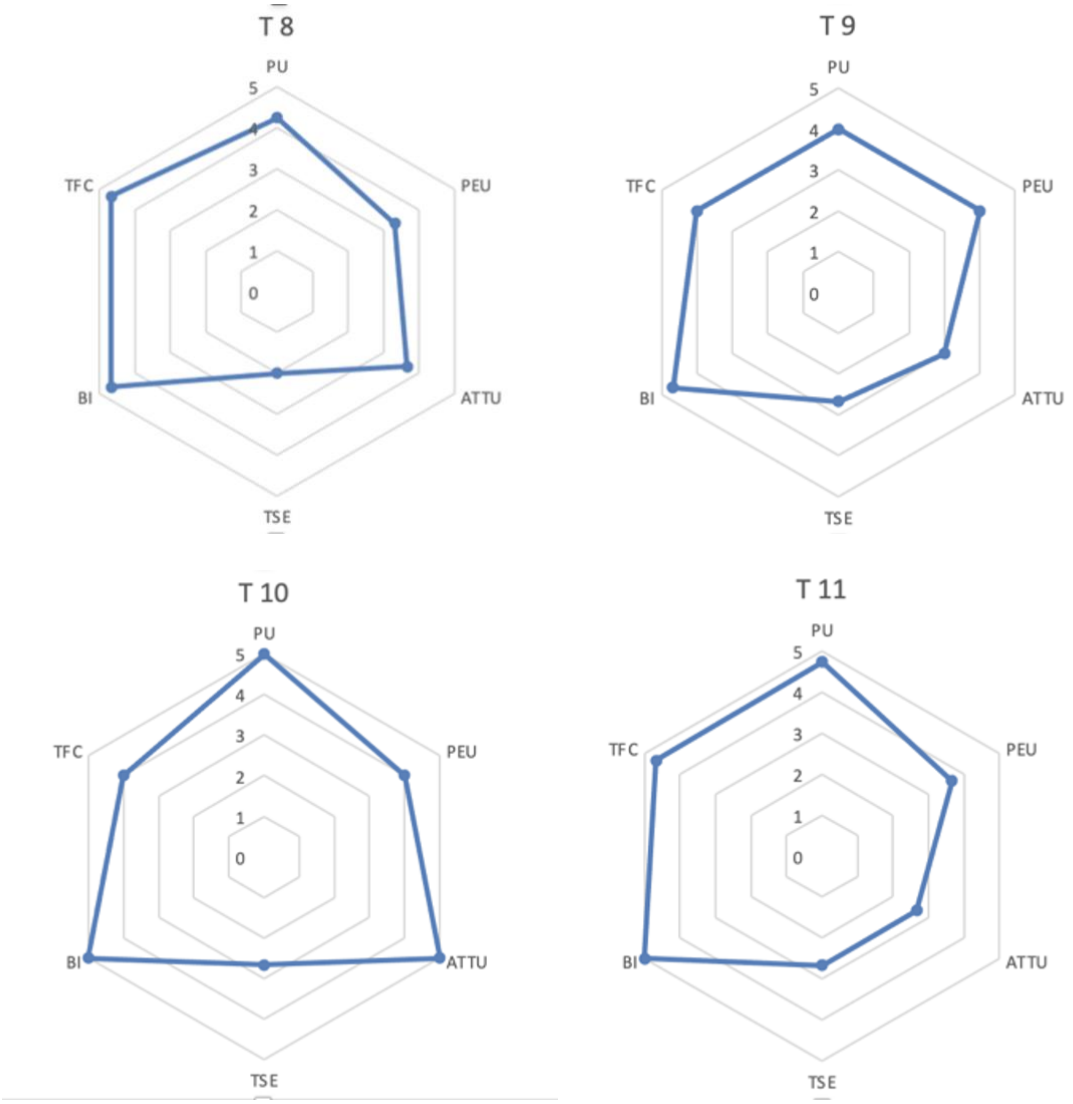
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T 9
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T 10
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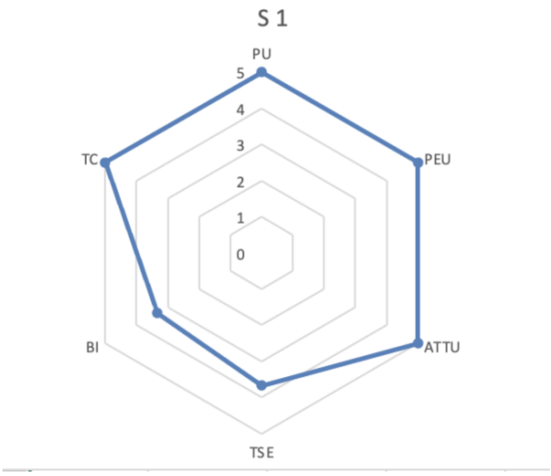
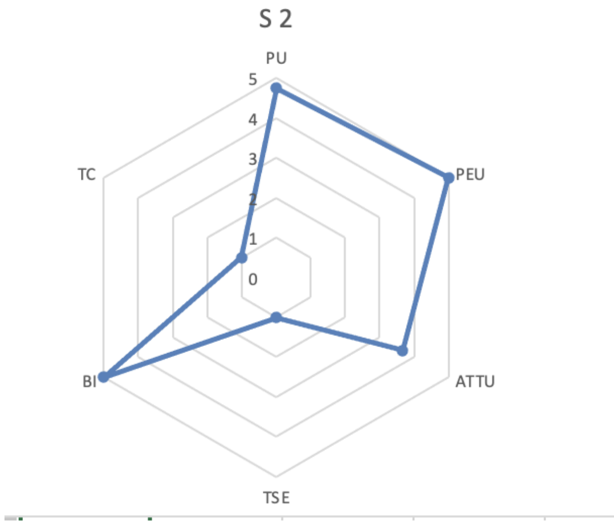
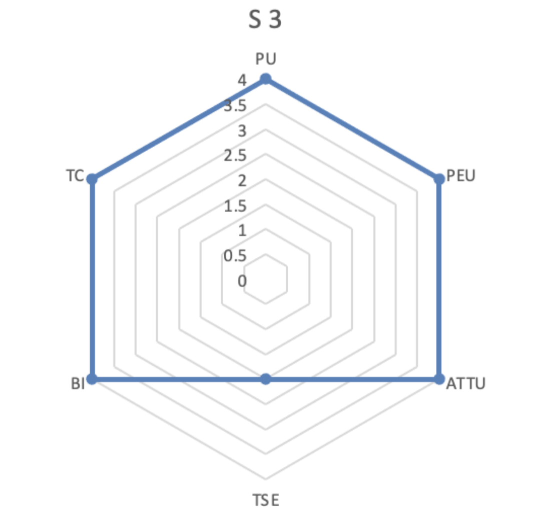
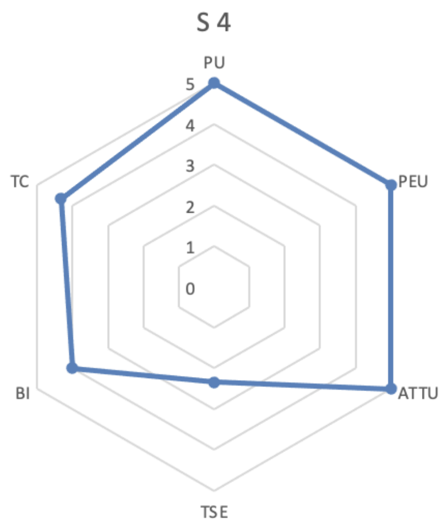
7.28 Appendix 7-28: Individual Students' TAM Results Chart





