How digital technologies have transformed 21st century pedagogy and learning

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**ABSTRACT:** *The education process of the 21st century has been heavily impacted upon by digital technology. This impact has culminated in the transformation of pedagogy and learning through the penetration of digital technology into the social, political and economic fabric of society. Learning is now more strategic with a greater emphasis on learner-centred learning and virtual collaboration, whereby the role of the teacher has changed to a facilitator of learning, rather than the fountain of knowledge.*

*This paradigmatic shift in approach responds to the need for life-long learning whereby, in a freelance economy, individuals will be expected to engage in working landscapes requiring a broad range of skill sets, including the soft skills. A freelance economy encourages individuals, through greater levels of autonomy, to collaborate and engage in enhanced decision-making and, as a result, be positioned to participate in the improvement of society through the use of flexible learning structures supported by digital technologies. This expectation, therefore, impacts educational institutions across sectors, requiring them to provide learners with the skills necessary to continue their learning journeys well beyond their formal education. In response to this pedagogical shift, this paper provides insights into the wide scope of digital technology use for 21st century learning to date. It provides three exemplars that encompass: 1) School curriculum implementation; 2) Enhancing languages education and*

1. *Use of Zoom for online collaboration. All three address the challenges faced in implementation, in addition to outlining the associated expectations, strategies and support mechanisms.*

**KEYWORDS: Freelance economy; digital literacy; digital technology; learner-centred pedagogy; life-long learning; 21st century learning.**

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* 1. **Introduction**

The education process of the 21st century has been heavily impacted upon by digital technology. This impact has culminated in the transformation of pedagogy and learning through the penetration of digital technology into the social, political and economic fabric of society. Learning has become more flexible due to its decentralization and personalization, which has resulted in changes to pedagogy and learning in light of the new social, political and economic demands placed on educators (Breen, 2018).

Learning is now more strategic with a greater emphasis on learner-centred learning and virtual collaboration, whereby the role of the teacher has changed to a facilitator of knowledge, and not as the fountain of knowledge. This strategic development has impacted both learning and

pedagogy by making them more autonomous, requiring enhanced communication and technological skills, and a greater emphasis on data driven outcomes.

Education’s focus in the 21st century relates to life-long learning whereby, in a freelance economy, individuals will be expected to engage in working landscapes requiring a broad range of skill sets and not simply a specific set of skills. This freelance economy will encourage individuals, through greater levels of autonomy, to engage in enhanced decision making and, as a result, be positioned to participate in the improvement of society through the use of flexible learning structures. Whereby, these flexible learning structures will be developed within a pedagogical framework centring on life- long learning through self-regulation (Muianga,

2019). The expectations of a freelance economy, on educational institutions, will be to provide learners with the skills necessary to continue their learning journeys well beyond their formal education.

This paper provides three exemplars as to how digital technology has impacted on 21st century pedagogy and learning. These exemplars encompass 1) School curriculum implementation;

2) Enhancing language education and 3) Use of Zoom for online collaboration. All three address the challenges faced in implementation, in addition to outlining the expectations, strategies, and support mechanisms associated with each.

* 1. **Overview of the history and context of digital technologies in education**

“Our world”, Slaughter (2009, p. 16) acknowledged, “has become the electronic world”. As a result, learners’ social lives are seen as being driven by technology which in turn promotes learners’ engagement and stimulates their appreciation of lifelong learners. Slaughter also emphasises, as a result, teachers have a responsibility to provide new levels of pedagogy and learning that are relevant, effective, and socially engaging of learners.

Cuban (1986) highlighted that by the early 20th century, education had become a priority for many countries. This priority was based on the link between a country’s economic growth and stability and the commensurate level of education of its citizens. Consequently, governments, Cuban further highlighted, began taking a greater interest in public education culminating in a rapid increase of learners in secondary schools. In addition, as a result of the uptake of digital communication technologies in developing countries GDP is known to increase (Wetmore, 2017).

