e-teach

Upskilling Digital Pedagogy

Upskilling Digital Pedagogy for Teachers and Future Teachers

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Erasmus+

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E-Teach Knowledge Paper

Upskilling Digital Pedagogy for Teachers and Future Teachers

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FOREWORD

The e-Teach project is an EU-supported Erasmus+ project with a partnership of 6 educational institutions from six countries. The partners include Vrije Universiteit Brussel (Belgium), Canakkale Onsekiz Mart University (Turkey), Baltic Education Technology Institute (Lithuania), University of Helsinki (Finland), Lucian Blaga University of Sibiu (Romania), and University of Social Sciences (Poland). The e-Teach project aims to transform pedagogical and digital pedagogic methods and techniques. The project develops digital pedagogy and provides training for teachers and prospective teachers on using digital pedagogy in digital learning applications and innovative teaching. This knowledge paper on digital pedagogy for teachers and future teachers consists of 7 chapters, written by researchers from project partners as a part of the project output. Each chapter includes two cases and offers practical advice on the applications of digital pedagogy.

Canakkale Onsekiz Mart University (COMU, Turkey) contributed to the first chapter. This chapter defines digital pedagogy. Then it discusses why digital pedagogy is needed and the construction of digital pedagogy in classrooms. Digital pedagogy's opportunities and risks are presented. The relationship between digital pedagogy, leadership and the role of digital pedagogy in higher education is discussed. In addition, digital competencies are explained. Finally, this chapter offers two cases as practical examples.

Vrije Universiteit Brussel (VUB, Belgium) contributed to the second chapter. This chapter first examines the main pedagogical theories that support digital pedagogy. Then it explores the pedagogical frameworks and design principles that are commonly used in digital teaching and learning. Finally, this chapter focuses on two cases that explain how the Community of Inquiry (CoI) and Universal Design for Learning (UDL) framework can be applied in real-life contexts by offering practical suggestions.

Lucian Blaga University of Sibiu (LBUS, Romania) contributed to the third chapter. This chapter explains different types of digital content development. Moreover, this chapter provides an overview of digital content development platforms and tools, with their advantages and disadvantages. The chapter gives practical guidance on creating synchronous and asynchronous lessons though the use of digital material, tools and platforms. Finally, this chapter provides two cases as examples.

The University of Helsinki (UH, Finland) contributed to the fourth chapter. This chapter states that integrating digital pedagogies in teaching and learning should be one of the critical elements of teachers´ professional knowledge. This chapter describes the nature of teachers´ professional learning and depicts digital pedagogical elements needed in teachers' professional expertise from four perspectives. First, teachers´ epistemic understanding of digitalization forms the basis for integrating digital pedagogies into teaching and learning. Secondly, teachers´ technological pedagogical knowledge and skills are applied while planning, implementing and assessing their teaching and students' learning. Thirdly, enable and challenge factors of teachers´ digital pedagogical competence development. Lastly, the chapter discusses the concept of teachers´ transformative digital agency. Finally, this chapter provides two cases as examples.

The University of Social Sciences (SAN, Poland) contributed to the fifth chapter. This chapter comprehensively defines hybrid and blended education in teacher education. The benefits and limitations of hybrid and blended education are explained in this context. Hybrid and blended courses and the application of technology-integrated teaching and learning in teacher education are described. Digital teaching methods and techniques and how to transform traditional approaches to digital pedagogy are explained. Finally, it provides two cases as examples.

Baltic Education Technology Institute (BETI, Lithuania) contributed to the sixth chapter. In this chapter, the organization and management of the learning processes are described in the context of hybrid & blended teaching, learning principles, and scenario-based digital technologies. In addition, the importance of artificial intelligence for

augmented, virtual and mixed reality and its use in classrooms are explained. Finally, this chapter presents two cases as examples.

Vrije Universiteit Brussel (VUB, Belgium) contributed to the seventh chapter. This chapter defines measuring and evaluating student performance in the digital age. The main challenges of assessment in digital learning environments are also explained. In addition, the opportunities offered by digital assessment and its risks are discussed. This chapter also provided two cases as examples.

e-teach
Upskilling Digital Pedagogy

Chapter 1: Introduction to Digital Pedagogy

Çanakkale Onsekiz Mart University

CHAPTER ONE: INTRODUCTION TO DIGITAL PEDAGOGY

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Abstract

This chapter provides a comprehensive overview of digital pedagogy and its significance in modern education. Digital pedagogy involves using digital technologies to enhance teaching and learning experiences. With the increasing ubiquity of technology in our lives, teachers must become familiar with the digital dimensions of education and employ pedagogical solutions that cater to their students' unique needs. The chapter emphasizes the importance of teachers developing digital pedagogical competence, which involves consistently evaluating and improving their attitudes, knowledge, and skills related to planning and conducting theory-based ICT-supported instruction. This entails not only a deep understanding of digital tools and resources, but also an awareness of how to use them effectively to promote learning based on digital pedagogy. Teachers' use of technology with digital pedagogical approaches may present both opportunities and risks to existing educational settings. Therefore, it is essential for digital pedagogy leaders to ensure that teachers possess the necessary digital competencies to achieve schools' goals in digital information, communication technology, and management to create the conditions for knowledge-based production.

1. The Definition of Digital Pedagogy

In today's digital age, essential efforts are needed to integrate digital pedagogy within the teacher education system to enhance the quality of education worldwide. Traditional pedagogical practices in schools are now being complemented by digital pedagogy, a new way of teaching and learning with information and communications technology**.** Nanjundaswamy (2021) stated that, while the world is moving towards digitalization in every field, digital pedagogy has started to form the basis of educational institutions. Innovation has influenced learning and has become a fundamental part of today's world by developing advanced teaching methods. A concept that has emerged to address this issue is digital pedagogy, which involves the integration of digital technologies and digital media to find solutions for social, emotional and educational needs, resulting in the development and change of the educational system and culture (Coovadia & Ackermann, 2021).

Digital pedagogy is concerned with new pedagogical approaches which use digital tools and resources to provide instructors with the necessary knowledge and competencies to teach (Becirovic, 2023). Digital pedagogy shifts its focus from merely utilizing ICT tools and skills to a more comprehensive approach to working in the digital world. Digital pedagogy is an increasingly broad field that encompasses a diverse range of pedagogical approaches and practices, all of which utilize digital devices, platforms, multimedia, productivity apps, and cloud computing to enhance the educational experience in schools (Davis et al., 2020). This transformation not only enhances students' knowledge and skills needed for the digital transition but also ensures diverse and flexible learning opportunities for all students (Dangwal & Srivastava, 2016). According to Omprakash and Mahaboobvali (2022), teachers actively use digital pedagogy and modern digital tools in schools for teaching and learning through online, hybrid, blended and face-to-face learning.

In *Digital Pedagogy Unplugged*, Fyfe (2011) argued that teaching with technology without digital pedagogy is illogical. It can be inferred that simply using technology in the classroom without an understanding of how to use it effectively for pedagogical purposes

is not productive. In this sense, digital pedagogy involves more than just using technology skillfully; it requires leveraging digital tools to provide the best possible learning experience for students, promoting the quality of education, and achieving its objectives. Thus, teachers need to broaden their understanding of digital pedagogy and cultivate diverse perspectives to ensure effective learning. In this context, teachers should be provided with opportunities to develop appropriate knowledge and skills to use and integrate the right technology according to personal teaching methods, subject content, and target group (Dangwal & Srivastava, 2016).

Digital technologies have revolutionized the way we live, work, and communicate, and education is no exception. In today's digital age, students are more connected than ever before, and the traditional methods of teaching and learning are no longer effective in engaging them (Nanjundaswamy, 2021). This has led to the rise of digital pedagogy, an increasingly broad field that encompasses a diverse range of pedagogical approaches and practices, all of which use technology to support and enhance teaching and learning (Davis et al., 2020).

Digital pedagogy is not just about the use of technology for technology's sake, but rather it is a strategic approach that recognizes the unique affordances of digital tools and seeks to harness them to transform the learning experience. By using digital tools to create engaging and interactive learning experiences, students can develop the knowledge and skills needed for the digital age, but also the critical thinking, problem-solving, and communication skills necessary for success in any field (Omprakash & Mahaboobvali, 2022). Moreover, the use of digital tools and different learning modalities of learning (online, hybrid, blended, and face-to-face learning) allows for more flexible and personalized learning experiences that cater to the unique needs and interests of individual students (Dangwal & Srivastava, 2016). This increased flexibility and personalization not only ensures that every student has access to quality education regardless of their location, background, or learning style (Dangwal & Srivastava, 2016) but can lead to increased engagement and motivation, ultimately enhancing learning outcomes (Coovadia & Ackermann, 2021).

Digital pedagogy is also used to facilitate global connections and cross-cultural understanding (O'Brien et al., 2007). With digital tools, students can connect with other learners and educators from around the world, participate in international projects, and develop intercultural competencies. This prepares them for a rapidly changing and interconnected world where cultural understanding and global perspectives are increasingly important. Finally, digital pedagogy can enable educators to collect and analyze data to improve teaching and learning outcomes (Seufert et al., 2019). Through learning analytics, educators can identify students' strengths and weaknesses, track their progress, and provide targeted feedback and interventions.

The range of digital tools and platforms available for teaching and learning is vast and includes MOOCs (Massive Open Online Courses), online forums, LMSs (Learning Management Systems), game-based learning, coding and programming, augmented and virtual realities, BYOD (bring your device), BYOT (bring your technology), BYOC (get your connectivity), maker spaces, blogging, microblogging, wikis, back channels, audio recording and music making, image and video editing, creation of infographics, slideshows, and presentations, digital storytelling, social media, collaboration tools, and mobile apps. The use of these tools can transform the learning experience and provide a range of opportunities for students to engage with and learn from their peers and teachers in new and exciting ways (Murty & Rao, 2019).

With a vast range of digital practices, tools and platforms available, teachers need to broaden their understanding of digital pedagogy and cultivate diverse perspectives to ensure effective learning. They should be provided with opportunities to develop appropriate knowledge and skills to use and integrate the right technology according to personal teaching methods, subject content, and target group (Dangwal & Srivastava, 2016). This way, teachers can make decisions about when and how to use these tools, prioritizing learner-teacher interaction and striving for high-quality education (Ozer, 2021).

2. The Need for Digital Pedagogy

Digital pedagogy is an essential aspect of education in the 21st century, as technology has become an integral part of our daily lives. The rise of digital technologies

has brought a paradigm shift in education, requiring teachers to adapt their teaching methods to meet the changing needs of students. With the increasing availability of digital tools and resources, it has become necessary to incorporate technology into the teaching and learning process to enhance engagement, increase collaboration, and improve learning outcomes (Pettersson, 2017).

Prensky (2001) considers today's students as 'digital natives' a term that refers to today's students who are comfortable and proficient in the use of digital technology, while their teachers, who did not grow up with this technology, are seen as 'digital immigrants'. This highlights the need for teachers to adapt their teaching practices to align with the preferences and needs of the digital generation. However, this does not mean compromising the quality of education, but rather rethinking the approach to education to incorporate technology in a meaningful way. Therefore, the clever use of digital technologies in teaching and learning has become an essential requirement for 21st-century education systems (Zhong, 2017).

The COVID-19 pandemic has further emphasized the need for digital pedagogy. With the widespread adoption of distance education during the pandemic, teachers and students started using digital tools much more intensely than in the past. However, many teachers worldwide were unable to provide quality education during the shift to online or blended learning as a result of the COVID-19 pandemic due to the lack of digital pedagogy knowledge and ICT skills (Pokhrel & Chhetri, 2021). To address this challenge, there is a growing need for digital pedagogy, which can help teachers recognize the importance and potential of using digital devices meaningfully to develop an engaging, effective and inclusive teaching and learning environment through the combination of face-to-face and online activities (Klink & Alexandrou, 2022).

Moreover, the pandemic has raised concerns about the digital divide, which refers to the unequal distribution of access to technology and the internet, with low-income families and marginalized communities having limited access to digital devices and internet connectivity. Therefore, education stakeholders must consider digital equality issues when introducing technology into the education system. Access to digital technologies can vary significantly among students locally and globally, and their level of

access to technology and the internet, digital literacy skills, and access to resources and support must be taken into account (Shonfeld, 2021). Furthermore, the pandemic has shown that without the proper pedagogical knowledge and technical skills to support students' learning and engagement in online lessons, technology can become a hindrance, especially for students from homes that lack an environment that supports distance learning. Hence, teachers should receive training in digital pedagogy not only to enhance their digital and pedagogical knowledge and skills but also to support students' digital literacy skills, which can ultimately increase the quality and inclusivity of technology-enhanced education (TEDMEM, 2020).

3. The History of Digital Pedagogy

The history of digital pedagogy can be traced back to the 1920s with instructional radio and the 1950s with instructional television (Aslan & Reigeluth, 2011). In the following decades, educators began to explore the use of computers in the classroom, but it wasn't until the 1980s and 1990s that personal computers became more widely available and affordable, leading to the proliferation of educational software. The 1990s marked a significant milestone in the evolution of digital pedagogy, with the advent of the internet. This provided new opportunities for educators to access vast amounts of information and communicate with individuals across the globe (Molnar, 1997). The internet also led to the emergence of e-learning, which allowed for the delivery of education through online platforms. The development of LMSs such as Moodle and Blackboard provided a framework for organizing and delivering online courses, leading to a shift in the way education was delivered. In the early 2000s, the use of digital technologies in education continued to evolve, with the development of interactive whiteboards and the increasing use of multimedia in the classroom (Maddux & Johnson, 2013). The widespread adoption of mobile devices such as smartphones and tablets in the 2010s led to the creation of mobile learning (m-learning) environments and educational apps and games, which provided learners with access to educational resources on the go (Sarrab et al., 2012).

In recent years, the COVID-19 pandemic has accelerated the adoption of digital pedagogy and brought to light the importance of technology in education (Pokhrel &

Chhetri, 2021). Teachers and students alike have had to navigate new online learning environments and technologies, such as learning management systems, video conferencing tools, and virtual reality applications. The development of these tools has allowed for immersive learning experiences, allowing students to feel like they are physically present in a classroom or laboratory. Video conferencing tools, such as Zoom and Microsoft Teams, have become essential for online teaching and learning, allowing educators to interact with their students in real time. Virtual reality tools have been used to create immersive learning experiences, allowing students to explore scientific concepts, historical events, and cultural sites in a way that would not be possible in a traditional classroom setting.

The evolution of digital pedagogy has provided new opportunities and challenges for educators and learners alike (Väätäjä & Ruokamo, 2021). The use of digital technologies has allowed for the creation of personalized learning environments, increased collaboration, and access to a wider range of resources. However, it has also raised concerns about the digital divide, privacy, and cybersecurity (Lewin & Lundie, 2016). Looking to the future, it is evident that technology will continue to play a vital role in education. The use of artificial intelligence, augmented reality, and blockchain in education is already being explored, and teachers must continue to adapt and innovate to provide the best possible learning experiences for their students. As the world becomes increasingly digital, it is essential that educators keep up with the latest technological developments to ensure that their students are prepared for the digital future.

4. Digital Pedagogy and Transformation of Education

Technological advances and social change put tremendous pressure on educational systems and organizations. Teachers need to constantly innovate their teaching and learning techniques to keep up with societal growing demands and expectations (Omprakash & Mahaboobvali, 2022) as outlined in current education reforms (Prestridge, 2010). Moreover, organizational processes and practices should be adopted in line with new social and work relationships, and teachers must have the necessary digital skills to deal with native digital learners.

The digital transformation from primary schools to universities' target groups includes two concepts. The first concept, which involves converting printed or physical materials (such as text, pictures, and sound) into digital formats through the use of computers, is commonly referred to as digitization. On the other hand, digitalization refers to the broader process of transforming various materials into digital form, and there are different strategies for achieving this, as opposed to simply creating digital versions of the original materials (Aybek, 2017).

Distance education started with higher education levels and later expanded to primary and secondary schools (Şentürk et al., 2020). The pandemic has changed the shape of education systems in schools, with concerns regarding differences in teacher support, capacities, students' resilience, motivation, and skills for independent and online learning, and gaps in opportunities that already exist (OECD, 2020). Therefore, teachers have a crucial role in shaping the attitudes and behaviors of their students through the use of technology-based tools and the purposeful selection and use of these devices. They should be professionally prepared to help students develop the multi-literacy needed to become digitally literate and interact with others online in a conscious and meaningful way (Hauck & Kurek, 2017). Integrating digital pedagogies into the entire student learning lifecycle can improve exam performance in school (Coovadia & Ackermann, 2021). This has encouraged educational institutions to develop formal education teaching and learning practices by integrating digital pedagogies into their lessons. To navigate this demanding context of managing and governing education institutions, teachers and principals must develop interdisciplinary expertise that demands new digital literacies and learning approaches that align with the sociocultural, psychological, and cultural needs of emerging global knowledge (Clarke & Clarke, 2009). The combined societal transformations present education systems with several technical challenges, and these changes must be understood together rather than examined in isolation (Bach et al., 2007). For example, in the early 1990s, university professors were suddenly required to create email accounts, and the rhetoric of innovation and time-saving promises made to faculty were generally accepted without resistance (Johnston et al., 2018). Similarly, the impact of emerging technologies on pedagogies has provided new opportunities for teachers and students at educational institutions. It is now being

realized that the effective use of digital pedagogy in the classroom environment affects various pedagogical approaches, offering flexible time and space and promoting diversity, which is not always possible in the classical classroom environment (Shonfeld et al., 2021).