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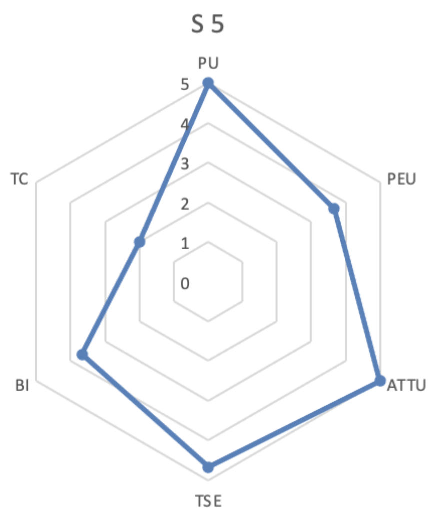
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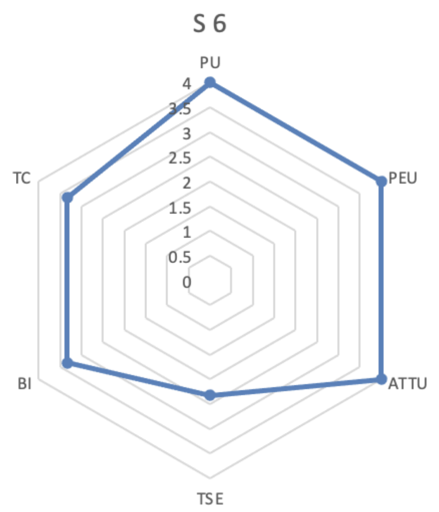
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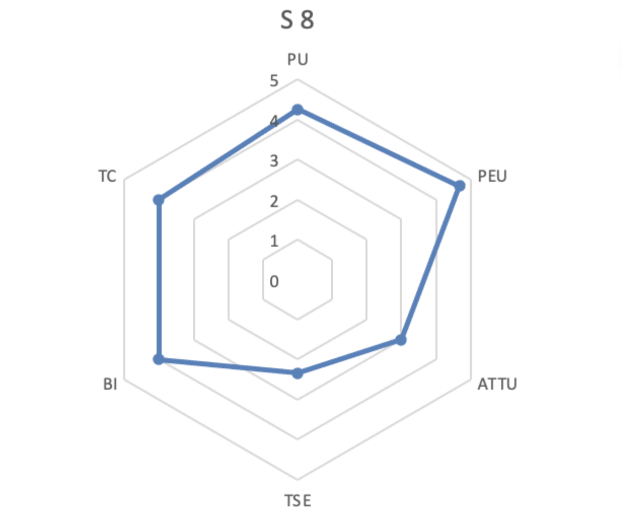
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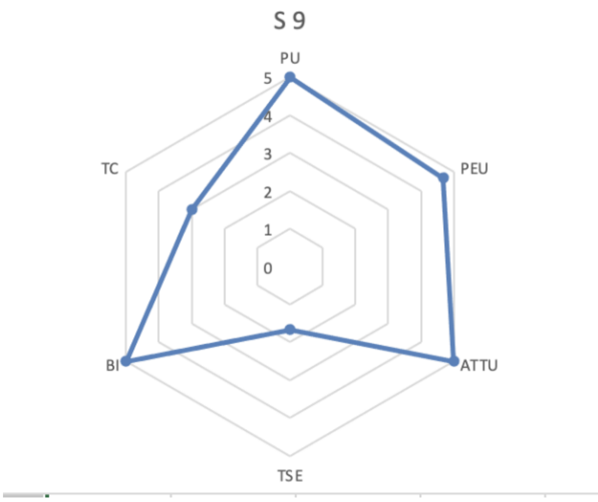
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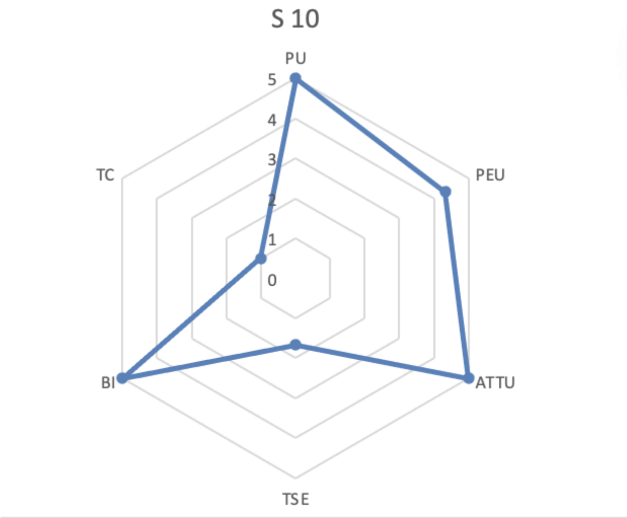
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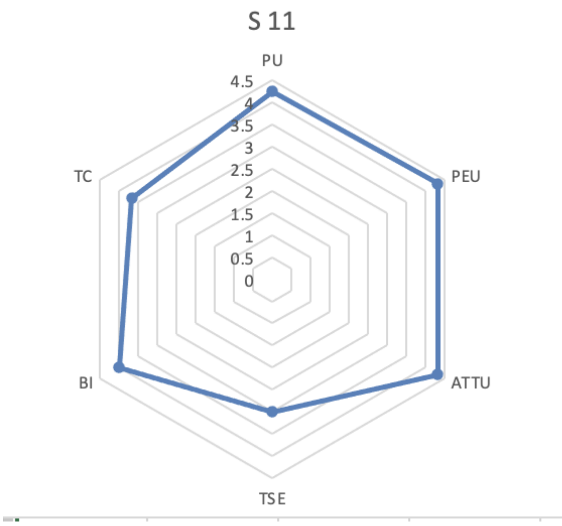
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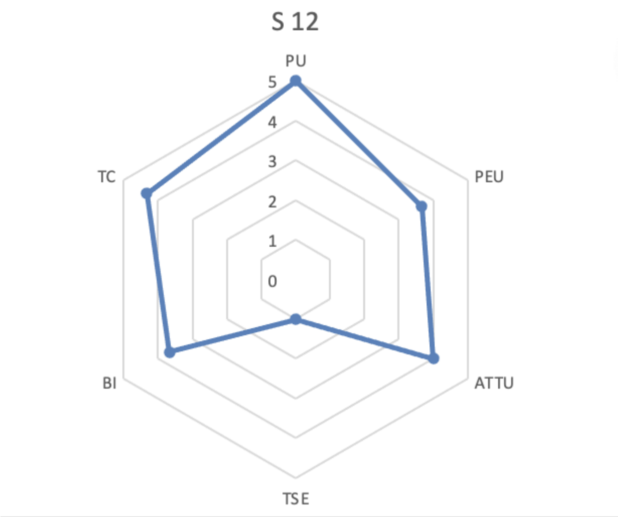