At the same time ideas relating to the mass production of resources, reflected by the industrial revolution, also began having an impact on education. Pedagogical and learning approaches started to mirror the assembly line approach to the production of goods, and ways in which large numbers of learners could be taught effectively were highly desired. This focus encouraged the

use of early digital technological tools in schools, for example, film, radio and television. Moreover, Selwyn (2011) argued, it was believed that the use of these types of digital technologies could provide learners with everything they needed to know, which Goodman (1995) highlighted, matched the prevailing view of learning as information transmission that learners were simply empty vessels devoid of knowledge. Within this educational landscape pedagogy and learning practices were teacher-centred/directed, where curriculum design and lessons were more prescriptive. Teaching and learning materials typically addressed the cohort as a whole with less opportunity for individualised learning. Similarly, resources to support learning linked to testing goals. But as the pedagogical change was fostered through the influence of social constructivism, along with the early impact of computers and Internet accessibility, digital technologies are now at the forefront and have acquired a permanent place in education, and continue to drive the transformation of pedagogy and learning, and learner autonomy.

Digital technologies, when focusing on an educational landscape, are defined by, for example, Victorian State Education and Training, Australia (2019), as electronic tools, systems, devices and resources that generate, store or process data. Like most developed countries Australia’s digital journey began in the late 1980s when schools could afford to purchase desktop computers for learners to use as a stand-alone digital tool. This development quickly expanded into the operation of the computer-lab were banks of computers were placed to provided learners with daily and ready access to digital technology. This use of digital technologies provided learners with enhanced levels of individualization through new ways of engaging in learning (Jonassen, 1991). For example, learners and their teachers had access to software, games and computer-tutors all designed to facilitate learning, via the use of digital technologies. This focus on digital technology stemmed from, as Jonassen outlined, theories of cognitivism and constructivism that had been introduced in the early 20th century. These theories, Papert (1980)

acknowledged, aligned with a learner-centred view of learning, which emphasized learning activities focusing on learners’ constructing and investigating knowledge.

For example, as Selwyn (2011) outlined, computer-tutors would assist learners in constructing and investigating knowledge by delivering skills to facilitate creative thinking and problem-solving. Therefore, the prevailing view, as Suppes (1966) expressed, was that computer-based instruction would provide learners with an education that was more flexible and individualized. However, the flexibility and individualization of learning, facilitated by digital technology, had its greatest impact in the 1990s through the advent of the Internet and the development of social networking communities. Sandholtz (1997) outlined, in the 1990s, there was a widely held belief that in order to take full advantage of computers it was necessary for teachers to focus on a learner-centred pedagogy. Using Muianga’s (2019) research as a guide, computers were represented as agents of change from a teacher-centred pedagogy to one emphasising learner-centred pedagogies. Consequently, through a focus on learner-centred pedagogies learners would be supported by digital technology to focus on skills which would, for example, facilitate their own learning (Muianga, 2019). Fadel (2008) highlighted that this way of learning was viewed by many as aligning with the idea that future work would require enhanced levels of autonomy and collaboration. Therefore, as articulated by Schhiro (2013), learner-centred pedagogy and learning stresses the needs and

interests of the learner.

As the use of educational technology grew via the capacity of learners to use their computers to connect with local networks through the Internet a shift in focus occurred towards learner-centred learning. This marked a third age of the impact of technology on pedagogy and learning. Most schools by the end of the 1990s had access to the Internet in some form. The teaching and learning platforms initially developed during this time period provided only static stations thus, learners were not positioned to engage with the digital technology beyond programmed materials.

However, with the coming of the Internet learners began to be able to access information from websites that allowed them to view knowledge from a plethora of sources. This capacity to access a limitless range of information, Dillon and Gabbard (1998) argued, was heralded as a major advancement in pedagogy and learning.

By the early 2000s, the Internet had developed into a dynamic resource allowing learners to engage in direct contact with others (both speaking and writing), and influence that contact, through, for example, authorizing content, language translators and Zoom meetings. These advancements in digital technologies have transformed pedagogy and learning through connecting learners with a world beyond their classrooms, via sophisticated communication involving the sharing, curating and creation of knowledge.