Pedagogy is a comprehensive term that encompasses the entire process of teaching and learning, including instructional theory, methods, evaluation, classroom management and feedback (Cavin, 2007). Effective pedagogy depends on various factors, such as the broader social system within which teaching and learning take place, the quality of theoretical and practical training received by teachers, their level of subject matter expertise, and their ability to effectively integrate diverse instructional strategies (Nanjundaswamy et al., 2021). From the perspective of Bandura (1986), teachers' pedagogical beliefs and attitudes play a crucial role in shaping their teaching behaviours in the classroom. With the increasing use of information and communication technologies (ICT) in education, teachers are forming their own beliefs about the role of ICT as teaching tools, the value of ICT for student learning outcomes, and their confidence and competency in using these technologies (Prestridge, 2010). However, as teachers are not yet adequately trained to digital pedagogy, their beliefs and attitudes may lead to a wrong use of essential components of digital pedagogy. For example, placing a computer in the middle of the classroom cannot make education and training effective and efficient. Teachers need to understand how to use technology effectively, the social-emotional learning theories behind the practice, and choose the right technology for the most appropriate learning outcomes for the students they seek (Omprakash & Mahaboobvali, 2022). At this point, digital pedagogy can be confused with digital literacy. That is why educators should know the difference. Digital literacy means the ability to use computer processing technology. Digital pedagogy includes many aspects, such as understanding the student's needs, keeping the classroom atmosphere in balance, motivating the students, monitoring their success, and enabling students to express their feelings while teaching the lesson with these technologies and tools. Digital pedagogy is related to the perception of human behaviour and needs rather than the use of technological tools in our physical classrooms with students at schools. In this context, digital pedagogy uses digital technologies to shape teaching qualifications to transform teaching practices and

learning experiences. It aims to explain how resources are used to a large extent. ICT brings many new ideas and initiatives to all fields of education and different new pedagogical educational experiences. It appears to be more than just the use of technology in the classroom; It has changed how it is taught and learned. The use of digital technologies creates new opportunities that enable diverse learning abilities and help educators to access and acquire complex areas of knowledge. It should emphasize the human element in digital pedagogy. In this regard, there are three essential elements that teachers should pay attention to in virtual lessons:

1) Not just transferring information,
2) Creating an environment for dialogue and discussion
3) Creating opportunities for students to reflect on themselves.

In this sense, Piaget's constructivist principles form the basis of developing digital pedagogy (Tabesh, 2018). In constructivist terms, this means that educators need to adjust their practices to allow students to shape the curriculum and use technology to construct knowledge (Shonfeld, 2021).

However, the differences between how students today learn and how teachers traditionally teach are often more profound than teachers may realize. As Clarke and Clarke (2009) have noted, these differences extend far beyond changes in technology, and include fundamental shifts in students' cognitive processes, learning preferences, and approaches to problem-solving. Given what has been said, technology does not necessarily enable better learning acquisition of knowledge if teachers do not design learning material according to students' sociocultural characteristics, experiences, and expectations. Another essential component of digital pedagogy is digital technology. Digital technology provides a variety of learning platforms, including MOOCs, online forums, LMSs, game-based learning, coding and programming, augmented and virtual realities, BYOD, BYOT, BYOC, maker spaces, blogging, microblogging, wikis, back channels, audio recording and music making, image and video editing, creation of infographics, slideshows, and presentations, digital storytelling, social media, collaboration tools, and mobile apps (Murty & Rao, 2019). However, teachers who plan

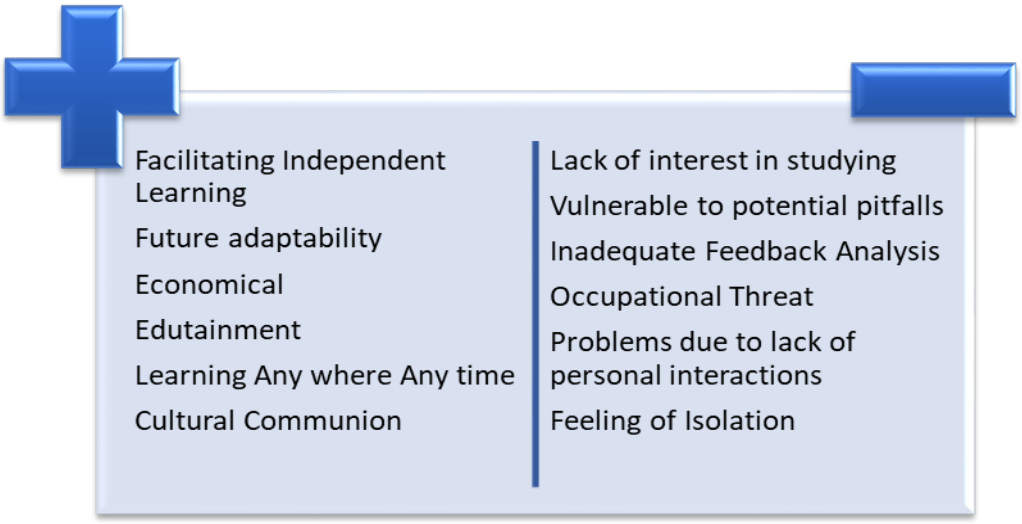
to incorporate these digital tools in their lessons must consider the content of their studies to avoid replicating traditional classroom approaches. The digital transition in education offers opportunities to rethink the possibilities of digital pedagogy, with an emphasis on developing a shared vision for the institution's excellence, promoting a digital learning culture and innovation, creating professional learning environments, and appropriate use of information technology (Aldawood et al., 2019). Digital pedagogy offers the novel and innovative pedagogical approaches needed to encourage and enable the positive digital transformation of education. It facilitates this process in various areas: thorough curricula, digital literacy and competencies of teachers and students, technology integration into education, teaching and learning strategies, and more. It responds to the teacher's need to teach successfully with the help of digital technology (Bécirovìc, 2023). Using digital tools in teaching can significantly help instructors and students achieve their goals and objectives, and integrating digital technologies enrich the educational process. Digital pedagogy may enhance all education processes, whether online, hybrid, or face-to-face (Kivunja, 2013). Digital pedagogy covers any virtual strategy that enhances the learning experience, including teaching strategies, using technologies, and transferring teaching content (Steele et al., 2019),

5. Digital Pedagogy–An Opportunity or a Risk?

In recent years, the use of technology and digital tools in education has increased significantly, leading to the emergence of digital pedagogy. Educational technologies present a significant opportunity to create new learning environments beyond traditional classrooms. However, the potential benefits of digital education must be balanced with careful consideration of the social, ethical, and epistemic assumptions underlying these changes (Lewin & Lundie, 2016). Thus, while this new approach to teaching and learning presents many opportunities, it also brings about potential risks that need to be considered. The opportunities and risks of digital pedagogy are represented by Murty and Rao (2019) in Figure 1. Scholars agree that education can only have adverse effects when using a technology-focused approach. Thus, technology should be integrated with suitable pedagogical methods and used in a pedagogical framework rather than as a device in schools (Arslan & Doğan, 2020). As seen in Figure 1, digital education should

be an innovative and sustainable change for education in the 21st century, but it can also be inefficient if not used correctly.

Figure 1. *Opportunities and Risks of Digital Pedagogy*



Source: Murty & Rao, 2019.

5.1. Opportunities of Digital Pedagogy

Digital pedagogy offers numerous opportunities to create more engaging, interactive, and effective learning experiences for students. By using digital tools, teachers can create and deliver educational content in a way that is more accessible and relevant to students, helping them to develop skills and knowledge that will be valuable both now and in the future. One of the most significant advantages of digital pedagogy is that it provides teachers with a range of models to choose from, such as hybrid or blended learning and online classes. By using these models, educators can deliver content in a more interactive and engaging manner, which can help to enhance student learning outcomes. Another key benefit of digital pedagogy is that it facilitates independent learning. By providing students with access to digital resources and materials, teachers can empower them to take charge of their learning, exploring topics and subjects that interest them at their own pace. This can help to foster a sense of curiosity and intellectual engagement among students, and can also help to develop important skills like research,

critical thinking, and self-directed learning. Digital pedagogy also promotes adaptability. Digital technologies are constantly evolving, and by incorporating them into the classroom, teachers can help students develop the skills they need to thrive in an ever-changing world. For example, digital pedagogy can help students develop important digital literacy skills, such as how to use digital tools and resources effectively and responsibly.

In addition, digital pedagogy offers several economic benefits to both students and institutions. Firstly, it reduces the cost of textbooks and other traditional learning materials as most educational resources are now available digitally. This can result in significant savings for students and their families. Secondly, it eliminates the need for physical classroom infrastructure, such as buildings, desks, and chairs, which can be expensive to maintain. Thirdly, it reduces the need for commuting to and from school, which can save students money on transportation and accommodation costs. Lastly, digital pedagogy enables institutions to offer courses to a larger number of students at once, without being constrained by physical classroom capacity, which can result in more efficient use of resources and cost savings. Furthermore, digital pedagogy can foster edutainment, or educational entertainment, by utilizing interactive and engaging digital tools to teach and reinforce educational concepts. For example, incorporating gamification elements, such as quizzes or challenges, into the learning experience can make it more fun and engaging for students. Interactive multimedia resources, such as videos, animations, and simulations, can also make learning more enjoyable and memorable. Digital pedagogy can also provide access to a wide range of educational resources that can make learning more interesting and relevant to student's interests and experiences. For instance, teachers can use digital tools to provide real-life examples or case studies that are directly related to students' experiences or cultural backgrounds. By doing so, digital pedagogy can help to create a more meaningful and engaging learning experience that goes beyond traditional textbook learning. Digital technologies allow for a variety of educational resources and materials to be easily accessible to students at any time and from anywhere. This means that students can access a wealth of information and learning opportunities beyond what is provided in the traditional classroom setting. For example, students can access videos, podcasts, interactive simulations, and other

digital resources that can help them understand and engage with a subject more deeply. This can be particularly beneficial for students who have different learning styles or who may be struggling with a particular subject. It also enables teachers to provide personalized feedback and support to individual students.

Another important benefit of digital pedagogy is the possibility to foster cultural communion among students from diverse backgrounds in several ways. Digital technologies can enable students to connect and communicate with peers from different parts of the world, which can help to broaden their perspectives and promote intercultural understanding (Murty & Rao, 2019). For example, students can collaborate on group projects or engage in online discussions with classmates from different countries or cultural backgrounds. Secondly, digital pedagogy can help to promote inclusivity and accessibility in education by providing materials and resources that cater to different cultural backgrounds and learning styles. This can help to ensure that all students feel represented and valued in the classroom or online environment. Lastly, digital technologies can provide opportunities for students to engage with and learn about different cultures and traditions. For example, students can access online museums or cultural exhibits, participate in virtual exchange programs, or use digital tools to explore different languages and customs. This can help to respect students' cultural identity, and promote cultural awareness and sensitivity, which are important skills in an increasingly interconnected world (Miller & Petriwskyj, 2013). Finally, the integration of digital pedagogy into lessons also supports the development of shareable and reusable course materials. This can help to save time and resources for both teachers and students, as educational content can be easily shared and adapted for different purposes.

5.2. Risks of Digital Pedagogy

While digital pedagogy offers several advantages, there are also potential risks that need to be considered. One risk is that learners may lose interest in studying if the digital materials provided are not engaging enough. In such cases, the digital materials should be designed to capture the learner's attention and promote active engagement. Another risk is that digital pedagogy may be vulnerable to potential technical issues, such

as internet connectivity or server problems, which may disrupt the learning process. Cyberattacks may also pose a threat to digital pedagogy, as they can lead to data breaches or system failures. It is important for educators to have contingency plans in place to address such issues promptly. Furthermore, it is crucial to have adequate feedback mechanisms to measure the effectiveness of digital pedagogy. Without effective feedback analysis mechanisms, educators may not be able to monitor the progress of their students or evaluate the effectiveness of the teaching approach, which could hinder the overall effectiveness of the pedagogical approach. Digital pedagogy can also contribute to a lack of personal interactions, which could lead to feelings of isolation among learners. It is essential to incorporate opportunities for social interaction and communication among learners, as this can help foster a sense of community and enhance the overall learning experience. Educators should also provide additional support to learners who may require it, such as virtual office hours or online tutoring sessions, to help ensure that learners are supported throughout their educational journey. Moreover, the digital divide can create barriers for some students, and teachers need to develop their digital competencies to ensure that all students can access the same educational opportunities. This includes ensuring that students have access to the necessary technology and connectivity, as well as providing training and support to help students navigate the digital learning environment.

Finally, it is important to highlight that technology alone cannot provide good learning. Digital pedagogy is more than just using technological tools; it involves creating engaging learning experiences that are relevant to the target group, goals, and objectives of education. Contrary to expectations, digital education also brings unpredictable psychological limits to the topics being taught because, as students, they base their behavior almost entirely on monitoring. This can lead to the mechanization of teaching, which reduces students' habits, such as asking questions, criticizing, experimenting, solving problems, and even consulting a book (Pettersson, 2017).

In conclusion, digital pedagogy offers a pathway between traditional face-to-face education and ICT-based learning. Although distance education applications can be highly successful, they can suffer from issues such as a lack of motivation, feedback, and

social isolation. Digital pedagogy plays a crucial role in addressing these challenges, and it has become a necessity rather than an option to ensure that education systems can function effectively in the digital age. To maximize the benefits of digital pedagogy, it is essential to integrate technology with suitable pedagogical methods and frameworks and to remain aware of the potential risks and limitations of digital education.

6. Digital Competences of Teachers

To implement digital pedagogy holistically and facilitate transition towards Education 4.0, it is crucial to consider the unique characteristics of the students (Oliveira & Souza, 2022). Educational systems are adapting to increasing student diversity in terms of background, socio-cultural aspects, and personal characteristics by providing teachers and pre-service teachers professional development opportunities to develop digital skills and increasing access to educational resources (Arslan & Doğan, 2020). The meaning and scope of digital competencies, such as digital pedagogy, ICT competence, digital literacy and digital pedagogical competence, are often used interchangeably to describe the competencies needed by stakeholders working in educational contexts (Pettersson, 2017). A clear definition of digital competencies is provided by Ferrari and colleagues (2012, p.30):

> *"Digital Competence is the set of knowledge, skills, attitudes, abilities, strategies and awareness required when using ICT and digital media to perform tasks; To solve problems; contact; manage information; act ethically and responsibly; cooperate; create and share content and information for work, leisure, participation, learning, socialization, empowerment and consumption."*

Therefore, digital pedagogy goes beyond the technical skills required to use digital technologies in the classrooms. The concept of digital pedagogical competence refers to the ability to consistently apply the attitudes, knowledge and skills required to plan and conduct, evaluate and revise ICT-supported teaching based on theory, current research and proven experience to support student's learning in the best possible way (From, 2017, p.48). According to Kivunja (2013), digital pedagogy refers to the inclusion of

computer-assisted digital technologies in the art of teaching that enriches learning, teaching, assessment and the entire curriculum. Therefore, teachers must have digital pedagogical competence for good lesson planning in distance education. According to Ilomaki et al. (2016), digital competence consists of four components:

1. the technical skills needed to use digital technologies;
2. the ability to use and apply digital technologies in different working situations;
3. the ability to evaluate digital technologies critically for their ethical issues, limitations, and challenges;
4. the motivation to participate in and commit to the digital culture.

Digital pedagogy can help teachers create or adapt activities that appeal to and support their culturally diverse students. Teachers can focus on their students' needs, requirements and cultural differences by using technology to personalize learning. Teachers must learn about students' cultures in the classroom and be aware of what digital technology should address cultural diversity and how it can be used to differentiate activities and support their students (Shonfeld et al., 2021).

7. Leadership and Digital Pedagogy

A leader is responsible for implementing all organizational changes. This perspective of change proves it to be the leader’s vision, which can bring organizational success and growth as a result of the adoption of any transformation. It can be defined that the concept of digital pedagogy and leadership is fundamentally about change. Because the change in digital pedagogy requires transformation and leadership, leadership is more about evolution than stability. Leadership is critical because it strongly determines direction and outcomes at the micro level of schools or broader systems. Learning education provides the main form of leadership and the purpose of creating and maintaining education conducive to good learning (OECD, 2013). Sheninger (2014) argues that leaders in the digital age must now embrace social media to communicate the school's vision and reach all stakeholders. Social media platforms such as Facebook and Twitter allow school leaders to create and disseminate school narratives through text, images, video and shared content. This can allow leaders to communicate their visions

to stakeholders, involve other educators in conversations, build professional partnerships and enhance knowledge. Innovation in the school environment is likely integral to learning digital pedagogical leadership in setting new directions. Digital pedagogy must provide learning experiences of the same and equal quality for students as face-to-face teaching. Education policymakers and school administrators should also consider these changes when designing and planning in-service training for teachers (Väätäjä & Ruokamo, 2021). Digital leadership practices align closely with transformational and transactional leadership styles with an emotional intelligence orientation (Aldawood et al., 2019). Additionally, Sheninger (2014) defined digital leadership as not about flashy tools but a strategic mindset that leverages available resources to improve what we do while anticipating the changes needed to cultivate a school culture focused on engagement and achievement.