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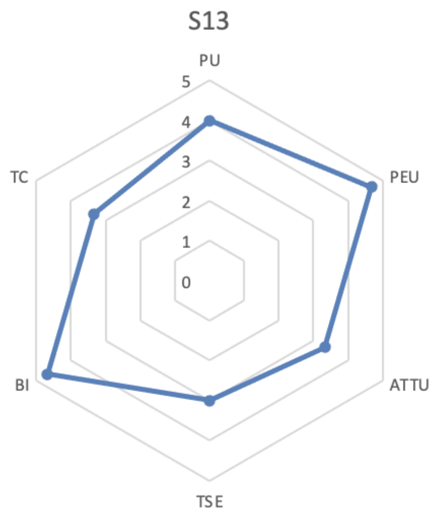
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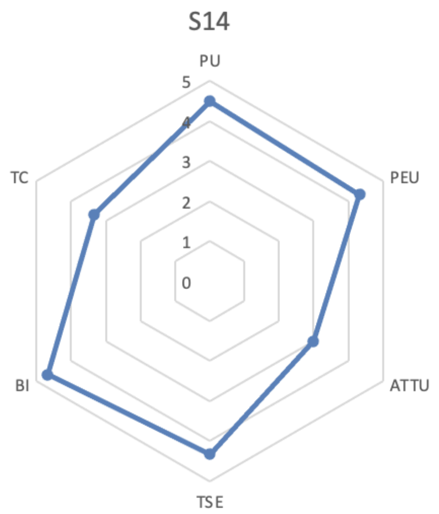
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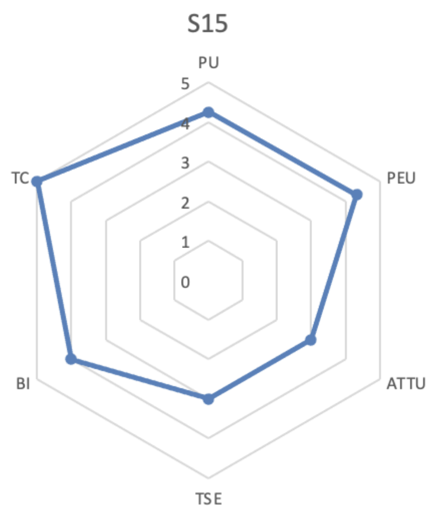
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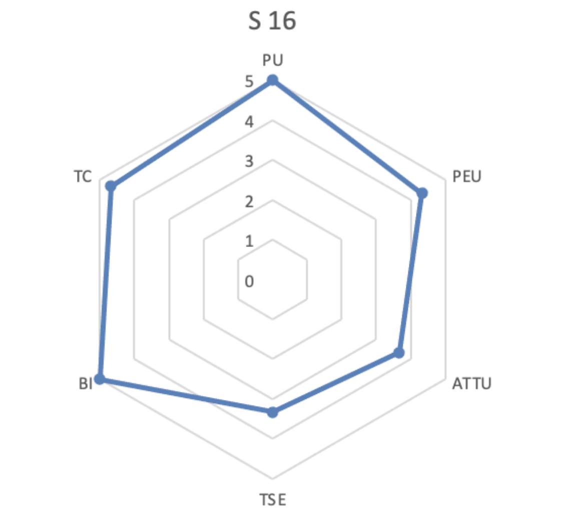
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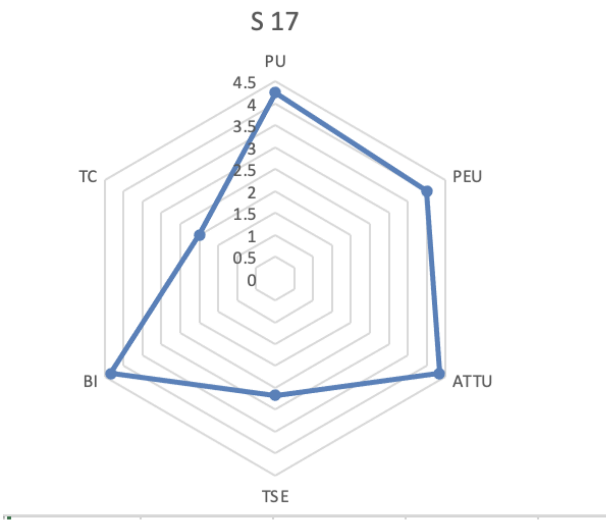
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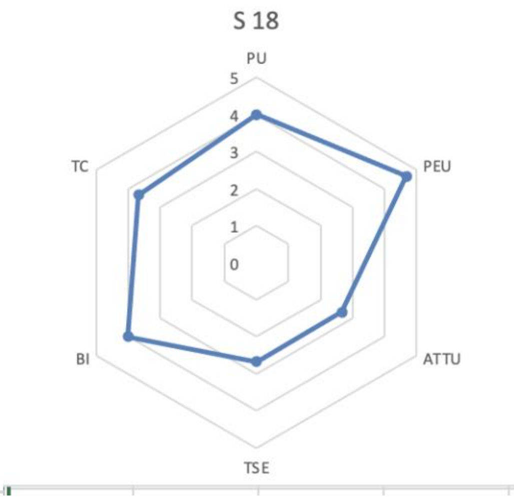
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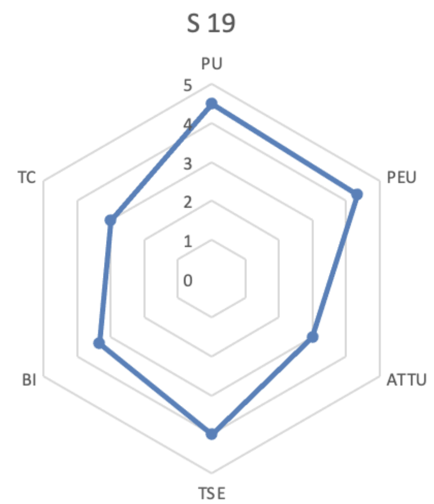