Juxtaposed to the introduction of digital technology into schools in the early 21st century was also the rapid technological advancement of computer technology and the focus on a knowledge society. The development and availability of newer and more powerful processing systems, Voogt and Knezek (2008) explained, resulted in new and faster ways of connecting and therefore, communicating. As a result, these advancements placed pressure on schools and teachers to follow suit and to find ways in which to integrate technology into their pedagogy and learning. Digital technology skills became highly valued within society and the flow-on impact was, for example in Australia, the national curriculum positioned information and communication technologies alongside literacy and numeracy accoding to Australian Curriculum, Information and Communication Technology, retrieved on 19th December 2020 from [https://www.australiancurriculum.edu.au/f-](http://www.australiancurriculum.edu.au/f-) 10-curriculum/general-capabilities/information- and-communication-technology-ict-capability/ .

One of the key drivers to these advancements outlined above has been an increased capacity of the learner to undertake social networking on a global scale. It is this capacity for learners to social network, the Australian Institute for Teaching and School Leadership Limited (2020)

highlighted, that has had one of greatest impacts on pedagogy and learning, for example, through the introduction of project-based, problem-based and collaborative-based learning. Therefore, these models of teaching (Joyce, Weil, & Calhoun, 2009) are the next focus points of this paper.

The Buck Institute for Education (2003)

defined *project-based learning* (PBL) as:

*a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks (p.4).*

Newell (2003) suggested that PBL enabled learners to engage in a wide range of skills that focused on areas such as research, communication and organization. McGrath (2003) added that learners who engaged in a PBL environment developed excellent social skills and as a result, become highly engaging. Further research by Chen and McGrath (2003) and Chen and Chen (2007) also found that learners become more empowered through their capacity to design knowledge through an ability to re-evaluate their own beliefs as learners.

Schuetz (2020) highlighted that instead of pedagogies and learning focusing on short-term memorization strategies, project-based learning provided, an opportunity for learners to engage deeply with the target content, bringing about a focus on long-term retention. Similarly, Lathram, Lenz and Van Ark (2016) suggested that in the freelance economy of the 21st century, workers engage in a series of projects rather than serve a specific organization. They believe that the flow- on effect, with respect to technology in education, would culminate in learners being required to learn about, and engage in, solving real-world issues. This emphasis on real-world problem- solving would be expected to be reflected in connecting learners to real-world issues instead of teacher-based questions developed from a non-authentic curriculum.

A focus on real-world issues would transform the pedagogical and learning landscape by fostering a shift from the traditional teacher- centred approach a more learner-centred

approach. In a teacher-centred approach to learning learners are expected to listen to teachers and undertake readings that would be later assessed to recall and reproduce what had previously been ‘learned’ about a topic. In contrast, in a real-world problem-solving learning experience, the learner is expected to undertake an interactive learning experience that reflects a greater degree of autonomy and requires the subsequent skill sets associated with an enhanced level of ownership. Thus, it can be appreciated that this approach to students’ education would invoke change to traditional pedagogy and learning, which can be facilitated by digital technologies. Such transformation would be attributed to the learner’s capacity to move beyond the static classroom environment to a global and virtual space through the use of digital technologies. Similarly, the next section of explores the relevance of problem-based learning to this pedagogical transformation.

The genesis of *problem-based learning* (PrBL) can be traced back to the work of Dewey (1938). He believed that for teachers to engage learners in learning they needed to appeal to a learner’s natural instincts to investigate and create. Through PrBL, Kurt (2020) argued, the role of the teacher shifted from a traditional linear model to one that reflected a sequential pattern. This shift was seen as having a subsequent impact on traditional pedagogy and learning through the introduction of digital technologies, again through their ability to support learner autonomy. Cornell University’s Centre for Teaching Innovation (2020) defines problem-based

learning (PrBL) as:

*a student-centred approach in which students learn about a subject by working in groups to solve an open-ended problem. This problem is what drives the motivation and the learning (p.1).* Barrows (1986) and Savery and Duffy (1995) highlighted that PrBL is a pedagogical and curriculum design methodology often used in higher education and K-12 environments. PrBL focuses on the teacher not simply providing learners with memorized facts, rather it facilitates learners to apply new knowledge to new situations. Learners, within a PrBL environment, encounter

contextualized and structured problems that required their investigation, and discovery of, appropriate solutions.