It is a transformed construct of leadership that grows out of the leader's symbiotic relationship with technology. Different dimensions of what elements can be used to indicate successful digital leadership exists. For example, Zhong (2017) defined digital pedagogical leadership in education as transforming schools into learning places in the digital age and enabling teachers and students to explain, adopt and apply these technologies effectively and efficiently. Additionally, Sheninger (2014) defined seven dimensions of digital leadership; communication, public relations, branding, sustainability, student participation, learning, professional growth, development, reimagining areas, and environments of opportunity. The dimensions described here are that leaders must opt for digital information and technology management and create conditions for value-based production. In addition, leaders should be able to bring education stakeholders and employees together around a shared vision rather than using the control element frequently in terms of human resources management. If we look at the school environment, the human resource in charge reveals its talent and potential in line with the organization's objectives. In this context, digital school leaders should be trained and educated in line with human resources digitalization and school vision. It should be able to provide the necessary cooperation with the stakeholders to its potential. In other words, digital leadership is a type of leadership that has essential responsibilities due to the nature of the rapid changes in the field of education. Digital leadership inspires

educational change and aims to engage and encourage students, teachers and other stakeholders in transformation (Aldawood et al., 2019). Digital leadership is a leadership skill that considers situations such as having an uninterrupted internet connection everywhere, using the right technology and mobile devices at the right time, and personalized technology according to the purpose (Zhong, 2017). In this context, teaching students coding and robotic applications, web 2.0, digitalization of printed books or forms, and even communication through various mobile applications, the increasing use of technology in schools necessitates digital pedagogy leadership (Oz, 2019). On the other hand, digital pedagogical leadership requires creating or developing the vision and technology-based school culture necessary for the school's future success. In addition, pedagogical leadership requires a combination of thoughts, behaviour and skills to use the training necessary to develop the skills of education stakeholders in line with this vision and culture. In line with these combinations, it can be said that leaders with pedagogical leadership competencies are needed to achieve schools' goals. Digital pedagogy leaders prefer digital information, communication technology and management to create the conditions for knowledge-based production in educational institutions. As it is known, leaders enable all educators to research and evaluate their practices (OECD, 2013). In addition, pedagogical leaders should be able to gather the stakeholders around a vision instead of having an idea in terms of human resources management. According to Oz (2019), the duty of school leaders is to discover the talent and potential of the human resources in the school in line with the organization's goals. In this context, digital pedagogical leaders should cooperate with stakeholders to train human resources in line with digitalization and school vision and reveal their potential. As it can be understood from here, digital pedagogy, which is based on the human element, provides opportunities for education stakeholders to express themselves, create spaces for dialogue and discussion, and engage in reflective thinking skills rather than just transferring information.

8. Cases

Case 1 - Case From Çanakkale Onsekiz Mart University, Turkey

"Pedagogy is the driver; technology is the accelerator" (Michael Fullan)

As Fullan (2011) suggested, instructors should judge good digital pedagogy by its effectiveness in equipping students for a successful future in line with the path chosen by the student. This means invoking constructs from previously established experiences to successfully navigate the future social, emotional and cultural challenges the student will face throughout life. An effective pedagogy uses formative and summative assessment to monitor progress while developing effective habits that promote autonomy and informal lifelong learning.

Aim: The management problem-solving techniques lecture in higher education is adapted to digital pedagogy, aiming to prepare students for their professional future by analyzing and examining real-life events. The case studies will show how to make the best decision by moving from the theoretical framework while solving problems.

The following items have been prepared by following a digital pedagogy:

1. Collaboration: Graduate students today feel like the ability to work together is extremely important; therefore, when instructors choose technologies that facilitate the development of these skills, it is genuinely beneficial. This can add a dimension to group work that helps students build necessary technological skills.

2. Inclusion: Ensure that the incorporated technology allows every student to participate.

3. Works Towards Class Participation: Engaging tools work the best.

Figure 2. *Designing Digital Pedagogy in Lecture*

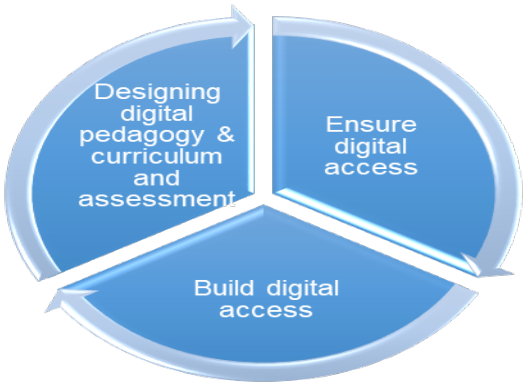


Figure 2 shows that digital pedagogy should be integrated into the lecture design, curriculum, and assessment, focusing on building and ensuring digital access.

Experience: The lecture is designed to foster joint participation and engagement between the lecturer and students. Throughout the course, both the lecturer and students take turns introducing subjects, followed by a discussion of the theoretical basis and several case studies. The prior experience of this lecture is to create a digital learning environment that encourages self-reflection and facilitates the exchange of information, dialogue, and discussion to provide a meaningful learning experience for the intended audience. Graduate students will follow the weekly lecture plan shown in Table 1.

Assessment: Each student must choose one of the syllabuses shown in Table 1 and make a research paper and presentation in the digital environment. Each student will be evaluated by ensuring participation in the discussion and question section. In addition, the student making the presentation shares the case studies related to the presentation with other students at the beginning of the lesson. Each student is encouraged to discuss the subject interactively and to express their criticisms and suggestions. Presentations and homework are also delivered to the lecturer electronically.

Table 1. The Management Problem-Solving Techniques Course In Higher Education *Processing of Topics by Week*

As seen in Table 1, the 14-week lesson plan of the management problem-solving techniques course in higher education is presented. According to the weekly topics, graduate students are required to prepare the lecture that will include critical thinking, communication and collaboration using digital tools.

Weeks	Topics
1.	Reasons for knowing problem-solving strategies in the management
2.	Game Theory (case study)
3.	Organizational Perspectives (Hoy and Miskel)
4.	Fishbone Diagram, Conflict Resolution Strategies
5.	Decision making: Optimising
6.	Decision making: Satisficing
7.	Decision making: Muddling and Scanning
8.	Decision making: Garbage Can Model and Politics Model
9.	Using Best Models to Solve Managerial Problems
10.	Shared decision making: a comprehensive model
11.	Shared decision making: a simplified model
12.	Working on Case Studies in Problem-Solving
13.	General Evaluation of the Term and the lecture (discussion session with the group)
14.	Final Exam

Case 2 - Case from Çanakkale Onsekiz Mart University, Turkey

*"The answer does not lie in the rejection of the machine but rather in the humanization of man," (*Paulo Freire, 1996).

It is seen that the basic idea advocated in the critical pedagogy approach is that learning environments provide students with a conscious, critical awareness of better world order and gain experience in the practice of freedom by developing their social criticism and questioning skills. From this perspective, the differences arising from the unique structure of online learning environments and the use of pedagogical approaches necessitated a digital pedagogy understanding. With this perspective, Case 2 aims to combine diversity and cultural differences with digital pedagogy.

Web Dcdp: An online '*Diversity, Culture and Digital Pedagogy* collaboration tool where pre-service teachers from different cultures choose common lessons.

Aim: This lecture aims to enable pre-service teachers to incorporate digital pedagogy into their skills to help them acquire the role of technology in teaching pedagogy and content knowledge. In situations where certain elective courses are not in high demand or there is a lack of available instructors, graduate students can take advantage of the train station model, which provides online learning opportunities.

This model is an application model that will bring together pre-service teachers from different countries and cultures under the roof of digital pedagogy. As they gain experience with the train station model, the university staff realize that individual rotations can better respond to student needs and begin individualizing their practices. As the name of the train station model suggests, as the student gains success, they move to another station. In addition, thanks to this model, students can gain diversity and cultural richness. 10-12 students who take this model course come together once or twice a month and work with their devices in the common area. At the same time, a lecture helps students with technical and academic problems that may occur. This assessment is done for assessment for learning which raises the learner's cultural and diversity awareness and focuses on their strengths.

Experience: The teaching module opens with a goal-based pre-assessment by the lectures. After the assessment, a digital learning path is determined for each student, and supporting scaffolding is established with the help of formative assessments.

They work on different tasks according to their needs: independently on online material and under the coaching of their lectures, with the lectures' direct instruction, in collaboration with their peers. As students reach their goals, lecture support decreases and intensifies for those with difficulty. While completing the cycle with summative evaluations, a new module is started for the next station.

Assessment: Each student must do a research paper and presentation in a digital environment. Each student will be evaluated by ensuring participation in the discussion and question section. In addition, the student making the presentation shares the case studies related to the production with his friends at the beginning of the lesson. Each student is encouraged to discuss the subject interactively and to express their criticisms and suggestions. Presentations and homework are also delivered to the lecturer electronically.

Lecture Coordinators: European Union university instructors in higher education.

User Groups: European Union graduate students in higher education.

References

Aldawood, H. A. Alhejaili, M. Alabadi, O. Alharbi, & G. Skinner (2019). *Integrating Digital Leadership in an Educational Supervision Context: A Critical Appraisal,* 2019 International Conference in Engineering Applications (ICEA), 1-7.

Arslan, H. & Doğan, M. (2020). Yüksek öğretimde hibrid öğrenme modeli. (Hybrid Learning Model in Higher Education Institutions) *Azerbaijan National Academy of Sciences Social Sciences,* (*2)* 140-150.

Aslan, S., & Reigeluth, C. M. (2011). A trip to the past and future of educational computing: Understanding its evolution. *Contemporary Educational Technology*, 2(1), 1-17.

Aybek, Y. H.S. (2017). Üniversite 4.0'a geçiş süreci: kavramsal bir yaklaşım. *AUAd*, *3*(2), 164 - 176.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs: Prentice-Hall.

Bach, S. Haynes, P. Lewis & J. Smith (2007). *Online Learning and Teaching in Higher Education.* Open University Press McGraw-Hill Education UK.

Bécirovìc, S. (2023). *Digital Pedagogy The Use of Digital Technologies in Contemporary Education.* Springer Briefs in Education Open and Distance Education: Springer

Cavin, R. (2007). *Technological Pedagogical Content Knowledge in Pre-Service Teachers Through Microteaching Lesson Study.* In K. McFerrin, R. Weber, R. Carlsen & D. Willis (Eds.), Proceedings of SITE 2008--Society for Information Technology & Teacher Education International Conference (pp. 5214-5220). Las Vegas, Nevada, USA: Association for the Advancement of Computing in Education (AACE).

Clarke, T., & Clarke, E. (2009). Born Digital? Pedagogy and Computer-Assisted Learning. *Education & Training, 51*(5), 395-407.

Coovadia, H. & Ackermann, C. (2021). Digital Pedagogy–An Opportunity or A Threat? *Accounting Education,30*(1), 42–62.

Dangwal, K. L., & Srivastava, S. (2016). Digital pedagogy in teacher education. *International Journal of Information Science and Computing, 3*(2), 67–72.

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence—An emergent boundary concept for policy and educational research. *Education and Information Technologies,* (21) 655–679.

Ferrari, A. Punie, Y. & Redecker, C. (2012). *Understanding Digital Competence in the 21st Century: An Analysis of Current Frameworks* Institute for Prospective Technological Studies (IPTS), European Commission, Joint Research Centre

Freire, P. (1996). *Pedagogy of the oppressed (revised).* New York: Continuum.

Fyfe, P. (2011). Digital Pedagogy Unplugged. *Digital Humanities Quarterly*, 5(3) Available from www.digitalhumanities.org/dhq/vol/5/3/000106/000106.html.

From, J. (2017). Pedagogical digital competence—between values, knowledge and skills. *Higher Education Studies, 7*(2), 43–50.

Fullan, M (2011). *The Moral Imperative Realized*. Corwin Press.

Hauck, M. & Kurek, M. (2017). *Digital Literacies in Teacher Preparation. In: Thorne*, S., May, S. (eds) Language, Education and Technology. Encyclopedia of Language and Education. Springer.

Johnston, B. Macneill, S. & Smyth, K. (2018). *Conceptualizing the digital university, the intersection of policy, pedagogy, and practice.* Palgrave Macmillan imprint is published by the registered company Springer Nature Switzerland.

Klink, M. van der & Alexandrou, A. (2022) Editorial: the call for digital pedagogy, *Professional Development in Education*, *48*(4), 541-545.

Kivunja, C. (2013). Embedding digital pedagogy in pre-service higher education prepares teachers for the digital generation. *International Journal of Higher Education*, *2*(4), 131-142.

Lewin, D. & Lundie, D. (2016). Philosophies of digital pedagogy. *Studies Philosophy and Education*, *35* (3), 235–240.

Maddux, C. D. & Johnson, D. L. (2013). *Technology in education: A twenty-year retrospective*. Routledge.

Miller, M. & Petriwskyj, A. (2013). *New Directions in Intercultural Early Education in Australia*. Springer Science Business Media Dordrecht.

Molnar, A. (1997). Computers in education: A brief history. *The journal*, 24(11), 63-68.

Murty, R., & Rao, K. N. (2019). Integrating digital pedagogies into a typical student learning lifecycle and Its Effect On Exam Performance for Proceedings On, Digital Pedagogy B.V (Gayatri Vidya Parishad College of Engineering (A), Visakhapatnam, Ap, India. Icdp 2019: International Conference On Digital Pedagogies.

Nanjundaswamy, C., Baskaran, S., Leela, M.H. (2021). Digital pedagogy for sustainable learning. Shanlax *International Journal of Education, 9* (3), 179-185.

O'Brien, A. J., Alfano, C., & Magnusson, E. (2007). Improving cross-cultural communication through collaborative technologies. In *Persuasive Technology: Second International Conference on Persuasive Technology*, PERSUASIVE 2007, Palo Alto, CA, USA, April 26-27, 2007, Revised Selected Papers 2 (pp. 125-131). Springer Berlin Heidelberg.

OECD (2013), Leadership for 21st Century Learning, Educational Research and Innovation, *OECD Publishing.* http://dx.doi.org/10.1787/9789264205406-en

OECD (2020). *A Framework to Guide an Education Response to the COVID-19 Pandemic of 2020*. https://read.oecd-ilibrary.org/view/?ref=126_126988-t63lxosohs&title=A-framework-to-guide-an-education-response-to-the-Covid-19-Pandemic-of-2020.

Oliveira, K.K. de S. & Souza R.A.C. (2022). Digital Transformation towards Education 4.0. *Informatics in Education. 21*(2). 283-309.

Omprakash H. M. & Mahaboobvali, K. (2022). Digital Pedagogy; Orientation, Practices, Competencies and Pedagogical Model: A Contemporary Digital Technology*. internatıonal journal of specıal educatıon*, *37* (3).

Oz, O. (2019). Digital Leadership: Being a school leader in the digital world. *International Journal of Leadership Studies*: *Theory and Practice*. *3*(1), 45-57.

Ozer, N. (2021). The human-centred approach in online learning environments: critical digital pedagogies. 1st International Conference on Educational Technology and Online Learning – ICETOL 2021 Full Paper Proceedings.

Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of the COVID-19 pandemic on teaching and learning. *Higher education for the future*, 8(1), 133-141.

Prestridge, S. (2010). The alignment of digital pedagogy to current teacher beliefs. Paper presented at ACEC2010: Digital Diversity. Melbourne, Australia: Australian Council for Computers in Education.

Prensky, M. (2001). *Digital Natives, Digital Immigrants*, MCB University Press.

Pettersson, L.E. (2017). Mobile-Assisted Learning and Higher-Education ESP: English for Physiotherapy. Ling. Poznan. 60, 81–94.

Sarrab, M., Elgamel, L., & Aldabbas, H. (2012). Mobile learning (m-learning) and educational environments. International journal of distributed and parallel systems, 3(4), 31.

Seufert, S., Meier, C., Soellner, M., & Rietsche, R. (2019). A pedagogical perspective on big data and learning analytics: A conceptual model for digital learning support. *Technology, Knowledge and Learning*, 24, 599-619.

Sheninger, E. (2014). *Digital Leadership: Changing Paradigms for Changing Times*. Thousand Oaks, CA.

Shonfeld, M., Cotnam-Kappel, M., Judge, M. (2021). Learning in digital environments: a model for cross-cultural alignment. *Education Tech Research* (*69*), 2151–2170.

Sentürk, Ş. Duran, V. Yilmaz, A. (2020). The Secondary School Students' Opinions on Distance Education. *Journal of Education and e-Learning Research, 7*(4), 360-367.

Steele, J., Holbeck, R., & Mandernach, J. (2019). Defining effective online pedagogy. *Journal of Instructional Research,* 8(2).

Tabesh, Y. (2018). *Digital pedagogy in mathematical learning.* G. Kaiser, H. Forgasz, M. Graven, A. Kuzniak, E. Simmt, & B. Xu (Eds.), Invited lectures from the 13th international congress on mathematical education. ICME-13 monographs. Cham, Switzerland: Springer International Publishing.

TEDMEM. (2020). *COVID-19 sürecinde eğitim: Uzaktan öğrenme, sorunlar ve çözüm önerileri.* Ankara: Türk Eğitim Derneği Yayınları.

Väätäjä, J. O., & Ruokamo, H. (2021). Conceptualizing dimensions and a model for digital pedagogy. *Journal of Pacific Rim Psychology.*

Zhong, L. (2017). Indicators of digital leadership in the context of K-12 education. J*ournal of Education of Technology Development.* 10, 27–40.