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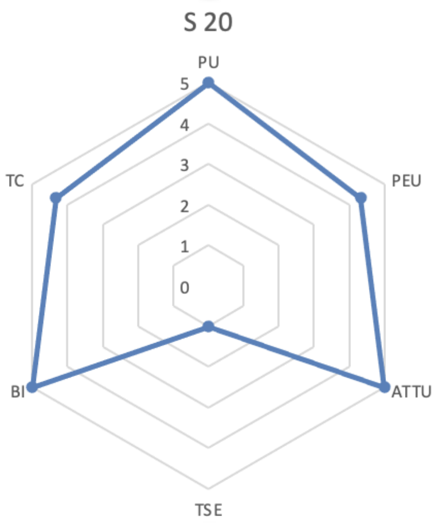
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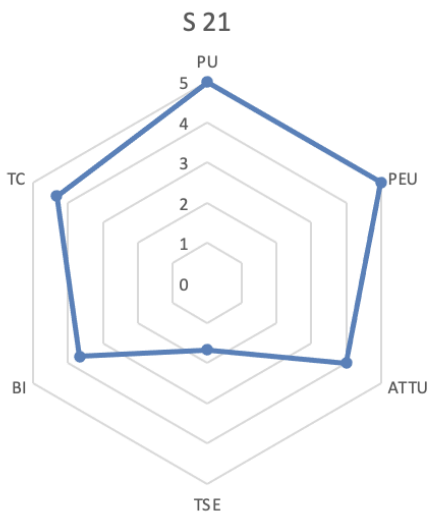
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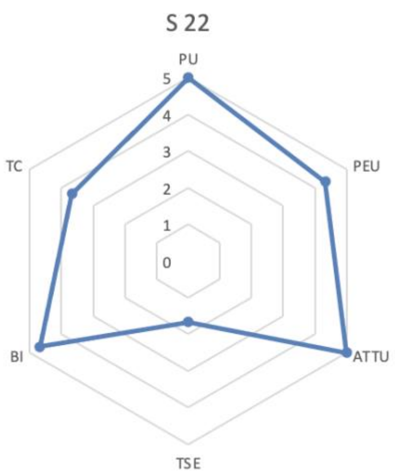
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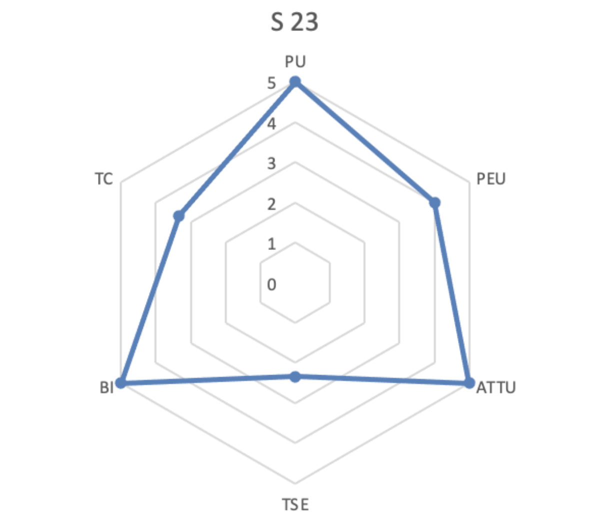
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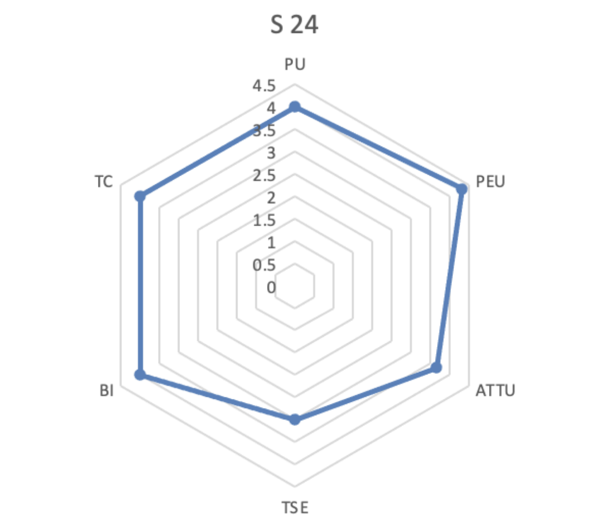
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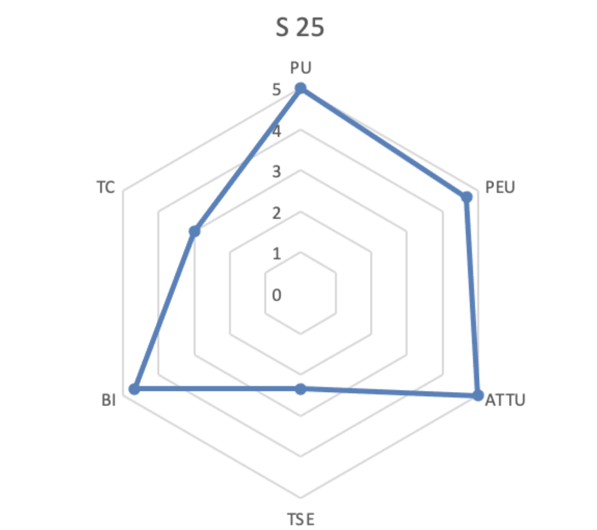
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7.29 Appendix 7-29: Independent-Samples Mann-Whitney U Test