The teacher’s role, Kurt (2020) points out, becomes that of a facilitator whereby, material is presented to inform the learner as to what needs to be achieved by providing knowledge to be applied to a given problem. Kurt also added, within this learning environment assignments may vary in length from relatively short to entire semester, with an emphasis on daily and timely facilitated group work. It through PrBL that learners strengthen their team work, communication and research skills in addition to honing their critical and problem-solving skills, all skills that Kurt acknowledged, as essential to life-long learning.

The introduction of problem-based learning changes the focus of learning from the teacher to the learner. This change is reflected in the teacher facilitating the learner’s ability to problem solve, and as such, the assessment processes are not necessarily based on the recall of knowledge but the learning that has occurred through the problem-solving process. It was this movement towards assessing the learning process, and not simply the recall of knowledge, that transformed pedagogy and learning with the assistance of digital technology, for example in researching, interacting with peers and resources, producing, and presenting. The next section takes this model of teaching one step further in exploring a focus on collaborative learning, which is also interactive and which digital communicative technologies can foster worldwide and 24/7.

Laal and Ghodsi (2012) highlight that:

*Collaborative learning is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product (p.1).*

Collaborative learning, according to Gokhale (1995), encouraged a pedagogical philosophy based on the grouping or pairing of learners for the purpose of achieving a learning goal. Gokhale emphasises, learners are responsible for one another’s learning in addition to their own, and as a consequence, the success of learner is

dependent upon the help of their peers. Panitz (1996) argued, as a result of this philosophy the underlying premise of collaborative learning is reliant on consensus, in contrast to the potential competition of students in a whole class teaching group. Therefore, as Dillenbourg (1999) highlighted, collaborative learning is about learners sharing responsibility and engaging in collective decision making so that they learn together.

Collaborative learning builds on the social constructivist perspective on learning as espoused by Vygotsky (1978). Vygotsky’s work highlighted the significance of others involved in the learning process. Vygotsky outlined that learning originated through social interaction through the use of scaffolding within the Zone of Proximal Development. Wood, Bruner and Ross (1976) argued that scaffolding occurred within social interaction by learners creating conditions to support the learning of the less competent learners (Habibi & Dashwood, 2020).

Collaborative learning, Domingo (2008) argued, requires team-work with learners provided with defined roles to ensure the success of the group. Lizzio and Wilson (2006) also noted that for collaborative learning to be effective it needed to include team building activities, an emphasis on the value learners place on attaining a goal, so learners develop the ability to become autonomous (Knight & York, 2003). It was this focus on creating autonomous learners where digital technologies transformed the pedagogy and learning of the 21st century. This transformation occurred, as in the case of project- based and problem-based learning, through a movement away from the traditional teacher- centred model to a learner-centred model. By emphasising a learner-centred model, education has undertaken a paradigm shift whereby, the learner needs to be more heavily involved in the learning process and not simply the outcome of that process (Richardson, Dang, Nguyen, & Nguyen, 2020).

Project-based, problem-based and collaborative-based learning are examples of teaching models (Joyce, Weil, & Calhoun, 2009) that highlight where digital technologies

are facilitate 21st pedagogy and learning. This impact is reflected, as Schhiro (2013) argued, with a shift in focus away from a teacher-centred pedagogy to one espousing a learner-centred pedagogy that stresses the needs and interests of the learner. Where learners are connected to a world beyond their classrooms, via sophisticated communication involving the sharing, curating and creation of knowledge. With this in mind, the next section provides three exemplars that reflect the application of digital technologies within a 21st century pedagogical and learning environment, in keeping with the facilitation of communicative interactions that under pin project-based, problem-based and collaborative- based learning.

* 1. **Challenges faced: three exemplars**

In these section three exemplars are provided and discussed in relation to current research, curriculum and pedagogical application of digital technologies in practice. The first, provides insights into the Australian National Curriculum requirements by examining their interpretation at a state level and then how they may translate into students’ learning experiences in classrooms. The second looks at the application of digital technologies in terms of their ability to improve languages learning (whether EFL or other added languages), which has been a challenge for decades, in spite of continued improvements in pedagogical methods and approaches. Then the final exemplar reports on recent research that shows how digital technologies are able to foster collaborative approaches to learning online and remotely. This exemplar is applied to the higher education context where digital technologies can enable laboratory work to be carried out remotely rather than in a physical space.