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Upskilling Digital Pedagogy

Chapter 2: Theories and Design Principles of Digital Pedagogy

Vrije Universiteit Brussel

CHAPTER TWO: THEORIES AND DESIGN PRINCIPLES OF DIGITAL PEDAGOGY

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Abstract

Digital technologies have immense potential to support innovative teaching and learning. However, the use of these technologies should be supported and guided by grounded pedagogical theories and appropriate design principles to achieve effective learning outcomes. Thus, this chapter examines several theories, approaches, frameworks and design principles that support digital pedagogy. Some of the learning theories and approaches to digital pedagogy covered in this chapter are Behaviorism, Cognitivism, Constructivism, Social Constructivism and Connectivism. Furthermore, this chapter explores how these learning theories can be applied to digital learning. Specifically, pedagogical frameworks and design principles used in digital learning such as Bloom's Digital Taxonomy, Cognitive Load Theory (CLT), Cognitive Theory of Multimedia Learning (CTML), Community of Inquiry (CoI) and Universal Design for Learning (UDL) framework were presented. Finally, this chapter offers some practical examples of how digital technologies can be used to construct inclusive, meaningful and engaging learning experiences. For this purpose, two cases are provided to illustrate the application of the Community of Inquiry (CoI) and Universal Design for Learning (UDL) framework in technology-enhanced classrooms.

1. The Importance of Learning Theories and Design Principles

Digital technologies provide new exciting opportunities for teaching and learning that reflect today's digital world. Educational technologies allow teachers to rethink traditional lectures in favour of more flexible, engaging and personalised learning experiences (Juniu, 2006; Nanjappa & Grant, 2003). However, the use of technology in learning does not necessarily imply innovative pedagogical approaches; how instructors use technology plays a much more important role in the success or failure of implementing technology in schools (Morchid, 2020). An effective digital pedagogy largely depends on instructors' understanding and conscious use of learning theories, approaches and design principles that can support digital learning (Avidov-Ungar & Eshet-Alkalai, 2011). Therefore, the choice of educational technologies should be supported by learning theories and approaches to digital pedagogy that shape and orient the learning process toward specific educational goals.

2. Overview of the Foundational Learning Theories

The foundational learning theories include Behaviorism, Cognitivism, Constructivism, Social Constructivism, and in recent times, Connectivism. Each of these theories provides a unique perspective on teaching and learning that inform most instructional design models and educational practices.

Behaviorism focuses on observable behaviors as the key indicators of learning. Cognitivism, on the other hand, goes beyond behavior to explore and explain the cognitive processes involved in learning. Constructivism asserts that knowledge is constructed actively by the learner. Social Constructivism, in contrast, emphasizes the role of social interaction and cultural context in the learning process. Finally, Connectivism centres on learning that takes place through networks and communities.

The foundational learning theories should be seen as complementary rather than mutually exclusive, as each one provides a unique perspective on teaching and learning. Familiarity with these theories is crucial in selecting the best approach for a given context, target audience, and activity. Moreover, these theories have informed some of the most

important frameworks and theories applied to digital pedagogy. Consequently, understanding the foundational learning theories is essential for digital pedagogy practitioners in creating effective learning experiences for their students.

2.1. Behaviorism

Behaviorism, a theory of learning that emerged in the early 1900s from the work of John B. Watson, is based on the idea that the human mind is a "black box" whose inner workings cannot be fully understood and are subjective (Schunk, 2012).

The central tenet of Behaviorism is classical or Pavlovian conditioning, which is grounded in the stimuli-response framework. According to this theory, behavior is simply the result of a stimulus, and behaviorists analyze the connections between different stimuli and environmental responses. Consequently, Behaviorism sees learning as the acquisition and strengthening of responses (Kesim & Altınpulluk, 2015).

On the pedagogical level, Behaviorism has led to a focus on what can be objectively observed and measured. The core learning principles of Behaviorism include contiguity, repetition, and reinforcement (Ertmer & Newby, 2013). Behaviorist theories of learning, especially with the contributions of Skinner, emphasize the importance of defining measurable learning objectives and the content to be taught, which were previously overlooked (Schunk, 2012). Specifically, Behaviorists assert that the content should be presented from the simplest to the most complex topics and that learners should be supported with continuous reinforcements (i.e., positive feedback) while avoiding punishments, as they can hinder learning (Clark, 2018). Therefore, Behaviorism supports conventional, teacher-centered pedagogical approaches that view learning as a process of acquiring knowledge and memorizing it.

Although this approach to learning is now considered as outdated, it provided the theoretical foundation for the development of teaching machines and programmed instruction (Ertmer & Newby, 2013). Additionally, according to Kesim and Altınpulluk (2015), it remains one of the primary theoretical approaches used in foreign language teaching (e.g. audio-lingual method), quiz-making (e.g. multiple-choice quiz), and

gamification (e.g. badges and certificates). Finally, it is frequently used to reinforce or weaken undesired behaviors, such as providing feedback, recognition, and grades (Clark, 2018).

However, Behaviorism has several limitations and may not be suitable for enhancing higher-order skills such as critical thinking, metacognition, decision-making, and problem-solving, which are the focal points of other learning theories.

2.2. Cognitivism

In the mid-20th century, the emergence of Cognitivism marked a significant shift in the understanding of learning and education. The prevailing Behaviorist approach, which viewed behavior as a product of environmental stimuli, was challenged by Cognitivism's focus on internal mental processes. Cognitivism recognized the vital role played by mental processes, such as attention, perception, memory, and problem-solving, in the acquisition of knowledge (Greitzer, 2002). Rather than simply responding to environmental cues, Cognitivism posited that learners actively engage with information, processing it in a way that facilitates its integration and understanding (Schunk, 2012).

To explain information processing, Cognitivism often uses the two-store memory model proposed by Atkinson and Shiffrin (1968). According to this model, information moves through three memory stores, including sensory registers, short-term memory, and long-term memory, in a linear fashion. Information from all five senses is initially received by the sensory registers, which then filters it through attention. Information that is retained in short-term memory is maintained through rehearsal and linked with related information in long-term memory, where it is encoded for storage. Factors such as meaningfulness, elaboration, organization, and connections with prior knowledge are critical in facilitating the storage of new information.

Cognitivism's emphasis on internal mental processes has led to a better understanding of how learners engage with information and has been particularly relevant in the development of effective digital teaching and learning methods that prioritize meaningful learning and active engagement. One of the key aspects of cognitivism that

is relevant to digital pedagogy is the idea of active information-seeking behavior (Van Merrienboer & Ayres, 2005). This means that learners actively seek out information and engage with it, rather than just passively memorizing it. Online learning environments can provide opportunities for active learning, such as problem-based and interactive activities, simulations, and discussions that engage learners in critical thinking and problem-solving. Furthermore, active learning can be supported through the use of digital tools that enable learners to explore and interact with content in a variety of ways. For instance, digital media such as videos, podcasts, and infographics can be used to present information in an engaging and accessible way, while interactive elements such as quizzes and polls can help learners to actively engage with the material.

Moreover, cognitivism recognizes the importance of prior knowledge and experiences in learning. Learners construct new knowledge by connecting it with their existing knowledge and experiences (Greitzer, 2002). In online learning, instructors can create activities and assessments that require learners to make connections between new and prior knowledge, promoting deeper and more meaningful learning (Juniu, 2006). Furthermore, instructors can use learners' existing knowledge, cognitive abilities, and experiences to tailor the content, activities and assessment methods of their courses, making them more inclusive and responsive to students' individual needs and preferences (Ertmer & Newby, 2013).

Finally, a cognitive approach emphasizes the importance of promoting self-regulated learning (Bandura, 1991), which is especially important in online or blended learning environments where students may not have direct support from instructors. Digital pedagogy can support self-regulated learning and autonomy by allowing learners to control the pace and sequence of their learning. Learners can navigate through content at their own pace, review material as needed, and choose the order in which they engage with learning resources (Deci & Ryan, 1985). In addition, online learning environments can offer a variety of resources and formats to suit different learning styles and preferences. This can include videos, written materials, interactive activities, and more. Giving learners choices in terms of the resources and formats they use to engage with the material can not only enhance their self-regulation, but also increase motivation and

engagement (Beishuizen & Steffens, 2011).

2.3 Constructivism

Constructivism is a psychological, pedagogical and philosophical theory that emerged in the mid-1990s, drawing upon the work of prominent scholars such as Jean Piaget, Lev Semyonovich Vygotsky, John Dewey and Jerome Seymour Bruner (Ertmer & Newby, 2013). While sharing similarities with cognitivism, constructivism differs from traditional cognitive theories in various aspects. Although both cognitivists and constructivists believe that the learner is actively engaged in the process of learning, constructivists see the learner not just as an active receiver of information, but as an active creator of knowledge based on personal experiences and interactions (Dick et al., 2014). In addition, both constructivism and cognitivism acknowledge the importance of metacognition, the ability to reflect on one's own learning processes. Both theories recognize that learners who are aware of their own thought processes and learning strategies are better able to regulate their learning and make connections between new and existing knowledge (Johnson & Davies, 2014). Finally, the social aspect of learning has common ground with Bandura's social cognitive theory. However, while Bandura (1977) emphasizes how children learn from others by watching and imitating behavior (behavioral development), Vygotsky (1978) emphasizes social interactions, language, and culture as the driving force for learning (language and cognitive development).

According to constructivism, learning is an active and reflective process that results from authentic, complex, and meaningful learning experiences that resemble real-life challenges (Amineh & Asl, 2015). In the constructivist view, the role of the instructor is to facilitate learning by providing minimal guidance, encouraging autonomy, and promoting self-directed learning (Nanjappa & Grant, 2003). While encouraging students' autonomy and active exploration, the instructor scaffolds students' learning in their construction of knowledge (Vygotsky, 1978). Additionally, instructors should provide multiple opportunities for peer-to-peer and learner-teacher interaction and collaboration that enable students to reflect, defend, refine, and possibly reconceptualize their construction of new knowledge (Schunk, 2012).

Technology can be a valuable tool in supporting the constructivist approach to learning (Juniu, 2006). Internet browsers encourage active exploration and selection of information to answer inquiry questions, promoting self-assessment and reflection on learning strategies. Interaction and collaboration can be supported by video conferencing tools, wikis, blogs, discussion forums, electronic mailing lists, or social media. Other multimedia programs and tools provide students with opportunities to demonstrate their knowledge in multimodal formats, create artifacts, and share expertise with their peers. For example, presentation software (e.g. PowerPoint, Canva), animation software (e.g. Animaker, Powtoon, Animate), and video software (e.g. iMovie, Moovly, Movie Maker) can be used to help students apply their knowledge by creating tangible products. Thus, according to the constructivist approach to learning, the primary use of technology in education should be to provide learners with multiple opportunities for reflection, questioning, critical evaluation, conceptual connection, and knowledge application through the creation of tangible outputs (Juniu, 2006).

2.4 Social constructivism

Social Constructivism, which originated from the work of Lev Vygotsky in the early 20th century, differs from Piaget's Constructivism in that it views learning as a sociocultural process rather than an individual one (Schunk, 2012). This approach emphasizes that knowledge is constructed and transmitted through social interaction and culture, with learning taking place when individuals actively engage in collaborative and interactive activities. Social interaction enables learners to share knowledge and skills, while communication helps them negotiate meanings as they construct their knowledge (Amineh & Asl, 2015). Vygotsky (1978) also observed that learners could acquire knowledge and skills more effectively with the guidance of more experienced peers or instructors. This guidance can reduce the zone of proximal development (ZPD), which refers to the difference between a learner's current abilities and their potential abilities with support. Thus, teachers are facilitators who create a safe and positive learning environment that encourages students to build meaning based on their experiences, views, values, background, and culture. According to this approach to learning, group activities that promote peer collaboration, reciprocal teaching, and expert guidance

should be encouraged (Schunk, 2012), and students should be challenged with authentic tasks that enable them to solve problems in realistic and meaningful contexts (Morchid, 2020).

Pedagogical approaches based on Socio-Constructivism emphasize learning through doing, collaborating, and reflecting with others (Amineh & Asl, 2015). In digital pedagogy, technology can foster collaboration and problem-based learning beyond what is possible in a traditional classroom (Mbati, 2012). Digital tools such as collaborative whiteboards, discussion boards, synchronous meetings, project management tools, and collaborative editing software make Socio-Constructivism an especially suitable approach to digital pedagogy. For example, Mural and Miro allow learners to brainstorm through digital sticky notes, while Padlet, Jamboard, Flipgrid, Google Meet, Zoom, Teams, Trello, Asana, Dapulse, Google Docs, Sheets, and Slides support collaboration and problem-solving in a variety of ways. Wiki software also enables students to work collaboratively and simultaneously on a project, facilitating joint problem-solving and knowledge construction. Therefore, the wide range of digital tools to support collaboration and authentic tasks makes socio-constructivism a particularly suitable approach to digital pedagogy (Mbati, 2012).

2.5 Connectivism

Connectivism is a learning model advanced by George Siemens (2004) that highlights the critical role of technology and large-scale networks in facilitating learning in the digital age. In the context of digital pedagogy, Connectivism offers an approach that leverages technology to promote collaboration, discussion, and critical evaluation of information, as well as to enhance problem-solving and decision-making skills.

George Siemens (2004) identified several principles of connectivism. One of the key principles of Connectivism is that learning and knowledge rest in diversity of opinions. This principle can be used by encouraging students to explore diverse online sources, engage in discussions with peers, and collaborate with individuals from varied backgrounds and cultures. Social media platforms, such as Twitter and LinkedIn, can facilitate networking with professionals and experts in the field, while blogs like

WordPress or Medium can provide a platform for sharing perspectives and insights on a specific topic.

As Siemens (2004) states, learners need to be able to navigate and evaluate sources of information critically with the vast amount of information available online. This involves not only identifying the most relevant and reliable sources of information, but also being able to interpret, analyse, and synthesise that information in a meaningful way. Technology can be used to support this process through the use of tools like digital libraries, citation managers, and online research databases.

Furthermore, Connectivism highlights the significance of current and precise knowledge as the objective of all learning activities Thus, students should be encouraged to evaluate the credibility and reliability of online sources, to critically assess the accuracy and relevance of information, and to stay up-to-date with the latest developments in their field of study (Utecht & Keller, 2019).

According to Connectivism, an essential skill for contemporary learners is the ability to identify and establish connections between various fields, ideas, and concepts. This principle can be applied by offering students interdisciplinary learning opportunities that enable them to investigate and link various subject areas and apply their knowledge in real-world settings. This approach can be facilitated through the use of digital tools that support collaborative and simultaneous work on projects, including wiki software (Downes, 2010).

In addition, Connectivism highlights the importance of cultivating and sustaining connections to facilitate continuous learning. This principle can be operationalized by promoting an environment of constant communication and collaboration among teachers, students, and external experts (Ravenscroft, 2011). This can involve creating opportunities for online discussions, group projects, and joint problem-solving activities that allow students to learn from one another and from field experts.

Finally, Siemens (2004) stresses that decision-making is an inherent component of the learning process. Thus, problem-based learning scenarios can provide an

opportunity for students to develop their decision-making skills and tackle practical issues. PBL involves presenting learners with real-world problems or scenarios and challenging them to work collaboratively to find solutions (Savin-Baden, 2014). In this context, digital tools can play a significant role in promoting collaborative work, knowledge sharing, and critical thinking, which are fundamental skills for effective decision-making by providing access to a wide range of resources, data, and tools that can be used to support the problem-solving process. For example, learners might use online databases or search engines to gather information relevant to the problem they are working on, or they might use software tools like Trello or Asana to manage their project and stay on track.

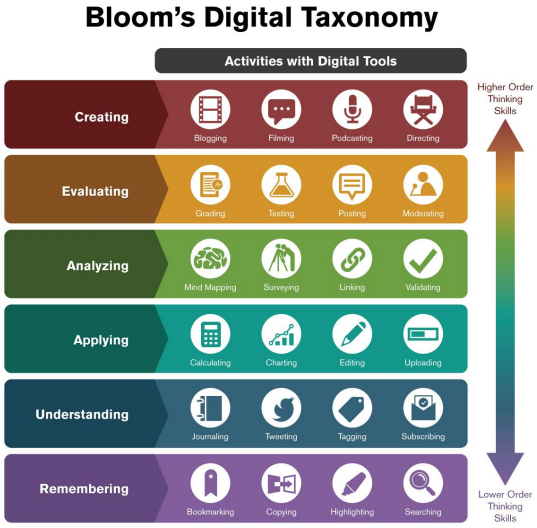
3. Pedagogical Frameworks and Design Principles in Digital Pedagogy

The field of digital teaching and learning has seen an influx of various frameworks and design principles that are grounded in one or more of the major learning theories. Some of the most important ones will be examined in this chapter to provide the reader with both theoretical and practical knowledge on how to design digital learning experiences that foster active learning, collaboration, and engagement.

3.1 Bloom's Digital Taxonomy

Bloom's taxonomy (Bloom et al., 1956) is a framework which differentiates progressive levels of learning, from remembering to evaluating. Afterwards, Anderson et al. (2001) added to Bloom et al.'s original taxonomy a new level of learning, which is 'creating' new knowledge, which represents the highest function of the taxonomy. In more recent years, Bloom's Taxonomy was revised in light of the increased use of digital technologies in education, which led to the emergence of a Digital Bloom's Taxonomy (Churches, 2010). Bloom's Digital Taxonomy (see Figure 1) reveals unique ways to use technology and digital tools to facilitate student learning experiences and outcomes.