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of PU is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.710[c]	Retain the null hypothesis.
2	The distribution of PEU is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.008[c]	Reject the null hypothesis.
3	The distribution of ATTU is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.542[c]	Retain the null hypothesis.
4	The distribution of TSF is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.435[c]	Retain the null hypothesis.
5	The distribution of BI is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.761[c]	Retain the null hypothesis.
6	The distribution of TFC is the same across categories of Group.	Independent-Samples Mann-Whitney U Test	.435[c]	Retain the null hypothesis.

a. The significance level is .050.
b. Asymptotic significance is displayed.
c. Exact significance is displayed for this test.

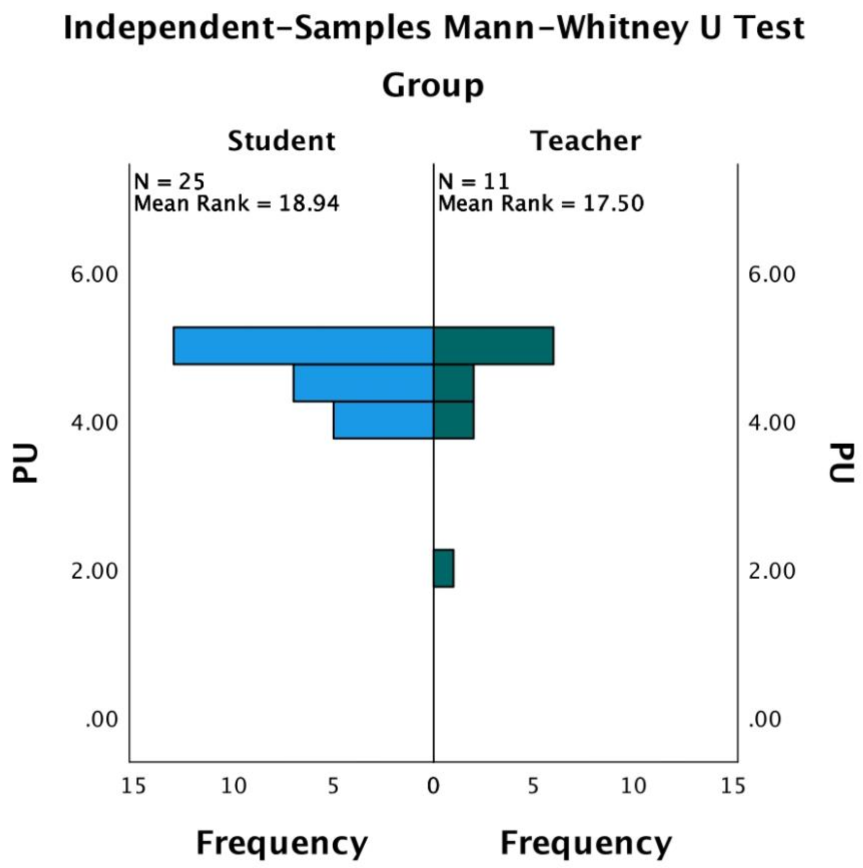
Independent-Samples Mann-Whitney U Test:

1- **PU across Group**

Independent-Samples Mann-Whitney U Test

Summary

Total N	36
Mann-Whitney U	126.500
Wilcoxon W	192.500
Test Statistic	126.500
Standard Error	27.357
Standardized Test Statistic	-.402
Asymptotic Sig.(2-sided test)	.688
Exact Sig.(2-sided test)	.710

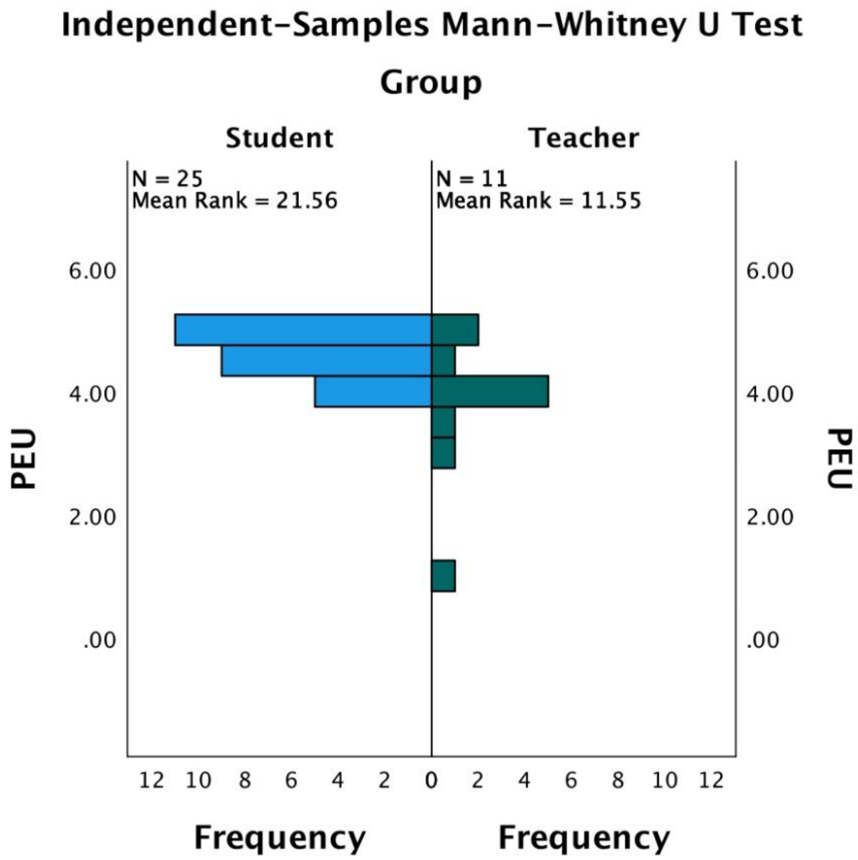


2- **PEU across Group**

Independent-Samples Mann-Whitney U Test Summary

Total N	36
Mann-Whitney U	61.000
Wilcoxon W	127.000
Test Statistic	61.000
Standard Error	27.788
Standardized Test Statistic	-2.753