* + 1. **Exemplar One - School curriculum implementation** The Australian Curriculum and Reporting Authority (ACARA, 2020) develops curriculum materials at the national level, which are then applied at the state level for implementation in

schools. ACARA (2020) advises:

Learning in Digital Technologies requires students to listen to, read, understand and be

able to use and evaluate a range of increasingly challenging informational texts. Students need to integrate and evaluate content presented in diverse media and formats, understand how to use a range of reading cues such as chapter headings and follow complex procedural and explanatory texts. Students need to be able to recognise and appropriately use technical symbols, icons and key terms which have more generic use as well as those that align with technical topics. Students will create clear and coherent informative, explanatory and persuasive texts using precise vocabulary and a range of visual and diagrammatic elements. Their texts will be developed and organised using a format and style appropriate to the purpose and audience. They will produce and publish a range of texts where information and ideas are relevant to the topic and supported by evidence and examples, where needed (p.2).

Although not an exhaustive set, the fact that the following standards apply to Year 8 students digital literacy outcomes provides an indication of the high level of sophistication and preparedness expected. For instance, they should be able to ‘use appropriate protocols when communicating and collaborating online’, ‘explain how text, image and audio data can be represented, secured and presented in digital systems’, ‘plan and manage digital projects to create interactive information’, use appropriate protocols when communicating and collaborating online’ and ‘evaluate information systems and their solutions in terms of meeting needs, innovation and sustainability’. Such standards are then broken down into ‘indicators’ of receptive and productive skills, where there is scope to assess students’ literacy at different levels of progression (ACARA, 2020, pp. 4-5). In addition, the standards highlight the importance of students being involved with multimodal texts and recognise their need to be able to understand how meaning is made through the various visual elements as opposed to the traditional emphasis on reading comprehension through decoding words. The skills make explicit that students need to understand how multimodal texts integrate visual, auditory and print.

Although students in Australia may bring

substantial experience with digital technologies to their learning situation as they are typically prolific in their lives outside school, given the availability of mobile smart phones, tablets and iPads, and Internet access, the standards highlight the importance of the teaching of the discipline metalanguage. In addition, it is not surprising that the standards take account of the interactive nature of digital technologies in not only identifying both receptive and productive skills as noted earlier but also embedding pedagogies that foster students’ meaningful use. For instance, the productive skills comprise speaking, interacting and creating (as opposed to the traditional composing), such that besides students being able to ‘use images, diagrams, tables, animations to convey ideas in a digital folio or pitch’, they should be able to interact with their peers in a group to justify their personal stance on a topic and provide an evidence-based argument.

In addition, the implementation of digital technologies in schooling includes a strong emphasis on robotics, where students in primary school in Years Three and Four “create digital solutions such as animations and games through the use of visual programming” (Queensland Department of Education, 2020a). In the following years students become involved in design processes and problem solving as well as learning more about digital systems and data. Along with this is the vital importance of personal safety as accessors of the Internet, although in schools this is a key priority in ensuring supervised and controlled access. The following videos of a play list of learning episodes provides insights into the Queensland Department of Education’s (2020b) resources provided for teachers and students. While robotics and coding have high priority as part of Science, Technology, Engineering, and Mathematics (STEM) in general there remains a continuing need for teachers to improve their skills in being able to integrate technology into their pedagogy (Donohue & Schomberg, 2015; Nyuli & Nyarambi, 2018). It is essential for students to have teachers who are au fait with the digital technologies in their capacity to enhance students learning and also their employability

and lifelong learning skills.

* + 1. **Exemplar Two - Enhancing languages education** One of the most significant potential positive impacts of digital technologies with regards to pedagogy and learning is in the field of languages education. The greatest failing to date