Figure 1. *Bloom's Digital Taxonomy Infographic Credit: Ron Carranza*



Remembering. At this level, learners are expected to recall and recognize information. Digital tools such as bookmarking, highlighting, bullet pointing, flashcards, online quizzes, and educational games can be used to facilitate memorization and recall of information. Interactive multimedia presentations can also provide learners with memorable experiences that aid in remembering information.

Understanding. At this level, learners are expected to explain, interpret, summarize, and compare concepts. Digital tools such as blog journaling, concept mapping software and multimedia presentations, can help learners understand complex concepts by providing interactive and engaging experiences.

Applying. At this level, learners are expected to apply their knowledge in new situations. Digital tools such as simulations and virtual labs can help learners apply their knowledge in a safe and controlled environment. Collaborative tools such as wikis and Google Docs can also be used to encourage learners to apply their knowledge by working together on projects.

Analyzing. At this level, learners are expected to break down and analyze information. Digital tools such as mind mapping or data visualization software and analytical tools can be used to help learners analyze and interpret data. Virtual case

studies and interactive scenarios can also be used to help learners analyze and solve problems.

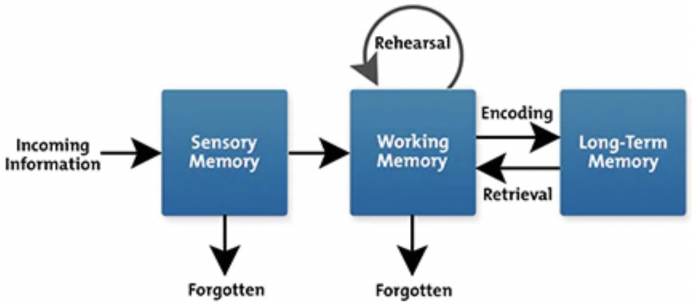
Evaluating. At this level, learners are expected to make judgments and evaluate information. Digital tools such as online debates and discussion forums can be used to encourage learners to evaluate information critically. Rubrics and self-assessment tools can also be used to help learners evaluate their own work and progress.

Creating. At this level, learners are expected to create new ideas, products, or solutions. Digital tools such as digital storytelling software, video editing tools, and graphic design tools can be used to help learners create their own multimedia projects. Collaborative tools such as wikis and Google Docs can also be used to encourage learners to work together to create new ideas and solutions.

3.2 Cognitive Load Theory (CLT)

One of the most widely known cognitive theories is the Cognitive Load Theory (CLT) by Sweller et al. (1998). This theory builds upon the well-known human information processing model, which explains how the human brain processes and stores information (Figure 2).

Figure 2. *Information Processing Model*



Source: *Sweller et al., 1998*

According to this model, the memory system is composed of three fundamental components: sensory memory, working memory, and long-term memory. Sensory memory functions as a filter to identify and select significant stimuli for further processing. The information selected by the sensory memory is then transferred to the working memory, where it is either processed or ignored. The working memory is essential for learning since it is the memory system employed by students while attending a lesson. However, the working memory has limited capacity in terms of both duration and capacity, which is referred to as "cognitive load." Under certain circumstances, these limitations may deplete cognitive resources and impede learning. Sweller et al. (1998) proposed that the working memory load could be influenced by several factors, including the complexity of the information relative to the learner's expertise (intrinsic cognitive load), the way information is presented to the learner (extraneous cognitive load), and the amount of learners' cognitive resources used to acquire and store new knowledge in long-term memory (germane cognitive load).

Instructors should have knowledge of the essential principles of Cognitive Load Theory (CLT) to not only comprehend how learners process knowledge but also to decrease cognitive load, which is imperative for encoding information in long-term memory. The CLT provides various recommendations for creating effective materials that optimize cognitive load for learners (Van Merrienboer & Ayres, 2005). These guidelines are particularly significant in digital pedagogy since technology is increasingly used in education. The utilization of multimedia resources, like images, audio, and animations in e-learning environments, can lead to cognitive overload and impede learning outcomes if not adequately designed (Low, 2009; Skulmowski & Xu, 2021). The CLT guidelines (Clark et al., 2006; Sweller et al., 1998) aim to simplify the intrinsic cognitive load, eliminate or reduce extraneous cognitive load, and maximize germane cognitive load, as explained below:

Simplify Intrinsic Cognitive Load: The intrinsic cognitive load represents the inherent complexity of the task, determined by the content's difficulty. To simplify intrinsic cognitive load, teachers should ensure that digital learning materials are appropriate for

the learners' expertise level. They should simplify complex concepts by dividing them into smaller, more manageable pieces of information.

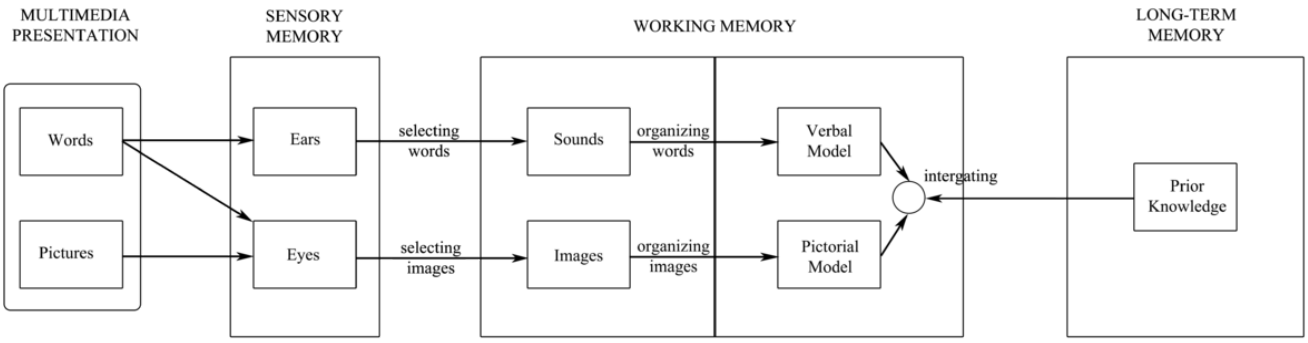
Reduce Extraneous Cognitive Load: The design of digital learning materials may cause extraneous cognitive load that distracts learners from the learning objectives. To reduce extraneous cognitive load, teachers should create digital learning materials that are clear and easy to follow. They should minimize the use of irrelevant graphics or multimedia (seductive details effect) and avoid splitting related information into different pages or sections (split-attention effect). Furthermore, learners are more likely to convert new information into long-term memory when redundant information is minimized (redundancy effect). Finally, the extraneous cognitive load is reduced when presenting information through both visual and auditory methods without redundancy (modality effect).

Maximize Germane Cognitive Load: The germane cognitive load is the cognitive load that supports learning and is necessary for learners to process and understand new information. To maximize germane cognitive load, teachers should design digital learning materials that encourage active engagement and reflection. For instance, they can use interactive activities or exercises that require learners to apply the new information or concepts they have learned.

3.3 Cognitive Theory of Multimedia Learning (CTML)

Another cognitive theory commonly used in digital pedagogy is the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2005). This theory is underpinned by three fundamental principles of cognitive science (as shown in Figure 3). Firstly, it posits that the human information processing system is comprised of two channels for visual and verbal processing (the dual-channels assumption), and research suggests that individuals are able to learn more effectively when presented with a combination of words and images, rather than words alone. Secondly, it asserts that each processing channel has a limited capacity (the limited capacity assumption). Finally, it posits that active learning necessitates the application of a coordinated set of cognitive processes during the learning process (the active processing assumption).

Figure 3. *Cognitive Theory of Multimedia Learning (CTML)*



Source: Mayer, 2005

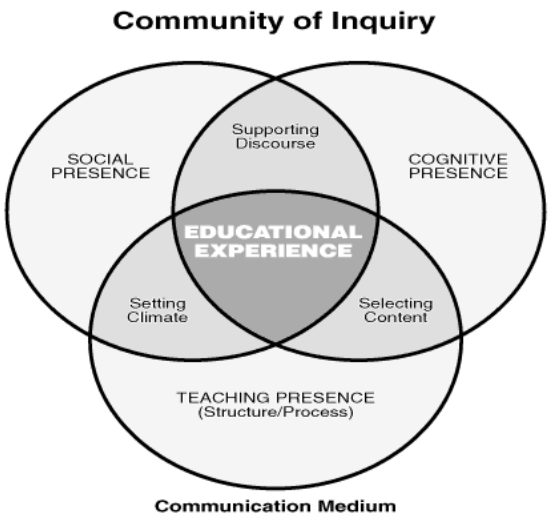
Mayer (2009) identifies 12 multimedia instructional principles that should guide the design of multimedia presentations. Among those, there is the modality principle, coherence principle, spatial and temporal contiguity principle, segmenting principle, personalization principle, signalling principle and redundancy principle. The modality principle indicates that people learn best when information is presented by combining visual and auditory methods. The coherence principle states that all information which is not relevant should be eliminated. The spatial and temporal contiguity principle informs us that the words should be aligned and presented simultaneously to the corresponding graphics. The segmenting principle affirms that people learn best when multimedia messages are presented in smaller chunks rather than in a continuous stream. The personalization principle suggests presenting the information in an informal instead of a formal way. The signalling principle claims that important visual or textual cues should be highlighted to direct learners' attention. According to the redundancy principle, combining graphics and narration can enhance learning more effectively than combining graphics, narration, and printed text. However, it is important to keep in mind that these principles are interdependent. For instance, the effectiveness of using both text and figures in a presentation varies depending on whether the information is relevant for understanding (coherence principle) or redundant (redundancy principle) (Low, 2009).

3.4 Community of Inquiry (CoI)

The Community of Inquiry (CoI) model for online and blended learning environments by Garrison et al. (2000) highlights 3 elements that can create a meaningful (collaborative-constructivist) learning experience: cognitive presence (processes and strategies); social and relational presence; teaching presence , as illustrated in Figure 4.

Social presence is the “ability of learners to project themselves socially and emotionally, thereby being perceived as “real people” in mediated communication” (Garrison & Arbaugh, 2007, p.159). Cognitive presence is the “extent to which learners can construct and confirm meaning through sustained reflection and discourse” (Garrison & Arbaugh, 2007, p.161). Teaching presence is the “design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes” (Garrison & Arbaugh, 2007, p. 163).

Figure 4. *Community of Inquiry framework (CoI)*



Source: Garrison et al., 2000

The use of technology in online learning environments can help facilitate the development of these three types of presences. Ice-breaker activities, such as personal introductions, informal group discussions, and digital storytelling, can enhance social presence. Additionally, learning management systems (LMS) can enable students to

create personal profiles, which can help teachers and students better understand one another. Online cognitive presence can be fostered by promoting active exploration and investigation, asking challenging questions for online discussions, using breakout rooms during online lectures for student discussions, and recording online lessons for students to review content. Finally, online teacher presence can be enhanced by providing meaningful individual and collaborative activities, triggering students' curiosity, supporting students' agency and autonomy to enhance intrinsic motivation, and providing constructive feedback and effective assessment.

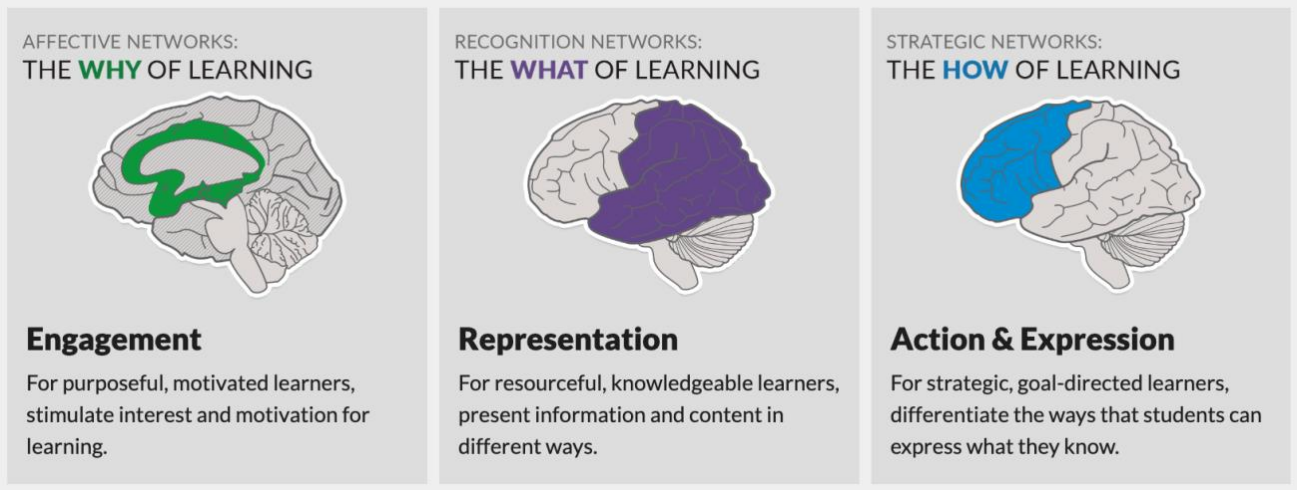
To maximize learning, it is recommended that these strategies be used in combination, as the three types of presences overlap and are interdependent on each other. By leveraging these three presences, instructors can design engaging and meaningful online learning experiences that foster collaboration, critical thinking, and deep learning.

3.5 Universal Design for Learning (UDL) Framework

The Universal Design for Learning (UDL) framework was developed in 1990 and early 2000 by the Center for Applied Special Technology (CAST) for making learning more accessible, meaningful and engaging through the use of digital technologies (Rao et al., 2021). Core UDL principles are addressing students' different needs, abilities and interests while reducing barriers that prevent them from reaching their full potential and providing equitable learning opportunities (Basham et al., 2016).

The UDL framework is based on scientific research about how humans learn, which encompasses three networks: affective, recognition and strategic networks (CAST, 2018). UDL guidelines focus on these three networks while acknowledging learners' variability to support the design of learning experiences through multiple means of Engagement, Representation, Action & Expression (see Figure 5).

Figure 5. *Universal Design for Learning Guidelines*



Source: CAST, 2018

The UDL framework, used as part of an instructional design process, provides a structure to design inclusive, personalised and flexible lessons and instructional material (Meyer et al., 2014). In the literature, there are various examples of how UDL can be applied at various levels (primary, secondary and tertiary education) and for different instructional goals (Ok et al., 2017; Rao et al., 2014). Among those, a wide number of studies have applied the UDL framework in online learning environments (Basham et al., 2016; Hollingshead & Carr-Chellman, 2019; Tobin, 2014).

In a technology-enhanced learning environment, several digital tools provide powerful means to support learners' engagement, representation, action and expression (Rao et al., 2021). For example, engagement can be fostered through tools that encourage interaction and collaboration, such as collaborative documents (e.g. Google Docs) or digital quiz tools (Kahoot, Quizalize, Quizlet Live, Socrative), digital flashcards (Quizlet, Memrise); multimodal online discussions (e.g. Padlet, Flipgrid) or synchronous discussions (e.g. breakout room activities). Some of the digital tools to support representation are digital graphic organizers (e.g., mind maps, Venn diagrams, infographics) video captioning, presentation slides, graphics, text-to-speech, highlighters, web pages and online curriculum materials. Finally, some of the digital tools for action and expressions are online collaborative documents and tools (e.g., Google Docs,

BoomWriter), presentation software (e.g., Powerpoint, Google Slides, Canva, Pixton), animated video tools (Powtoon, Animaker, Animoto), audio clips (audio apps on devices), digital graphic organizers (Read/Write/Think Story Map & Graphic Map, My Study Bar) and interactive whiteboard (Explain Everything, Miro, Mural) (Rao et al., 2021).

3.6 Self-Regulated Learning (SRL) Theory

Self-regulated learning theory (SRL) is a pedagogical approach that focuses on teaching students to be active agents in their own learning. SRL is based on the idea that learners who can effectively manage their learning processes, monitor their own understanding, and regulate their motivation and emotions are better equipped to succeed in academic and real-life settings (Persico & Steffens, 2017).

One of the pioneers of SRL is Barry Zimmerman, who has developed a comprehensive model of SRL. Zimmerman's model (2000) identifies three phases of self-regulation: forethought, performance, and self-reflection. The forethought phase involves goal setting, planning, and developing an understanding of the task at hand. The performance phase involves monitoring progress, self-instruction, and task strategies. The self-reflection phase involves evaluating outcomes, attributing success or failure, and adjusting strategies for future learning.

Self-regulated learning theory (SRL) plays a critical role in digital pedagogy as it aligns with the goals of technology-enhanced learning environments. In digital settings, learners have more control over their learning process, and SRL theory emphasizes the importance of learners being active agents in their own learning (Johnson, 2014).

To facilitate SRL in digital pedagogy, instructors should equip students with knowledge and skills to self-regulate their learning by providing them with opportunities for autonomy and choice (Steffens, 2006). For instance, instructors can encourage learners to set goals for their learning using platforms like Google Keep or Trello to create goal-setting boards and track their progress towards achieving their goals. Moreover, instructor can offer various resources, learning materials, and assessment options in a Learning Management Systems. This allows learners to take control of their learning and

make decisions that align with their own learning preferences (Beishuizen & Steffens, 2011).