Asymptotic Sig.(2-sided test)	.006
Exact Sig.(2-sided test)	.008

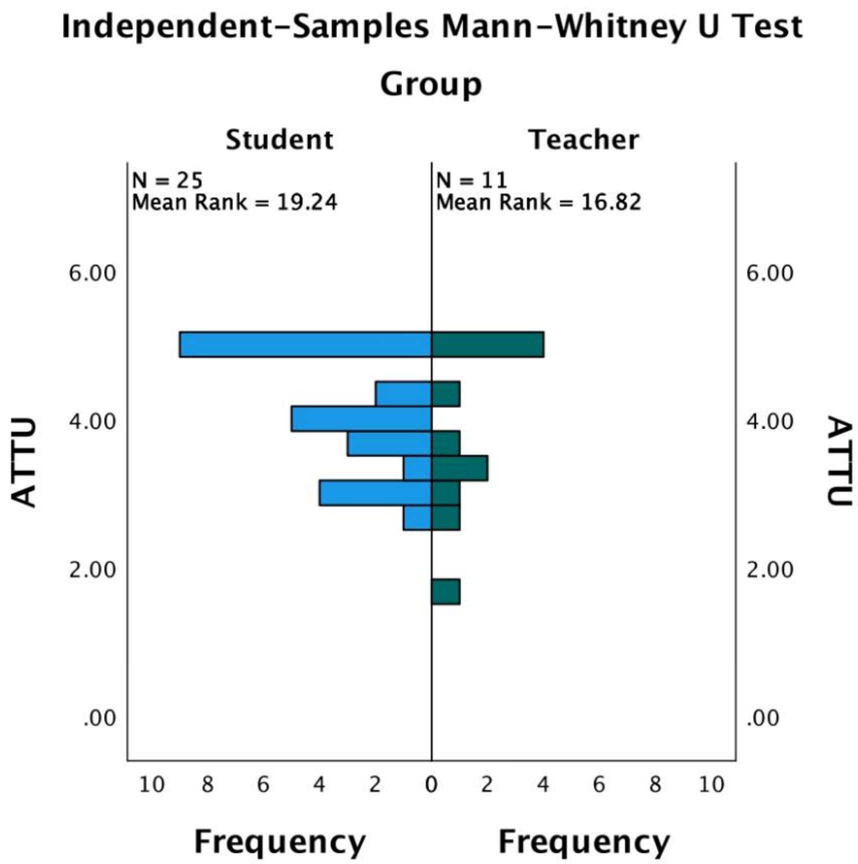


3- ATTU across Group

Independent-Samples Mann-Whitney U Test Summary

Total N	36
Mann-Whitney U	119.000
Wilcoxon W	185.000
Test Statistic	119.000

Standard Error	28.315
Standardized Test Statistic	-.653
Asymptotic Sig. (2-sided test)	.514
Exact Sig. (2-sided test)	.542

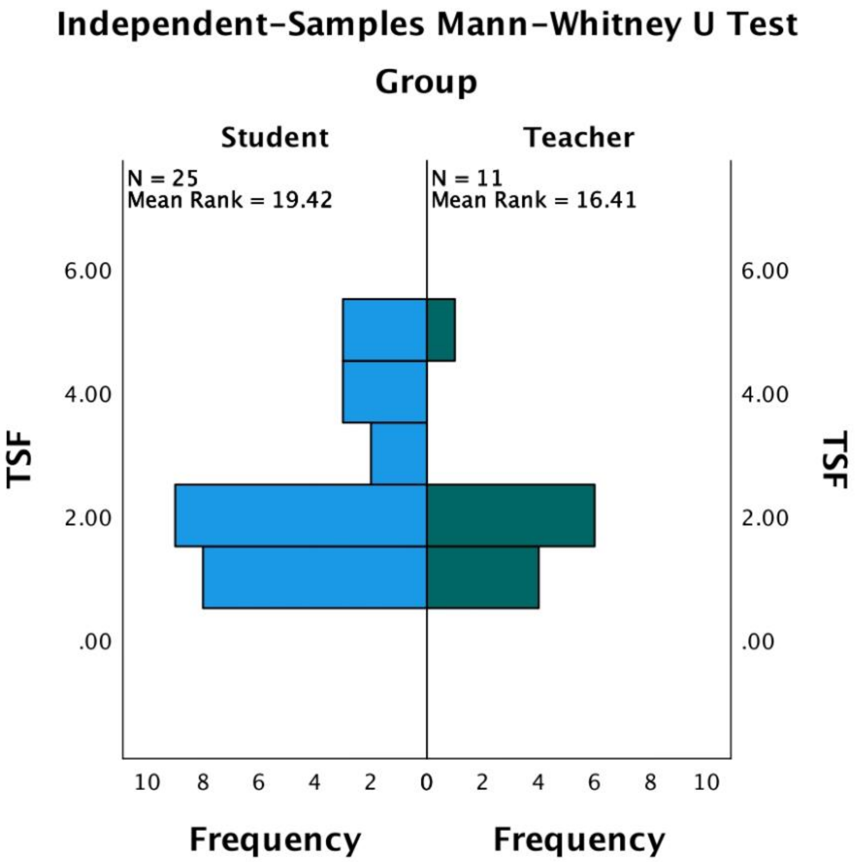


4- TSF across Group

Independent-Samples Mann-Whitney U Test Summary

Total N	36
Mann-Whitney U	114.500

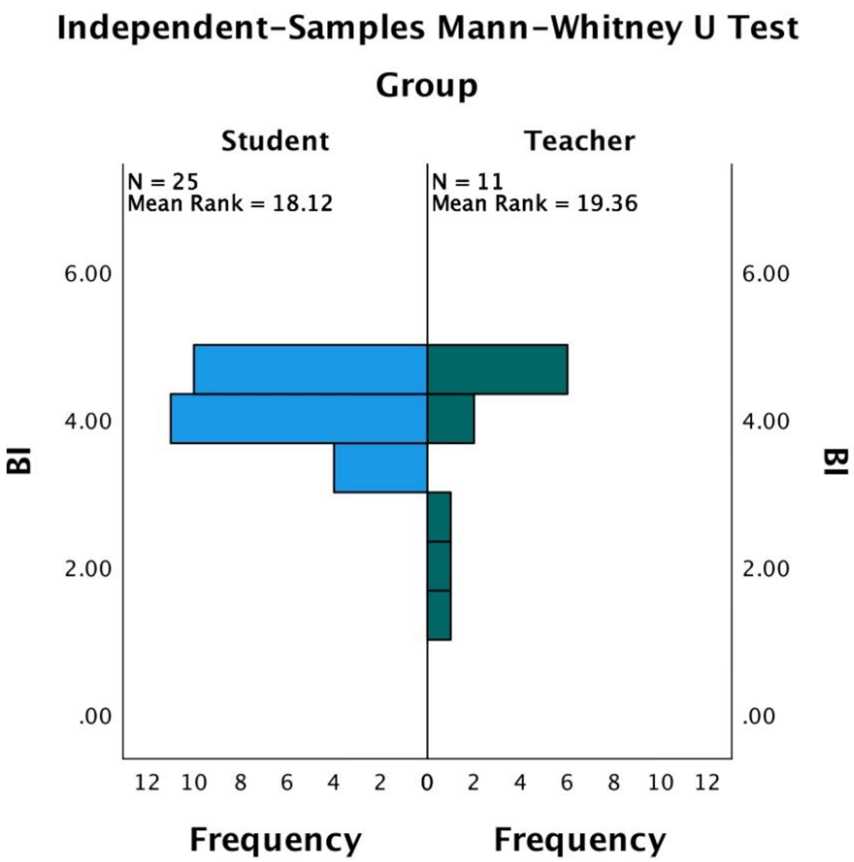
Wilcoxon W	180.500
Test Statistic	114.500
Standard Error	27.458
Standardized Test Statistic	-.838
Asymptotic Sig.(2-sided test)	.402
Exact Sig.(2-sided test)	.435