in any language learning context has been the

lack of opportunity for learners to use their added or second language (L2) to communicate for meaningful purposes (Halliday, 2003; O’Neill, 2018; 2020; 2021). With regards to English as a foreign language (EFL) many country have invoked the uptake of the Communicative Approach as in the adoption of Communicative Language Teaching (CLT) (Richards & Rodgers, 2007). However, it generally continues to be unsuccessful for this lack of communicative opportunity and also typically through lack of change to examination systems that continue to assess outcomes based on paper and pencil tests that are not communicative. In addition, many language teachers need professional development opportunities to ensure they are able to adapt their personal use of the target language to the level of the students in order to facilitate meaningful communicative interactions, even if only at the formulaic level (Campion, 2016; Van Lier, 2003; Wylie & Ingram, 1999). Thus, language teachers, in their aim to teach the CLT principle of *communicative competence,* need to be adequately prepared to manage the scope of language use, and balance fluency against accuracy, besides design learning experiences that are authentic in their relevance to real- life communicative needs and the integration of the four macro skills of listening, speaking, reading and writing, in the context of the digital world. Thus, it is not surprising that digital technologies, and mobile ones at that, have become the new resource to foster language learning. These technologies range from the mobile smart phone, iPad, Tablet, and Laptop where learners and teachers can interact and communicate for meaningful purposes with each other or speakers of the target language in other places and spaces. Moreover, these devices can also support individual use of languages learning programs that are geared to developing learner

autonomy through hierarchical-structured, individualized learning experiences, such as Duolingo (2020) [(https://www.duolingo.com/](http://www.duolingo.com/%29)), that includes built-in formative assessment. Such digital technologies today are vibrant and versatile, even allowing one to translate ‘in the moment’ when those communicating have no proficiency in the other’s language. In addition, research shows that languages learning can be supported through students use of video games and serious games (Vazquez-Calvo, Soyoof, & Cassany, 2020), where vocabulary improves as well as application to other communicative tasks. Vazquez-Calvo et al. (2020) found such digital technological uses also supported translation e.g., through Google, note-taking, spell and grammar checking, and digital writing, and encouraged students to discuss with each other and acquire the metalanguage.

In addition, through the support for purposeful communication the use of digital technologies are found to be motivating for learners and are more appropriate to contemporary pedagogy that recommends more collaborative, problem solving and project-based learning approaches (Achugar, Dworkin, & Gomez, 2020; Tochon, 2014). Thus, digital technologies can be very enriching by facilitating role-plays where dialogues can be highly structured to more flexible according to proficiency, communicative interactions can occur through live audio-video, chatbox, and video language games, as well as in real-life community involvement e.g., service learning (Lamb, Hatoss, & O’Neill, 2019). While these strategies are being used in many language learning contexts across the world and across all sectors of education, including early childhood for effective and capacity building pedagogy for both students and teacher’s availability of the supportive devices for all is essential, as is reliable access to the Internet and appropriate band width. In addition, teachers required professional development and the contemporary pedagogical approach, similarly, needs to be communicated to all involved to ensure a fully supportive learning environment, which in the case of languages learning can include a flipped approach as well.

* + 1. **Exemplar Three - Use of Zoom for online collaboration**

This exemplar examines recent research that further demonstrates how digital technologies are fostering the implementation of pedagogies that are in keeping with social constructivist approaches to learning. Such pedagogies are underpinned by the belief that students need to interact with their peers and critically reflect on the learning tasks in order to learn and co- construct new knowledge. In this exemplar the research into collaborative learning is reported to show how digital technologies are contributing to improving practice and are also responding to diversity of learners in terms of learning situation and curriculum demands related to laboratory tasks in electrical engineering in higher education. Traditionally, students are required to complete key laboratory tasks as part of their assessment, which traditionally has demanded their physical presence on campus at a particular time, and careful scheduling to ensure all may participate during the designated period. This is typically an expensive component of a learning program (Gleich et al., 2019) owing to the provision and maintenance of the laboratory equipment, although it may have intermittent use. However, with the advent of digital technologies and availability of the Internet, a growing body of research has investigated online solutions, where students might access a laboratory learning experience remotely at mutually agreed upon times via the Internet. Habibi and Dashwood (2020, p. 216) argue:

the provision of the online-LAB experience through remote laboratories is able to both counter ... [these typical] limitations as well as add value through facilitating a dialogic approach that involves collaboration with peers and critical reflective practice. In so doing, it also provides for the automatic building-in of formative assessment that “feeds forward” (Gonzlez, 2018) to enhance learning”.