Moreover, students should be taught how to monitor their progress and adjust their strategies as needed to achieve their goals (Lee & Tsai, 2011). Teachers can provide support and guidance through regular feedback, check-ins, and scaffolding to help students stay motivated and engaged. Ideally, teachers' feedback should be designed to be timely, clear, specific, and related to critical dimensions of the task, process and self-regulation level, in a way that fill a gap's understanding and/or suggest more effective strategies for processing and understanding the material (Hattie & Timperley, 2007).

Finally, students should be encouraged to reflect on their performance and evaluate their level of understanding, effort, strategies used on tasks and improvement in relation to their goals. For instance, students can use digital journals, portfolios or self-assessment tools to identify areas for improvement, modify their goals or strategies, and reinforce positive learning behaviors (Nicol & Macfarlane-Dick, 2006). Moreover, peer feedback can provide learners with opportunities to discuss and reflect on their learning experiences and identify areas for improvement, share knowledge and resources, and receive support from others (Steffens, 2006). Digital tools like Zoom, Google Meet, or Slack can be used to foster peer-to-peer collaboration and support.

4. Cases

Case 1 - How to apply the Community of Inquiry framework in an online course

The Community of Inquiry framework has often been used as a learning design model for online learning at all levels of education, from K12 (Sanders & Lokey-Vega, 2020) to postgraduate education (Nolan-Grant, 2019). This model has often been used to overcome the lack of engagement and motivation that students in an online environment may experience by facilitating interaction between learners and their teachers, between peers and between the learners and the online resources (Fiock, 2020). These types of interaction depend on three elements, namely cognitive presence,

social presence, and teaching presence (Garrison & Arbaugh, 2007). All elements are necessary to create a meaningful learning experience which, according to the CoI framework, depends on the creation of a community.

The following case study offers a practical approach for implementing the CoI framework into an online course based on the study of Sanders and Lokey-Vega (2020) that collects the best instructional strategies for fostering cognitive presence, social presence, and teaching presence in a K-12 setting.

Cognitive Presence and Course Design

Cognitive presence is the ability to construct meaning through sustained reflection and communication (Nolan-Grant, 2019). It includes four phases (see Figure 6): (1) a triggering event, which defines the focus of further inquiry; (2) exploration of the issue; (3) integration, which enables learners to construct meaning from concepts formed in the previous phase; and (4) resolution, through the application of students' new skills and knowledge into real-world scenarios (Garrison et al., 2000).

In the case study of Sanders and Lokey-Vega (2020), teachers used real-world examples to trigger students' interest and provided students with activities related to the inquiry process. They also used direct instruction and offered opportunities to brainstorm, explore, and reflect on the issue under analysis in online discussions. They provided resources such as articles, short videos, and interactive games to guide student knowledge construction. Finally, teachers used discussion strategies to promote the integration of ideas, engaged in discussions with students, and used modelling and information organizers, such as tables, to help students apply the new skills and knowledge to solve the problem.

Social Presence and Course Design

Social presence refers to the degree to which students are able to share their ideas, emotions and experiences, connect with others and feel part of a community (Fiock, 2020). Social Presence is composed of three aspects (see Figure 6): (1) emotional (affective) expression, which defines learners' ability to share their personality, emotions

and values; (2) open communication, which is the degree to which students feel free to express themselves, develop aspects of mutual awareness and recognition; and (3) group cohesion, which describes a sense of group commitment (Garrison et al., 2000).

In the case study, teachers used humanization strategies, such as adopting informal ways of communicating with students to bridge the distance between learner and teacher. They promoted social presence through activities that enhanced affective expression, by allowing students to express themselves using different tools (e.g. whiteboard, microphone, chat box, or breakout rooms). Furthermore, teachers ensured that learners felt safe to express themselves by teaching students adequate ways of interacting with their peers and by monitoring students' synchronous and asynchronous discussions. The teachers fostered open communication and group cohesion by using small groups to promote collaboration and communication between students and the teacher. Finally, group cohesion was enhanced through the use of synchronous break-out rooms in which students were teaching their peers in one-on-one, small-group, and larger-group settings.

Teaching Presence and Course Design

Teaching presence, which describes the design and facilitation of the learning experience, is the component of the CoI framework over which teachers have the most control (Fiock, 2020). It comprises three factors (see Figure 6): (1) design and organization (e.g., designing curricular material, establishing guidelines and evaluation criteria, etc.); (2) facilitation (e.g., setting course climate, ensuring student's understanding and participation, etc.); and (3) direct instruction (e.g., presenting content/questions, providing scaffolding, giving detailed feedback, etc.) (Garrison et al., 2000).

In the analyzed case, teacher presence was facilitated through various practices, such as establishing class norms, rules, and expectations that students could collectively abide by. Teachers planned and communicated the course content, instructional activities, and objectives to students to ensure they remained informed. They utilized interactive and diverse approaches to present the course content to capture students'

interest and attention. Facilitating discourse by integrating technology tools, such as Kahoot, Quizlet, and Blackboard Learning, was a crucial element in the pedagogical practices of the participating teachers. Finally, teachers provided timely and regular feedback to students via various channels, including written comments on assignments, email, one-on-one sessions, phone conversations, and text messages.

Figure 6. *Elements, Categories and Indicators of CoI Framework*

Elements	Categories	Indicators (examples)
Cognitive Presence	Triggering events	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Apply new ideas
Social Presence	Emotional expression	Emotions
	Open communication	Risk-free expression
	Group cohesion	Encouraging collaboration
Teaching Presence	Instructional management	Defining and initiating discussion topics
	Building understanding	Sharing personal meaning
	Direct instruction	Focusing discussion

Case 2 - How to apply the UDL Framework in online or hybrid learning environments

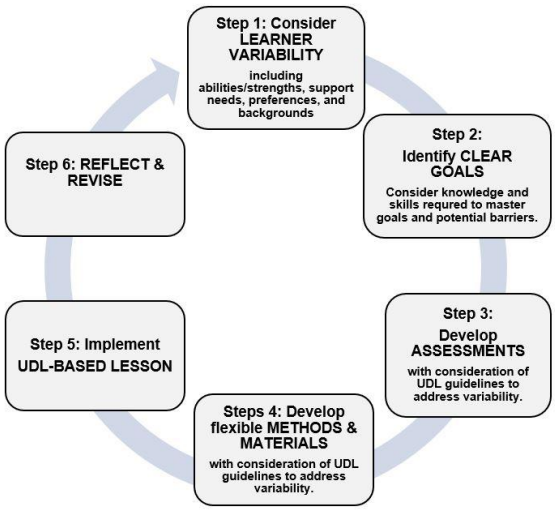
In an online or hybrid learning environment, students may experience more barriers than in a traditional classroom environment (e.g. lack of organization, motivation, self-regulation skills), especially those with disabilities in physical, learning, language, or behavior areas (Hollingshead & Carr-Chellman, 2019). Universal Design for Learning (UDL) is a helpful framework that allows teachers to integrate digital tools in purposeful and intentional ways that support students' needs, engagement, motivation, and

collaboration, and help them become self-directed learners (Courey et al., 2013; Tobin, 2014).

The UDL Design Cycle

The UDL framework comprises three principles, nine guidelines and thirty-one checkpoints, which should be considered while designing inclusive learning environments (see udlguidelines.cast.org for more information). Although there is no consensus on how to apply the UDL framework, Rao (2021) developed the "UDL Design Cycle" based on the widely used ADDIE model of instructional design (Figure 7).

Figure 7. *UDL Design Cycle*

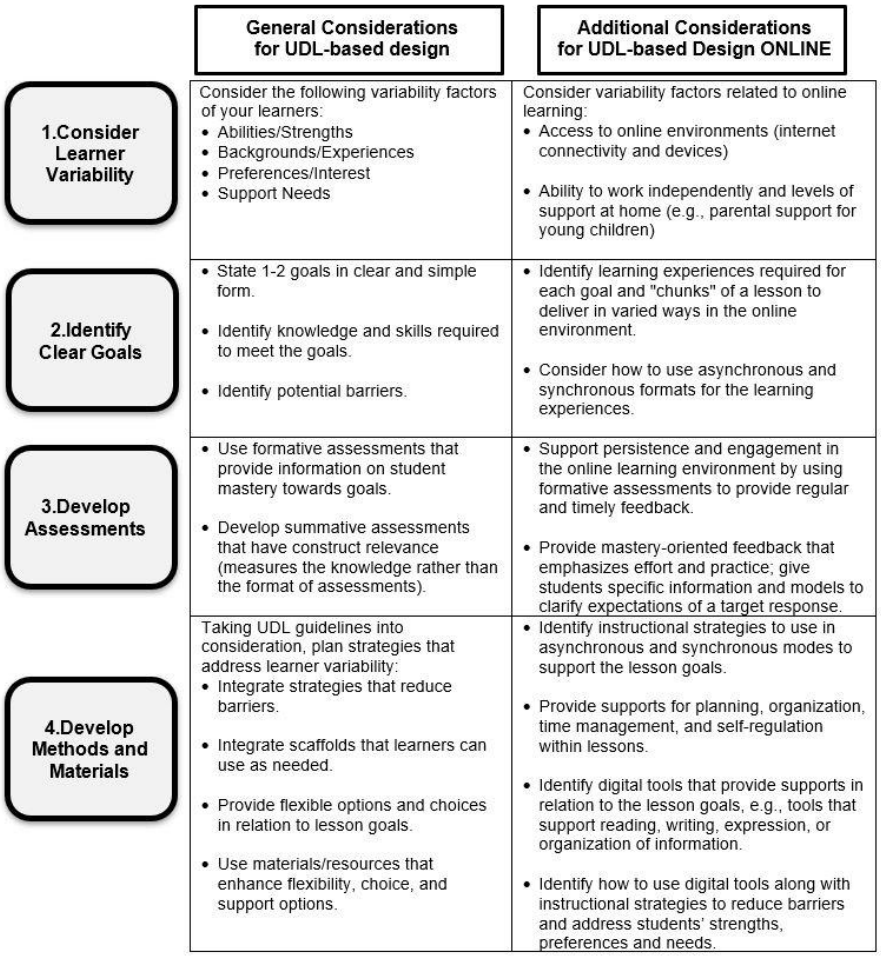


Source: Rao (2021).

The UDL Design Cycle starts with considering learner variability, which includes factors such as specific abilities, strengths, needs and interests. The next step is to identify clear goals and consider the knowledge and skills students will need to meet those goals and the barriers they might face. The following steps (develop assessment, flexible methods and material and implement UDL-based lessons) should take into account learners' variability. This design model can be applied in any educational setting, whether face-to-face, hybrid, blended or fully online environment. However, teachers

should be aware of additional factors when designing technology-enhanced learning experiences (Figure 8).

Figure 8. *UDL Design Considerations for Online Learning*



	General Considerations for UDL-based design	Additional Considerations for UDL-based Design ONLINE
1.Consider Learner Variability	Consider the following variability factors of your learners: • Abilities/Strengths • Backgrounds/Experiences • Preferences/Interest • Support Needs	Consider variability factors related to online learning: • Access to online environments (internet connectivity and devices) • Ability to work independently and levels of support at home (e.g., parental support for young children)
2.Identify Clear Goals	• State 1-2 goals in clear and simple form. • Identify knowledge and skills required to meet the goals. • Identify potential barriers.	• Identify learning experiences required for each goal and "chunks" of a lesson to deliver in varied ways in the online environment. • Consider how to use asynchronous and synchronous formats for the learning experiences.
3.Develop Assessments	• Use formative assessments that provide information on student mastery towards goals. • Develop summative assessments that have construct relevance (measures the knowledge rather than the format of assessments).	• Support persistence and engagement in the online learning environment by using formative assessments to provide regular and timely feedback. • Provide mastery-oriented feedback that emphasizes effort and practice; give students specific information and models to clarify expectations of a target response.
4.Develop Methods and Materials	Taking UDL guidelines into consideration, plan strategies that address learner variability: • Integrate strategies that reduce barriers. • Integrate scaffolds that learners can use as needed. • Provide flexible options and choices in relation to lesson goals. • Use materials/resources that enhance flexibility, choice, and support options.	• Identify instructional strategies to use in asynchronous and synchronous modes to support the lesson goals. • Provide supports for planning, organization, time management, and self-regulation within lessons. • Identify digital tools that provide supports in relation to the lesson goals, e.g., tools that support reading, writing, expression, or organization of information. • Identify how to use digital tools along with instructional strategies to reduce barriers and address students' strengths, preferences and needs.

Source: Rao (2021).

In addition to general variability factors, in an online environment it is important to consider whether students are equipped and can independently navigate the required technological devices. Another important factor that should be taken into consideration in online learning is students' self-regulatory skills, as they may have difficulty engaging in classroom activities without the physical presence and guidance of the teacher. Thus, instructional strategies that help students develop self-regulation, time-management and

organizational skills are essential for keeping students engaged and motivated in an online environment.

The digital environment offers several opportunities for supporting students' engagement and persistence. For instance, without a fixed class time, teachers can meet the learning objectives in different ways. Lessons can be structured with several activities that consider the different times required from each student to accomplish them based on students' needs and abilities. These activities can also be segmented into shorter learning experiences, or "chunks" for ensuring better comprehension.

Engagement is also supported through formative assessment that provides timely feedback and mastery-oriented feedback that values effort and practice and is specifically related to critical dimensions of the task or process of learning. This type of feedback clarifies faulty interpretations and/or suggests more effective strategies for processing and understanding the material.

When developing methods and materials, digital tools should be selected based on their features and ability to reduce students' barriers in an online environment and the lesson goals. Figure 9 provides a comprehensive, yet not exhaustive, overview of some digital tools that can support key skills areas (reading, writing, demonstration of knowledge, organization and self-regulation).

Figure 9. *Examples of Digital Tools*

Skills	Reducing barriers and providing support with digital tools	Examples of Digital Tools
Reading	• Utilize digital text features, such as text to speech, annotations, vocabulary and comprehension supports, translation • Text-to-Speech (TTS) helps with decoding and reading fluency; Dual Highlighting with TTS helps students track the word being read out aloud • Literacy support tools allow teachers and students to annotate and highlight digital text, which can support comprehension	• Text to Speech • Literacy support extensions (e.g., Read & Write for Chrome • Just Read • Natural Reader • Voice Dream Reader (app) • Using digital text features of e-textbooks
Writing	• Digital graphic organizers support brainstorming and planning • Speech to text tools support generation of text • Grammar and spell-check tools support revision and editing	• Digital graphic organizers (Lucid Chart, MindMup, Kidspiration Maps) • Speech to Text apps • Grammarly, Ginger (browser extensions)
Demonstration of knowledge	• Multimodal tools that allow students to integrate text, images, audio, and video can provide ways to demonstrate what they know. • Multimodal tools can provide ways for students to develop and express ideas with feedback from the teacher.	• Book Creator, UDL Book Builder • Infographics (e.g., Canva, Piktochart) • Flipgrid • Padlet
Organization and Self-Regulation	• Checklist apps • Calendar and reminder tools • Weekly Check-in form	• Google Keep • Evernote • Google Forms

Source: Rao (2021).

References

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages*, 1(1), 9-16.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Kruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* Upper Saddle River, NJ: Pearson.

Atkinson, R., & Shiffrin, R. (1968). Human memory: a proposed system and its control processes. *Psychology of Learning and Motivation*, 2, 89–195.

Avidov-Ungar, O., & Eshet-Alkalai, Y. (2011). Teachers in a World of Change: Teachers' Knowledge and Attitudes towards the Implementation of Innovative Technologies in Schools. *Interdisciplinary Journal of E-Learning and Learning Objects*, 7(1), 291-303

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, *50*(2), 248–287. https://doi.org/10.1016/0749-5978(91)90022-l

Basham, J. D., Smith, S. J., & Satter, A. L. (2016). Universal Design for Learning: Scanning for alignment in K–12 blended and fully online learning materials. *Journal of Special Education Technology*, 31(3), 147–155. https://doi.org/10.1177/0162643416660836

Beishuizen, J., & Steffens, K. (2011). A conceptual framework for research on self-regulated learning. *Self-regulated learning in technology enhanced learning environments* (pp. 1-19). Brill.

Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of educational objectives: The classification of educational goals: Handbook 1: The cognitive domain. New York, NY: W. H. Freeman.

CAST (2018). *Universal Design for Learning Guidelines version* 2.2. Retrieved October 2 from http://udlguidelines.cast.org

Churches, A. (2010). *Bloom`s digital taxonomy*. Retrieved September 30, 2022 from http://burtonslifelearning.pbworks.com/w/file/fetch/26327358/BloomDigitalTaxonomy2001.pdf

Clark, K. R. (2018). Learning theories: behaviorism. *Radiologic technology*, 90(2), 172-175.

Clark, R.C., Nguyen, F. and Sweller, J. (2006). E*fficiency in learning: evidence-based guidelines to manage cognitive load*. San Francisco: Pfeiffer.