5- BI across Group

Independent-Samples Mann-Whitney U Test Summary

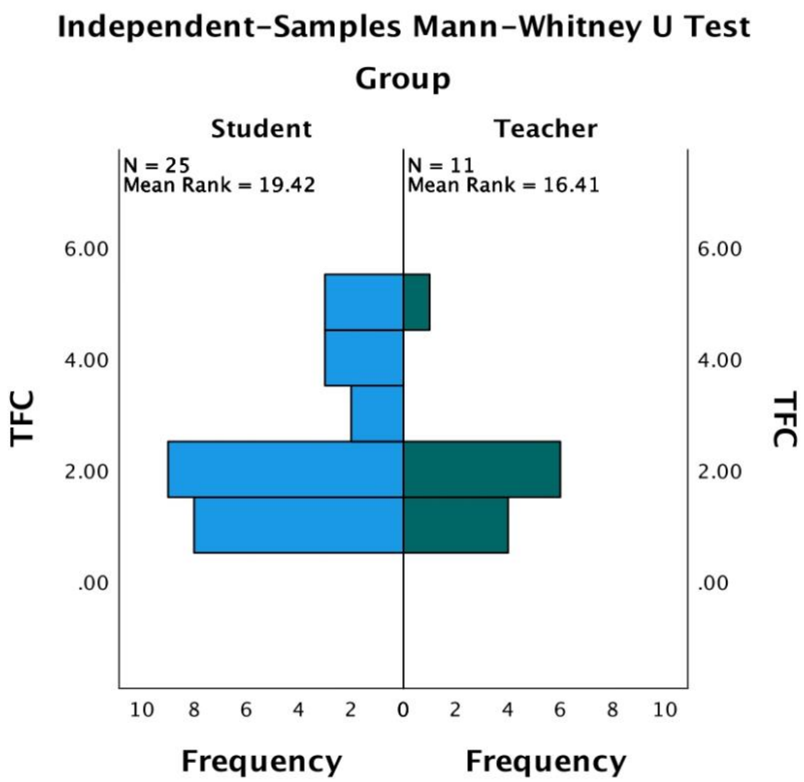
Total N	36
Mann-Whitney U	147.000
Wilcoxon W	213.000
Test Statistic	147.000
Standard Error	28.553
Standardized Test Statistic	.333
Asymptotic Sig.(2-sided test)	.739
Exact Sig.(2-sided test)	.761



6- TFC across Group

Independent-Samples Mann-Whitney U Test Summary

Total N	36
Mann-Whitney U	114.500
Wilcoxon W	180.500
Test Statistic	114.500
Standard Error	27.458
Standardized Test Statistic	-.838
Asymptotic Sig. (2-sided test)	.402
Exact Sig. (2-sided test)	.435



7.30 Appendix 7-30: Ethical Forms

UNIVERSITY OF EXETER

Ref (for office use only)

D1920-034

COLLEGE OF SOCIAL SCIENCES AND INTERNATIONAL STUDIES

All staff and students within SSIS should use this form; those in Egenis, the Institute for Arab and Islamic Studies, Law, Politics, the Strategy & Security Institute, and Sociology, Philosophy, Anthropology should return it to ssis-ethics@exeter.ac.uk. Staff and students in the Graduate School of Education should use ssis-gseethics@exeter.ac.uk.

Before completing this form please read the Guidance document which can be found at http://intranet.exeter.ac.uk/socialsciences/ethics/

Applicant details	
Name	Ahoud Alshaikh
Department	School of Education
UoE email address	[redacted]

Duration for which permission is required		
Please check the meeting dates and decision information online before completing this form; your start date should be at least one month after the Committee meeting date at which your application will be considered. You should request approval for the entire period of your research activity. Students should use the anticipated date of completion of their course as the end date of their work. Please note that retrospective ethical approval will never be given.		
Start date:06/01/2020	End date:17/07/2020	Date submitted:02/12/2019

Students only	
All students must discuss (face to face or via email) their research intentions with their supervisor/tutor prior to submitting an application for ethical approval. **Your application must be approved by your first or second supervisor (or dissertation supervisor/tutor) prior to submission and you MUST submit evidence of their approval with your application, e.g. a copy of an email stating their approval.**	
Student number	[redacted]
Programme of study	Doctor of Philosophy (PhD)
Name of Supervisor(s) or Dissertation Tutor	Dr Judith Kleine-Staarman Dr Taro Fujita
Have you attended any ethics training that is available to students?	Yes, I have taken part in ethics training at the University of Exeter EG the Research Integrity Ethics and Governance: http://as.exeter.ac.uk/rdp/postgraduateresearchers OR Ethics training received on master's courses.

UNIVERSITY OF EXETER

Ref (for office use only)

D1920-034

COLLEGE OF SOCIAL SCIENCES AND INTERNATIONAL STUDIES

All staff and students within SSIS should use this form; those in Egenis, the Institute for Arab and Islamic Studies, Law, Politics, the Strategy & Security Institute, and Sociology, Philosophy, Anthropology should return it to ssis-ethics@exeter.ac.uk. Staff and students in the Graduate School of Education should use ssis-gseethics@exeter.ac.uk.

Before completing this form please read the Guidance document which can be found at http://intranet.exeter.ac.uk/socialsciences/ethics/

Applicant details	
Name	Ahoud Alshaikh
Department	School of Education
UoE email address	aa807@exeter.ac.uk

Duration for which permission is required		
Please check the meeting dates and decision information online before completing this form; your start date should be at least one month after the Committee meeting date at which your application will be considered. You should request approval for the entire period of your research activity. Students should use the anticipated date of completion of their course as the end date of their work. Please note that retrospective ethical approval will never be given.		
Start date:06/01/2020	End date:17/07/2020	Date submitted:02/12/2019

Students only	
All students must discuss (face to face or via email) their research intentions with their supervisor/tutor prior to submitting an application for ethical approval. **Your application must be approved by your first or second supervisor (or dissertation supervisor/tutor) prior to submission and you MUST submit evidence of their approval with your application, e.g. a copy of an email stating their approval.**	
Student number	670050487
Programme of study	Doctor of Philosophy (PhD)
Name of Supervisor(s) or Dissertation Tutor	Dr Judith Kleine-Staarman Dr Taro Fujita
Have you attended any ethics training that is available to students?	Yes, I have taken part in ethics training at the University of Exeter EG the Research Integrity Ethics and Governance: http://as.exeter.ac.uk/rdp/postgraduateresearchers OR Ethics training received on master's courses.