In their research students of electrical engineering participated in the Voltmeter Divider Experiment online through the use of Zoom technology. The learning episode involved a small group of students e.g., five, where one

adopted the leader’s role and was designed in accord with Doolittle’s (1995) eleven principles. This role involved working with the students to guide them through a series of questions that fostered their use of the Voltmeter Divider. The ‘equipment’ for the experiment was available through LabVIEW (Iordache, Pop, Samoila, & Ursutia, 2011; National Instruments, 2019). By having to be prepared for its use students were taught the skills to set up their computer with the simulated equipment. During their learning they were able to use the equipment online to, manipulating the variables and both ask and discuss pre-set questions. They were able to verbally interact and collaborate as a team on the task’s challenges through the Zoom facility, and use the ‘chat’ as well as replay the recorded learning episode post the event. This research illuminated the importance of engineering graduates being able to experience learning collaboratively in preparation for their employment where the nature of today’s work demands highly effective interpersonal skills and teamwork. Thus, besides contributing to more effective formative assessment practices, the research identified the vital need “to design the application of technology to create a feeling of authenticity, and to ensure students are prepared in terms of their soft skills for effective collaboration” (Habibi, 2020, p. 293).

Learning online as exemplified here has become very much the norm in 2020 given the impact of COVID-19 19 across the world. However, while a highly successful example of the use of digital technologies to support and improve learning experiences, it is important to note that this depended on access to a computer, the software and a secure, reliable Internet connection to be at the optimal level of operation. In addition, not all laboratory practices may be adaptable to simulation, and the shift to complete tasks collaboratively online may also require students who are more used to traditional pedagogy, to first understand how collaborative learning works. This also means a change for the role of the teacher to that of facilitator of learning, hence the importance of the learning task design and assessment. Thus, there are implications for

both teachers and students to become familiar with the intentions of the pedagogy.

* 1. **Expectation, strategies and support**

The interconnectedness of digital technology with pedagogy and learning are reflected in the symbiotic relationships that exist between the expectations associated with the implementation of digital technology and the strategies developed to ensure the effective use of that technology within the education. In addition to the support that is required to facilitate these expectations of digital technologies, and the accompanying strategies, the above exemplars help demonstrate their relevance to the transformation of pedagogies and learning that has occurred in this space.

First, while expectations and support are important, learning will only be effective if the strategies, in particular those at the prelogical stage, have been clearly developed and articulated to all stakeholders. As highlighted in *Exemplar One - School curriculum implementation* there needs to be a national approach. For instance, the implementation of digital technologies in schooling, which includes a strong emphasis on robotics for students in primary school in Years Three and Four “creates digital solutions such as animations and games through the use of visual programming”. This cannot be undertaken without providing teachers with the appropriate knowledge and strategies to effectively deliver on expectations. The transformation of pedagogy and teaching by digital technologies can only be successfully implemented if teachers are upskilled with the appropriate strategies to facilitate learning in a learner - centred approach. Thus, it is vital to ensure their professional development.

Second, expectations need to be realistic, attainable and based on a need. For example, as highlighted in *Exemplar Two - Enhancing languages education* to address the greatest pedagogical failing to date in any language learning context by ensuring learners have the opportunity to use their added or second language to communicate for meaningful purposes. To expect teachers to undertake classroom learning

activities that continue to lack authenticity in a discipline centred on learning to communicate continues to be highly limiting and problematic. Thus, digital technology facilitates connecting to target language speakers besides different language learner groups of the same target language for meaningful communicative purposes (Halliday, 2003). Enhancements in this way allow teachers to structure learning experiences in a range of ways to accommodate different proficiency levels. In turn, the availability of digital technologies fosters the paradigmatic shift to project-based, problem- based and collaborative learning (Tochon, 2014). Such application of digital technologies has the capacity to create greater expectations, not only for teachers and students, but education systems as well. In addition, this approach to languages learning has the advantage of students transferring the skills developed through working with their peers to make meaning on authentic projects to learning in general and beyond school. This assists education systems in their need to ensure learners are ultimately equipped with the necessary skills set to meet the work demands of the growing freelance economies of the 21st century context. It is essential then that educational institutions and governments ensure that teachers and students are provided with sufficient support to build their capacity to adequately respond besides meet and address expectations.