Courey, S. J., Tappe, P., Siker, J., & LePage, P. (2013). Improved lesson planning with universal design for learning (UDL). *Teacher education and special education*,

36(1), 7-27.
Dick, W., Carey, L., & Carey, J. O. (2014). *Systematic Design of Instruction, The Loose-Leaf Version (8th Edition)* (8th ed.). Pearson.
Downes, S. (2010). Learning networks and connective knowledge. In *Collective intelligence and E-Learning 2.0: Implications of web-based communities and networking* (pp. 1-26). IGI global.
Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance improvement quarterly*, *26*(2), 43-71. https://doi.org/10.1002/piq.21143
Garrison, D. R., & Arbaugh, J. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, *10*(3), 157–172. https://doi.org/10.1016/j.iheduc.2007.04.001
Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education model. *The Internet and Higher Education*, 2(2-3), 87-105.
Greitzer, F. L. (2002). A cognitive approach to student-centered e-learning. In *proceedings of the human factors and ergonomics society annual meeting* (Vol. 46, No. 25, pp. 2064-2068). Sage CA: Los Angeles, CA: SAGE Publications.
Hollingshead, A., & Carr-Chellman, D. (2019). Engaging Learners in Online Environments Utilizing Universal Design for Learning Principles. *E-Learn*, *2019*(2). https://doi.org/10.1145/3310377.3310383
Johnson, G., & Davies, S. (2014). Self-regulated learning in digital environments: Theory, research, praxis. *British Journal of Research*, *1*(2), 1-14.
Juniu, S. (2006). Use of Technology for Constructivist Learning in a Performance Assessment Class. *Measurement in Physical Education and Exercise Science*, *10*(1), 67–79. https://doi.org/10.1207/s15327841mpee1001_5
Kesim, M., & Altınpulluk, H. (2015). A Theoretical Analysis of Moocs Types from a Perspective of Learning Theories. Procedia - Social and Behavioral Sciences, 186, 15–19. https://doi.org/10.1016/j.sbspro.2015.04.056
Lee, S. W. Y., & Tsai, C. C. (2011). Students' perceptions of collaboration, self-regulated learning, and information seeking in the context of Internet-based learning and traditional learning. *Computers in human behavior*, 27(2), 905-914.
Low, R. (2009). Cognitive Architecture and Instructional Design in a Multimedia Context. *Cognitive Effects of Multimedia Learning*, 1–16. https://doi.org/10.4018/978-1-60566-158-2.ch001
Mayer, R. E. (2005). Cognitive Theory of Multimedia Learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 31–48). Cambridge University Press. https://doi.org/10.1017/CBO9780511816819.004
Mayer, R. E. (2009). *Multimedia Learning* (2nd ed.). Cambridge University Press.

Mbati, L. A. (2012). Online learning for social constructivism: Creating a conducive environment. *Progressio*, *34*(2), 99-119.

Meyer, A., Rose, D. H., & Gordon, D. T. (2014). *Universal Design for Learning: Theory and practice*. CAST Professional Publishing.

Morchid, N. (2020). The social constructivist response to educational technology. *International Journal of English Literature and Social Sciences*, *5*(1), 263-270.

Nanjappa, A., & Grant, M. M. (2003). Constructing on constructivism: The role of technology. *Electronic Journal for the integration of Technology in Education*, *2*(1), 38-56.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in higher education*, 31(2), 199-218.

Nolan-Grant, C. R. (2019). The Community of Inquiry framework as learning design model: a case study in postgraduate online education. *Research in Learning Technology*, *27*.

Ok, M. W., Rao, K., Bryant, B. R., & McDougall, D. (2017). UDL in the preK-12 classroom: A systematic review of research. *Exceptionality*, *25*(2), 116-138. https://doi.org/10.1080/09362835.2016.1196450

Persico, D., & Steffens, K. (2017). *Self-Regulated Learning in Technology Enhanced Learning Environments. Technology Enhanced Learning, 115–126.* doi:10.1007/978-3-319-02600-8_11

Ravenscroft, A. (2011). Dialogue and connectivism: A new approach to understanding and promoting dialogue-rich networked learning. *International Review of Research in Open and Distributed Learning*, 12(3), 139-160.

Rao, K., Ok, M. W., & Bryant, B. R. (2014). A review of research on universal design educational models*. Remedial and Special Education*, *35*(3), 153-166. https://doi.org/10.1177/0741932513518980.

Rao, K. (2021). Inclusive Instructional Design: Applying UDL to Online Learning. *Journal of Applied Instructional Design*, *10*(1). https://doi.org/10.51869/101/kr

Sanders, K., & Lokey-Vega, A. (2020). K-12 Community of Inquiry: A case study of the applicability of the Community of Inquiry framework in the K-12 learning environment. *Journal of Online Learning Research*, *6*(1), 35-56.

Savin-Baden, M. (2014). Using problem-based learning: New constellations for the 21st century. *The Journal on Excellence in College Teaching*, 25(3,4), 197-219.

Schunk, D. H. (2012). *Learning Theories An Educational Perspective* (6th ed.). Boston, MA: Pearson.

Siemens, G. (2004). Connectivism: A Learning Theory for the Digital Age. *International Journal of Instructional Technology and Distance Learning*, *2*(1). http://jotamac.typepad.com/jotamacs_weblog/files/Connectivism.pdf

Sitti, S., Sopeerak, S., & Sompong, N. (2013). Development of instructional models

based on connectivism learning theory to enhance problem-solving skills in ICT for daily life of higher education students. *Procedia-Social and Behavioral Sciences*, *103*, 315-322.

Steffens, K. (2006). Self-regulated learning in technology-enhanced learning environments: Lessons of a European peer review. *European journal of education*, *41*(3-4), 353-379.

Skulmowski, A., & Xu, K. M. (2021). Understanding Cognitive Load in Digital and Online Learning: a New Perspective on Extraneous Cognitive Load. *Educational Psychology Review*, *34*(1), 171–196. https://doi.org/10.1007/s10648-021-09624-7.

Stenbom, S., Jansson, M., & Hulkko, A. (2016). Revising the community of inquiry framework for the analysis of one-to-one online learning relationships. *International Review of Research in Open and Distributed Learning*, *17*(3), 36-53.

Sweller, J., van Merriënboer, J. J. G., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review,* 10, 251–296

Tobin, T. J. (2014). Increase online student retention with Universal Design for Learning. *Quarterly Review of Distance Education*, *15*(3), 13-24

Utecht, J., & Keller, D. (2019). Becoming Relevant Again: Applying Connectivism Learning Theory to Today's Classrooms. *Critical Questions in Education*, *10*(2), 107-119.

Van Merrienboer, J. J., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *Educational Technology Research and Development*, *53*(3), 5-13.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Zimmerman, B.J. (2000). Attainment of self-regulation: A social cognitive perspective. In M. Boekaerts, P.R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13-39). San Diego, CA: Academic Press.

e-teach
Upskilling Digital Pedagogy

Chapter 3:
Digital Content Development

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CHAPTER THREE: DIGITAL CONTENT DEVELOPMENT

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Abstract

This chapter aims to provide a comprehensive overview of the methods, techniques, platforms and tools that can be used for the creation and development of digital content for educational purposes. One important aspect discussed is the use of learning management systems (LMS) which are software applications designed to manage, document, track, report, automate and deliver educational courses, training programs or learning and development programs. The chapter also presents educational applications designed to support the learning and teaching process through interactive activities. Additionally, digital content development platforms and tools are presented, which are applications, websites, educational platforms or online resources that can be used to facilitate certain tasks in the educational process.

1. Types of Digital Content

Digital content is an essential component of e-learning, as it provides learners with the information and resources they need to achieve their learning objectives. There are several types of digital content that are commonly used in e-learning. These include text-based content, multimedia content, and graphics and images (Clark & Mayer, 2016).

1.1 Text-based content

Text-based content is a critical component of e-learning, as it provides learners with written information that they can refer to as they progress through a course. Examples of text-based content include articles, eBooks, and whitepapers. When creating text-based content for e-learning, there are several best practices that should be followed to ensure that the content is effective and engaging for learners (Holotescu, 2004). Firstly,

it is essential to use clear and concise language when writing text-based content. This means avoiding technical jargon and complex sentence structures that can be difficult for learners to understand. Instead, content should be written in plain language that is easy to comprehend. Secondly, text-based content should be organized into logical sections that are easy to navigate. This can be achieved by using headings, subheadings, and bullet points to break up the content into manageable chunks. Additionally, it is helpful to include a table of contents or index to help learners find the information they need quickly. Finally, it is important to ensure that text-based content is visually appealing. This can be achieved by using images, graphics, and other visual elements to break up the text and make it more engaging for learners.

1.2 Multimedia content

Multimedia content is another important type of digital content that is commonly used in e-learning (Alsadhan et al., 2014). Multimedia content includes video, audio, and interactive elements such as animations and simulations. When creating multimedia content for e-learning, it is important to consider the needs and preferences of learners. For example, learners may prefer to watch a video rather than read a text-based article. In this case, it may be more effective to create a video that presents the same information in a visual and engaging format. Similarly, interactive elements such as animations and simulations can be used to help learners understand complex concepts and processes. When creating multimedia content, it is important to ensure that the content is accessible to all learners, by providing captions or transcripts for videos and ensuring that audio content is clear and easy to understand.

1.3 Graphics and images

Graphics and images are another important type of digital content that can be used to enhance the visual appeal of e-learning content. Graphics and images include images, infographics, and diagrams. When using graphics and images in e-learning, it is important to consider the purpose of the content and the needs of the learners. For example, infographics can be used to present complex data in a visual and engaging format, while diagrams can be used to illustrate processes and procedures. When creating graphics

and images, it is important to ensure that the content is clear and easy to understand. In addition, graphics and images should be used sparingly to avoid overwhelming learners with too much visual information. When used appropriately, graphics and images can be a powerful tool for enhancing the visual appeal of e-learning content and engaging learners (Tabor & Minch, 2013).

2. Digital content development platforms and tools

In today's digital age, the use of technology has revolutionized the way we learn and consume information. Digital content development platforms and tools have played a significant role in this transformation by providing a wide range of opportunities for learners and educators alike. These platforms and tools enable the creation, hosting, and delivery of digital content, allowing for more dynamic, interactive, and personalized learning experiences (Holotescu, 2004).

2.1 Characteristics of Digital Content Development Platforms

Digital content development platforms are software applications, websites, or online resources (Bostan, 2010). They can be accessed via the internet without requiring installation on a device and can be accessed both at home and at school/faculty. Digital content development platforms provide the student with opportunities beyond what we can provide with traditional materials such as books and paper. Unlike static and fixed resources, digital tools provide dynamic and interactive content that can engage students and promote active learning (Liu et al., 2020). Moreover, digital tools can personalize learning experiences, making them more relevant and engaging for students. Digital content development tools allow for the creation of multimedia materials such as videos, audio recordings, interactive simulations, and online quizzes. These materials can be customized to suit the learning needs and preferences of individual students, which can enhance their comprehension and retention of knowledge. Additionally, digital tools can facilitate collaboration and communication among students, which can foster a supportive learning environment and develop essential social and digital skills. Furthermore, digital content development tools provide instant feedback, which can help students monitor their progress and identify areas of improvement. Teachers can also use this feedback to

evaluate the effectiveness of their teaching and adjust their approach accordingly. Finally, digital tools can provide access to a vast amount of information and resources, allowing students to explore and deepen their knowledge beyond what is available in traditional materials (Bower & Torrington, 2020).

2.2 Types of Digital Content Development Tools

There are various types of digital content development tools available, each with its unique features and capabilities. Some of the most popular types include:

Learning Management Systems (LMS). Learning Management Systems (LMS) are software platforms that enable the creation, hosting, and delivery of digital content. LMS platforms typically provide a range of features including course creation, content management, user management, and tracking and reporting (Kant et al., 2021). Some popular LMS platforms include Moodle, Canvas, and Blackboard. One of the benefits of using an LMS for digital content development is that it provides a centralized location for course content and allows for easy tracking and reporting of learner progress. LMS platforms also often provide built-in assessment and feedback tools, such as quizzes and surveys, which can help to assess learner understanding and provide feedback. However, there are also some limitations to using an LMS for digital content development. For example, some LMS platforms can be complex to use and require a significant investment of time and resources to set up and maintain. Additionally, some LMS platforms may not provide the level of customization or flexibility needed for certain types of digital content.

Content authoring tools. Content authoring tools are essential for creating digital content as they provide an intuitive and user-friendly interface for authors to create, edit and publish content (Khademi et al., 2011). These tools vary in their complexity and functionality, with some being simple text editors while others are complex multimedia authoring software that provide advanced features like animations, simulations and interactive quizzes. One of the key advantages of content authoring tools is the ability to create templates, which helps in maintaining consistency and uniformity in the presentation of the content. Additionally, content authoring tools often come with pre-built assessments, quizzes and interactive elements, allowing authors to easily incorporate

these features into their content without needing to have expertise in coding or programming. Another feature of content authoring tools is drag-and-drop interfaces, which allow authors to easily move and position elements within the content, making the content creation process more efficient and streamlined. Examples of content authoring tools include Articulate Storyline, Adobe Captivate, and Lectora Inspire. Each of these tools has its own unique features and functionalities, but they all share the common goal of simplifying the process of digital content creation and enhancing the overall learning experience for learners.

Multimedia creation tools. Multimedia creation tools are widely used in digital content development because they allow content creators to develop engaging and interactive learning materials. These tools typically provide features such as video and audio editing, animation creation, and special effects to enhance the visual and auditory elements of digital content (Holotescu, 2004). For example, Adobe Premiere Pro is a popular video editing software that provides a range of tools for editing, color grading, and audio mixing to create professional-quality videos. Camtasia is another popular multimedia creation tool that allows for the creation of screen recordings, animations, and interactive quizzes. Vyond is a cloud-based animation tool that allows users to create animated videos using pre-built templates and characters. Multimedia creation tools can help content creators to easily create dynamic and engaging content that is visually appealing, audio-rich, and interactive. This type of content can be particularly effective for visual and auditory learners, who may find it easier to understand and retain information presented in a multimedia format. However, it's important to ensure that multimedia elements are used effectively and do not distract from the learning objectives of the content (Clark & Mayer, 2016).

2.3 The advantages and disadvantages of tools and platforms for developing digital content

2.3.1 Advantages. Digital content development tools and platforms offer several advantages for educational purposes (Bostan, 2010, Clark & Mayer, 2016, Holotescu, 2004, Mąkosa, 2013). These benefits include:

- ***Access to educational materials.*** Students can view the materials presented in a course several times as often as they need to. This feature can be particularly helpful for students who require additional time to fully comprehend complex concepts or those who miss a class or lecture due to unforeseen circumstances. Moreover, digital resources, virtual libraries and all materials available through the Internet allow students easy access to information.

- ***More efficient time management****.* Digital tools can help teachers and students save time by automating routine tasks, such as grading assessments and tracking attendance. Additionally, digital content development platforms allow teachers to create and share materials easily, so students can access them anytime and from anywhere, reducing the need for physical distribution of materials. This can help students to manage their time more effectively and complete their coursework at their own pace.

- ***Flexibility****.* Digital content development platforms facilitate self-paced learning, allowing students to access learning materials at their own pace and review difficult concepts as needed. This personalized approach to learning helps students who may struggle to keep up with the pace of traditional classroom teaching, reducing the risk of dropout and fostering a deeper understanding of the material.

- ***Collaboration****.* Digital tools make it easier for students to work together on projects and communicate and share feedback with each other in real-time, regardless of their location. For example, digital content development platforms like Google Docs or Microsoft Office 365 allow multiple users to collaborate on the same document simultaneously.

- ***Automatic alerts and reminders****.* Students can receive automatic alerts and reminders to submit their homework on time, helping to ensure that assignments are completed and submitted in a timely manner. This feature saves time for both educators and students and helps to keep everyone on track with their coursework.

- ***Personalised learning****.* Work assignments and tasks can be easily customized to the individual learning needs and preferences of students. This promotes greater student motivation and engagement, as students are able to work on tasks that are tailored to their individual needs.

- ***Emergency education****.* Digital content development tools and platforms are particularly useful in emergency education situations, such as during pandemics, as they allow students to continue learning remotely without the need for physical interaction with others, reducing the risk of contracting and spreading viruses.

2.3.2 Disadvantages. While there are many advantages to using digital content development tools and platforms in education, there are also some potential disadvantages, including:

- ***Technical difficulties****.* These tools and platforms can sometimes be complex and difficult to use, requiring technical expertise or training. Moreover, relying on digital tools and platforms for learning may be problematic if technology fails or is unavailable, causing interruptions in learning (Mąkosa, 2013).

- ***Cost****.* Some of the more advanced digital content development tools and platforms can be costly, which may not be feasible for smaller schools or institutions with limited budgets (Arkorful & Abaidoo, 2015).

- ***Quality control****.* With the ease of content creation, there is a risk of low-quality materials being produced and distributed, which may be misleading or inaccurate (Urokova, 2020).

- ***Online safety and privacy****.* Digital content development tools and platforms may pose security risks, including the protection of sensitive student information and the risk of cyberbullying or other forms of online harm (Khan et al., 2020).

- **Copyright and ownership issues**: The use of digital content can pose copyright and ownership issues, as it may not always be clear who owns the content and what permissions are required to use it (Kwall, 2001).

3. Digital content development into practices

Digital content development involves planning, designing, and creating effective content for online delivery. This includes adapting content for different platforms and devices, creating accessible content, incorporating interactive elements, and evaluating content effectiveness through feedback and analytics. In this section, we will discuss the best practices for digital content development according to the latest findings (Aparicio et al., 2016; Clark & Mayer, 2016; Yadav, & Chakraborty, 2021).

3.1. Digital content development for online delivery

Planning and designing digital content. In order to create effective digital content, it is important to plan and design the content carefully. This involves developing a content plan that identifies the learning objectives and goals of the course. Once the learning objectives have been established, the content should be designed in a way that is engaging and interactive. This can include the use of multimedia elements, such as video and audio, and interactive elements such as quizzes, simulations, and games.