7.31 Appendix 7-31: Ethical Approvals

UNIVERSITY OF EXETER

GRADUATE SCHOOL OF EDUCATION

St Luke's Campus
Heavitree Road
Exeter UK EX1 2LU

http://socialsciences.exeter.ac.uk/education/

CERTIFICATE OF ETHICAL APPROVAL

Title of Project:
Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK

Researcher(s) name: Ahoud Alshaikh

Supervisor(s): Dr Judith Kleine-Staarman
Dr Taro Fujita

This project has been approved for the period

From: 06/01/2020
To: 17/07/2020

Ethics Committee approval reference: D1920-034

Signature: Justin Dillon Date: 01/12/2019

(Professor Justin Dillon, Professor of Science and Environmental Education, Ethics Officer)

GRADUATE SCHOOL OF EDUCATION

St Luke's Campus
Heavitree Road
Exeter UK EX1 2LU

http://socialsciences.exeter.ac.uk/education/

CERTIFICATE OF ETHICAL APPROVAL

Title of Project:
Exploring the Role of Technology in Formative Assessment from Students' and Teachers' Perspectives: Case Study of an International Baccalaureate Secondary School in the UK

Researcher(s) name: Ahoud Alshaikh

Co-Investigators:

Supervisor(s): Judith Kleine-Staarman, Taro Fujita

This project has been approved for the period

From: 01/03/2021
To: 25/09/2021

Ethics Committee approval reference: D2021-116

Signature: Justin Dillon Date: 16/03/2021

(Professor Justin Dillon, Professor of Science and Environmental Education, Ethics Officer)

7.32 Appendix 7-32: Case School Study Approval

[redacted]

[redacted]

PRE DPIA SCREENING QUESTIONS

All new proposals for processing of data are required to undertake the screening process (see below) to establish whether a full DPIA is needed. GDPR Article 35(4) and (5)

PROJECT NAME: ***Exploring the Role of Technology in Formative Assessment: Case Study of a Secondary School in the UK***			**DATE: 21/01/2020**
DATA PROCESSOR: Ahoud Alshaikh			
DPIA Screening Questions	**Yes (x)**	**No (x)**	**Comments**
Will the project involve the collection of new information about individuals?		✓	It is about the views and perception of the use of technology in Formative assessment.
Will the project compel individuals to provide information about themselves?		✓	The only place their names are written is on the consent form
Will the information about individuals be disclosed to organisations or people who have not previously had routine access to the information?		✓	
Do you propose using information about individuals for a purpose it is not currently used for, or in a way it is not currently used?		✓	

Does the project involve you using new technology which might perceived as being privacy intrusive? For example, the use of biometrics or facial recognition.		✓	
Will the project result in you making decisions or taking action against individuals in ways which can have significant impact on them?		✓	
Is the information about individuals of a kind particularly likely to raise privacy concerns or expectations? E.g. health records, criminal records or other information that people would consider to be particularly private.		✓	
Will the project require you to contact individuals in a way which they find intrusive?		✓	
Will the project store information be using cloud technology?	✓		It will be stored in a private account and the data will be encrypted. No sensitive data will be stored in the cloud. Extra security measures will be applied.
Will the project store information transfer information outside the European Economic Area?		✓	

[redacted]

PRE DPIA SCREENING QUESTIONS

All new proposals for processing of data are required to undertake the screening process (see below) to establish whether a full DPIA is needed. GDPR Article 35(4) and (5)

THIS SECTION TO BE COMPLETED BY THE COMPLIANCE DEPARTMENT

- Risk of harm to data subjects or Academy

NONE ☐

LOW ☒

MEDIUM ☐

HIGH ☐

A HIGH risk is one where it is more likely than not that the processing will cause harm. In such circumstances, a robust Impact Assessment should be conducted in consultation with the Academy's Compliance Department and likely involving necessary consultation with (potential or actual) data subjects and other stakeholders: processing should cease until this is completed.

Comments:

Any Subject data collected will be anonymised and pseudonyms used instead.

Permission granted ☒ Permission not granted ☐

Reasons:

- Minimal to no risk for subjects involved.
- Compliance will conduct an assessment of the process involved at the start of it, and then a review carried out later on in the course of the research project. This may involve observing one of the sessions or reviewing contents of any records taken. If at any time there is risk of data leakage, authorisation will be withdrawn.

Signed: [redacted] by: Compliance Manager

Name:

COMPLIANCE DEPARTMENT [redacted]

7.33 Appendix 7.33: Candidate Vetting Checklist

[redacted]

[redacted]

CANDIDATE VETTING CHECKLIST

Item	Details	Date Verified
Name:	Ahoud Alshaikh	15 JAN 2020
Job Title	PhD Student	15 JAN 2020
Date of Birth	[redacted]	15 JAN 2020
Nationality(s)	[redacted]	15 JAN 2020
Evidence of Full Address	[redacted]	15 JAN 2020
Full CV	https://www.linkedin.com/in/ahoud-alshaikh-1a36459/	15 JAN 2020
Proof of ID	[redacted]	15 JAN 2020
Proof of Change of Name		15 JAN 2020
National Insurance Number	[redacted]	15 JAN 2020
Disqualification Declaration	N/A	15 JAN 2020
Right to Work in UK/Visa Expiry	N/A	15 JAN 2020
Satisfactory Reference A	[redacted]	15 JAN 2020
Qualification	MA, MSC	15 JAN 2020
Satisfactory Reference B	THE UNIVERSITY OF EXETER	15 JAN 2020
Clear DBS – Reference No:	[redacted]	15 JAN 2020
DBS Update Service	06-09-2020	15 JAN 2020
Overseas Police Clearance Body:	N/A	15 JAN 2020
Starting Date: Finishing Date:	2 MARCH 2020 29 MAY 2020	15 JAN 2020

Organization Name:

Name	Position	Date	Signature
AHOUD ALSHAIKH	PHD STUDENT UNIVERSITY OF EXETER	6 MARCH 2020	

References

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