Third, support will be a major contributing factor in the attainment of pedagogical change and provision of digital technologies. As highlighted in *Exemplar Three - Use of Zoom for online collaboration*, students are required to complete key laboratory tasks as part of their assessment, which traditionally has demanded their physical presence on campus at a particular time, and careful scheduling to ensure all may participate during the designated period. As noted, this requires teachers and learners to be supported in the application of the digital technologies required for this purpose. While collaborative learning may be applied in a range of contexts and is relevant to both problem solving and project- based learning, to manage it remotely, and gain

the pedagogical advantages of using the video or audio-recordings as follow up resources requires stable Internet and mutual access. Moreover, as Habbibi (2020) found, it is important to carefully design the task and learning experience, and also prepare roles and responsibilities of students. Nevertheless, this approach also contributes to students transferring the teamwork skills acquired through this pedagogical approach to future group interactions. Thus, the necessary resources need to be on hand to effectively address and support these expectations. As well, it is necessary to ensure that teachers have been provided with the appropriate professional learning in terms of the underpinning pedagogical theory and the related practical strategies.

While digital technologies have been well established in transforming pedagogy and learning in the 21st century it is important not to lose sight of the symbiotic relationships that exists between expectations, support and strategies. Besides the vital importance of teacher professional development in this area, this relationship will play a significant role in determining the overall success of the facilitating teaching models, such as, project-based, problem- based and collaborative-based learning.

* 1. **Conclusions**

From their genesis in the introduction of simple digital tools, such as, film, TV and radio, todays digital technologies have huge impact and continued potential for significant enhancement of pedagogy and learning. Initially, they were applied to mass production spawned by the industrial revolution and to support the view of learning that treated students as empty vessels waiting to be filled with information. This approach emphasized the teacher at the centre as the ‘fountain of all knowledge’ and the learner as non-contributor to their own learning, just simply waiting to be ‘taught’ what was required to be learned. Within this approach knowledge was simply viewed as a recall of information to be assessed at the end of each term or semester.

With the advent of advances in digital technology this traditional information transmission view of teaching and learning has

been challenged (Fadel, 2008) and superseded through innovation and need for improvement. The necessity to move to a focus on the freelance economy of the 21st century, where workers are required to problem solve and not simply adhere to an organizational dogma is well advanced in recognition of living in a globalised world (Bindé, 2005). This impact on workers of the 21st century has also flowed through to education where a greater emphasis is now placed on ensuring that leaners are being prepared to meet the associated challenges of globalisation and being able to effectively communicate internationally in the 21st century and beyond. Governments need to be aware of this and the importance of ensuring that their citizens are provided an education system that can facilitate their learning and development for their continued personal growth and that overall supports both economic growth and stability.

To achieve this outcome, it will be necessary to ensure that individuals have access to a stable Internet and have the capacity to use the digital technologies for both learning, work and living. The importance of this emphasis on access to high quality/speed Internet is stressed, as O’Neill (2021) points out, it provides access to the gateway to knowledge and independent learning, besides providing strategies to dramatically uplift education and business. However, she notes it has become the new global divide in leaving the many, many, people, who do not

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have this access, behind. Thus, the provision of digital technologies for education has already demonstrated an impact and will continue to do so as its uptake increases. It is capable of transforming pedagogy and learning into the 21st century, including students’ learning autonomy and transferrable skills moving forward to work and the demands of being a lifelong learner. The transformation of pedagogy and learning will continue to evolve as a greater focus is placed on learner-centred models of teaching. Importantly, these learner-centred models of teaching will encourage, and facilitate, greater learner autonomy via the use of digital technologies that will link learners beyond the restrictions of their classrooms and the *content* knowledge of their teachers. The culminating transformation of pedagogy and learning for the 21st century and beyond, through digital technologies, will be teachers facilitating a learner’s desire to undertake life-long learning thereby, breaking forever the bonds that have, for over 200 years, propagated the linear approach. In contrast, the use of digital technologies in education obviates the tradition of treating students as mere receivers of information by building their capacity acquire the skills to develop as autonomous learners, which are transferable in their transition to work and the need for lifelong learning in the modern world where jobs may become redundant but hopefully not people.

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