Adapting content for online delivery. When creating digital content, it is important to consider the online delivery method. Factors such as file size, accessibility, and compatibility with different devices and platforms should be taken into account. File size can impact loading times and the user experience, while accessibility ensures that learners with disabilities can access the content. Compatibility with different devices and platforms ensures that the content can be accessed by a wide range of learners.

Creating accessible content. In order to ensure that digital content is accessible to all learners, it is important to design the content with accessibility in mind. This can include using accessible text, images, and multimedia elements, providing captions and transcripts for audio and video content, and ensuring that the content can be accessed using assistive technologies such as screen readers.

Implementing interactive elements. Interactive elements can increase learner engagement and interactivity with digital content. Quizzes, simulations, and games can

be used to assess learning outcomes and provide feedback to learners. These elements should be designed in a way that is user-friendly and enhances the learning experience.

Assessing and evaluating digital content. It is important to assess and evaluate the effectiveness of digital content through feedback and analytics. This can help to identify areas for improvement and ensure that the content is meeting the learning objectives. Feedback can be gathered through surveys, quizzes, and other forms of assessment. Analytics can provide data on learner engagement, completion rates, and other metrics that can be used to evaluate the effectiveness of the content.

3.2. Creation of synchronous and asynchronous lessons by using digital tools

According to Zingaro and colleagues (2013), digital content development platforms enable two modes of learning: Synchronous and Asynchronous.

Synchronous. Synchronous learning is a real-time, instructor-led approach to education that enables teachers to control the whole lesson, creating, coordinating, monitoring and adapting to the educational environment in real-time. This mode of learning allows for immediate feedback and interaction between students and teachers. Synchronous learning is often facilitated through video conferencing, online classrooms, and live chats, and is particularly useful for delivering lectures, conducting discussions, and answering questions.

Asynchronous. Asynchronous learning involves students learning at their own pace, time, and place without the need for real-time interaction with teachers. This mode of learning is particularly useful for self-paced learning, collaborative projects, and distance learning. Asynchronous learning provides students with greater flexibility and convenience as they can access materials and resources at any time, allowing them to fit their learning around their work and personal commitments.

However, in education is also used blended learning which is a combination of synchronous and asynchronous modes of learning. In a blended learning environment, students engage in face-to-face instruction with a teacher or professor, as well as online activities and resources, such as video lectures, interactive modules, and discussion

forums. This approach allows for greater flexibility in terms of scheduling and provides students with access to a wider range of resources and learning opportunities (Castro, 2019).

3.2.1 Creation of video lessons (asynchronous learning)

In recent years, digital tools have revolutionized the way education is delivered, with the use of educational videos becoming increasingly popular among teachers and learners (Brecht, 2012). These videos can be successfully integrated and used in a variety of educational settings, including Blended Learning. One of the primary benefits of using video materials is that they capture students' attention more easily, as they are already accustomed to this type of media in their everyday lives. Additionally, videos can be paused, rewinded, and reviewed as many times as needed, allowing students to learn at their own pace and ensuring they fully understand the content. By inserting questions or prompts within the video, teachers can further engage students in their own learning process, and can quickly assess their level of understanding. In this context, creating educational videos has become an essential skill for educators seeking to enhance their teaching methods and engage learners in a more effective way.

To create effective and engaging educational videos, there are several stages that should be followed:

1) **Determine the learning objective**: The first step is to determine the learning objective for the tutorial. This will help the creator identify the key topics that need to be covered in the tutorial.

2) **Define the target audience**: The creator should define the target audience for the tutorial, as this will help them to tailor the content to the needs and preferences of the audience.

3) **Develop an outline**: The creator should develop a detailed outline of the tutorial, including the key points to be covered, the structure of the tutorial, and any supporting materials that will be used.

4) **Write a script**: Based on the outline, the creator should write a script for the tutorial. The script should be clear, concise, and engaging, with a conversational tone to make it more appealing to the audience.

5) **Plan the visuals**: Once the script is complete, the creator should plan the visuals that will accompany the narration. This may include slides, animations, or other graphics that will help to illustrate the content of the tutorial.

6) **Record the narration**: With the script and visuals in hand, the creator should record the narration for the tutorial. They should speak clearly and with enthusiasm, and pay attention to pacing to keep the audience engaged.

7) **Edit and refine**: Once the recording is complete, the creator should edit the video to ensure that the content is clear, the pacing is appropriate, and the visuals are effective. They may need to re-record certain sections, add or remove content, or adjust the pacing or visual elements to improve the tutorial.

8) **Test and publish**: Finally, the creator should test the tutorial with a sample audience to ensure that it is effective and engaging. If necessary, they can make further adjustments before publishing the tutorial for a wider audience to access and learn from.

The structure of a video tutorial can be as follows:

- **Introduction and greetings**: The creator of the tutorial should start with a warm greeting and a brief introduction of themselves and the topic they will be covering.

- **General information:** The creator should provide general information about the topic or subject of the tutorial and its importance, , as well as any necessary background information. Explanation of each topic: The creator should clearly explain the main concepts and ideas related to the topic, breaking them down into smaller, more easily digestible parts.

- **Step-by-step explanations**: The creator should provide step-by-step instructions for how to apply the concepts covered in the tutorial. This may include demonstrations, examples, and exercises for the viewer to follow along with.

- **Results and review**: The creator should demonstrate the results of applying the concepts and review the main points covered in the tutorial.

- **Conclusion and Farewell**: The creator should end with a brief summary of the key takeaways, and a friendly farewell to leave a positive impression.

To create different types of video tutorials in the educational sector, such as screencasts, video assistance or "talking head" videos, and tutorials, specialized programs such as Camtasia Studio, Screen2exe, Jing, Werbineria, Wink, UV SoundRecorder, and BB FlashBack Express can be used. These programs enable the capture of on-screen images, video editing, sound recording, and exporting in various formats such as AVI and FLV.

3.2.2 Creation of interactive lessons with digital tools (synchronous learning)

Creating an interactive lesson with digital tools can enhance the learning experience for students by promoting engagement and participation. Interactive lessons involve the use of multimedia, activities, and assessments to provide a dynamic and interactive learning environment (Alsadhan et al., 2014).

Here are some step-by-step instructions to create an interactive lesson with digital tools:

1) **Define the learning objectives**: Start by identifying the key learning objectives for the lesson. This will help guide the development of the lesson and ensure that it aligns with the course curriculum.

2) **Choose an interactive platform**: Select an interactive platform that meets the needs of the learning objectives and the target audience. There are several digital

tools available that allow for the creation of interactive lessons, such as Kahoot, Quizlet, Mentimeter, and Nearpod.

3) **Develop the lesson structure:** Outline the lesson structure by breaking down the learning objectives into smaller components and determining the multimedia and activities that will be used to support them. Consider using a mix of visual aids, audio, and interactive activities to keep learners engaged.

4) **Create multimedia elements**: Create or source multimedia elements such as videos, images, audio, and animations that support the lesson content. Be sure to select multimedia that is appropriate for the target audience and that aligns with the learning objectives.

5) **Design interactive activities**: Develop interactive activities that engage learners with the lesson content. Examples of interactive activities include interactive presentations, quizzes, polls, discussions, and virtual simulations.

6) **Create assessments**: Develop assessments that measure the students' understanding of the lesson content. Consider using different types of assessments such as multiple-choice questions, open-ended questions, or even gamified assessments.

7) **Add feedback**: Provide feedback to students on their performance in the interactive activities and assessments. Positive feedback can motivate students to continue engaging with the lesson content and provide valuable insights for future lessons.

8) **Test and refine**: Test the interactive lesson with a small group of students to identify any areas for improvement. Refine the lesson based on feedback received from students and adjust any elements that do not align with the learning objectives.

An interactive lesson with digital tools typically follows a structured approach to ensure that the learning experience is effective and engaging for the learners. Here is a general outline of the structure:

- **Introduction**: Begin by introducing the topic of the lesson and setting the learning objectives for the learners.
- **Warm-up**: Use a digital tool such as a quiz or a game to engage the learners and get them interested in the topic.
- **Presentation**: Use multimedia tools such as videos, images, and animations to present the main concepts and ideas of the lesson.
- **Interactive Activities**: Include various interactive activities such as interactive presentations, quizzes, polls, discussions, and collaborative projects to help learners apply the concepts they have learned and engage in active learning.
- **Assessment**: Use digital tools such as quizzes, surveys, or assignments to assess learners' understanding and progress.
- **Conclusion**: Summarize the main points of the lesson and provide additional resources for learners who want to continue learning about the topic.

Throughout the lesson, it is important to maintain an engaging and interactive learning environment by using a variety of digital tools such as online whiteboards, chat rooms, and video conferencing software (Yadav & Chakraborty, 2021). Also, it is important that teachers ensure prior to the lesson that learners have access to the necessary digital tools and are comfortable using them.

3.3. Tools for the creation of digital lessons and content

In the context of online learning, digital tools can be used to create various types of resources in digital format and to facilitate different types of online learning activities (Table 1).

3.3.1. Tools that replace traditional boards

- Padlet: an online virtual bulletin board where students can share text, images, videos, and links.
- Symbaloo: a visual bookmarking tool that allows teachers to organize and share resources with their students.
- Webjets: a tool for creating visual boards to organize and share ideas, links, and multimedia.

3.3.2. Tools for creating virtual classes

- Edmodo: a learning management system that allows teachers to create and manage online classes, assignments, and discussions.
- Google Classroom: a platform that enables teachers to create and manage classes, assignments, and communication with students.
- Schoology: a learning management system that offers features for online courses, communication, and collaboration.

3.3.3. Tools for collaboration

- Google Docs: a collaborative document editing tool that allows students and teachers to work together on a document in real-time.
- Slack: a messaging app that enables team communication and collaboration.
- Microsoft Teams: a collaboration platform that offers chat, video meetings, file sharing, and integration with other Microsoft tools.

3.3.4. Tools for creating online lessons/conferences:

- Zoom: a video conferencing tool that allows teachers to hold virtual classes, meetings, and webinars.

- Webex: a video conferencing platform that offers features for online meetings, events, and training.
- Blackboard Collaborate: a web conferencing tool that offers features for online classes, meetings, and webinars.

3.3.5. Tools for creating video lessons:

- Panopto: a video platform that allows users to create, manage, and share videos securely.
- Screencast-O-Matic: a screen recording tool that allows teachers to record their screen, webcam, and audio to create video lessons.
- Camtasia: a screen recording and video editing tool that offers more advanced features for creating and editing video lessons.
- Loom: a screen recording tool that allows teachers to create quick videos to explain concepts or provide feedback.

3.3.6. Tools for presentations:

- PowerPoint: a presentation software that allows teachers to create and share slideshows.
- Prezi: a presentation software that offers a more interactive and dynamic way to present information.
- Google Slides: a cloud-based presentation software that allows for collaboration and sharing of presentations.
- Canva: a graphic design platform for creating engaging and professional-looking presentations and other learning materials.

3.3.7. Tools for testing knowledge:

- Kahoot: a game-based learning platform that allows teachers to create quizzes, surveys, and interactive games to test student knowledge.
- Quizlet: a study and learning tool that allows teachers to create flashcards, quizzes, and games for students to practice and test their knowledge.
- Google Forms: a survey and assessment tool that allows teachers to create quizzes and surveys to test student knowledge.
- Mentimeter: an online interactive presentation tool that allows presenters to engage with their audience in real-time.

A comprehensive description of the various types of free web-based digital tools is presented in an article (Bower, 2020) published on the Educase2 platform.

Table 1. *Effective tools for creating digital content within e-learning platforms*

No.	**Category**	**Tools**	
1	Tools that replace traditional boards	• Idroo • Openboard • Miro	• Awwapp • Tutorsbox • Classflow
2	Tools for creating virtual classes	• Google Classroom • Edmondo • LearningApps • Easyclass • Tutorroom	• Edulastic • Nearpod • Classflow • Moodle
3	Tools for recording a lesson	• Panopto •Screencast-O-Matic	•Camtasia • Loom

4	Tools for creating online lessons/conferences	• Zoom • ReadyTalk • WebEx	• ClickMeeting • Electa Live • Google Meet
5	Tools for creating recorded video lessons	• Panopto Screencast-O-Matic • Loom • Smart Notebook (Record button)	• Webcam Video Recorder • Online Screen Recorder • Screen Castify
6	Tools for presentations	• Mentimeter • Prezi • Canva • Google Slides • StoryJumper • Wakelet	• Spark Adobe • Venngage • Biteable • Powtoon • Flipsnack
7	Tools for testing knowledge	• Kahoot • Word Wall • Google Forms • Testmoz • Kubbu • ClassMarker	• Socrative • ProProfs • Quizizz • Quizlet • Quizalize

4. Cases

Case 1 - Collaboration applications - Online creation of educational digital content

Google Drive is a utility that allows the online creation and modification of documents, spreadsheets and presentations and their sharing with other users. This is a very useful tool for collaboration between teachers and pupils/students regarding their assignments and projects, which can be accessed and modified from anywhere.

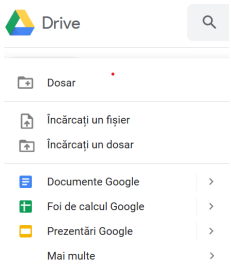
Benefits:

- the possibility of editing from any location, at any time;
- obtaining feedback from several users at the same time;
- complete and real-time visibility of the editing process;
- uploading and downloading documents in different formats (Google Cloud, 2019).

Creating a document in Google Docs

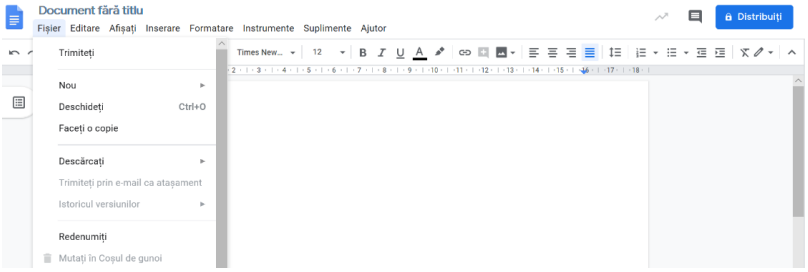
Connect with your Gmail account and start adding new documents, which can be grouped into folders. For this, select the Google Documents option from the New menu (fig. 2.40).

Figure 1. *Creation of a Document*



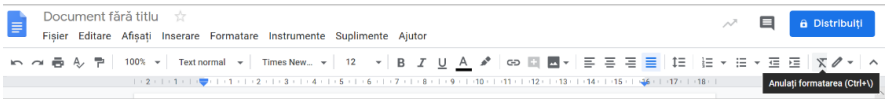
Google Docs will open a new window to allow you to create and edit the new document. To rename the document, use the File option (fig. 2) Rename from the menu or type the title directly in the column without a title. Document Once the document is named, its name appears above the menu bar, and all changes made will be saved automatically.

Figure 2. *Name of a document*



Naming a Google Docs document allows you to do everything from Microsoft Word, with basic operations such as: copying text, bold (enhancing the font), adding italics, underlining, changing the size and colour of the font, the four alignment styles (left, center, right, justify), as well as creating lists (Bullets /Numbering). All these options are found as command buttons on the toolbar. In addition, at the right end of the bar there is a button to cancel all formatting done (Figure 3).

Figure 3. *Canceling Formats*

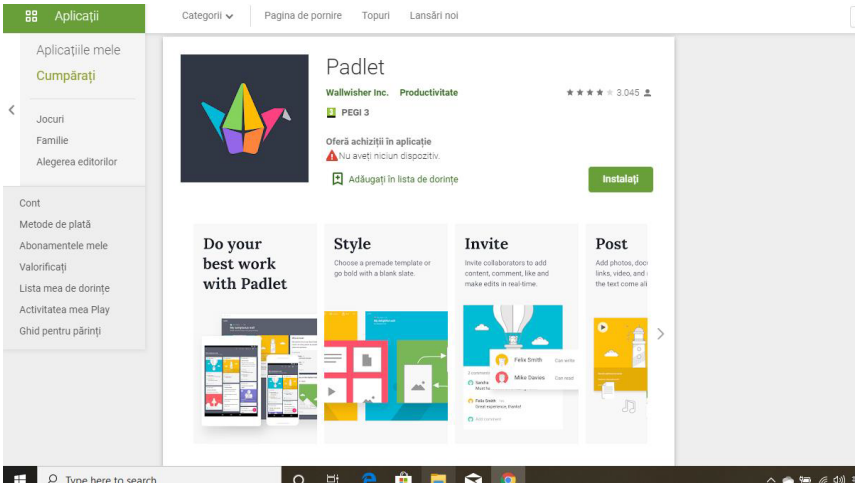


Additional formatting options, such as page orientation, numbering, spacing, or applying Heading styles, can be found grouped in the Formatting menu. The Insert menu allows inserting images, tables, equations, hyperlinks, footnotes, special characters, working in sections, numbering pages, and creating a table of contents automatically. Although the menus and toolbars offer only a fraction of the facilities provided by Microsoft Word, they are sufficient for creating and modifying documents. The documents created in this way can be downloaded in different formats (.docx, .rtf, .pdf) on the personal computer, with the Download option, from the File menu.

Case 2 - Collaborative development of digital educational content with Padlet

Another good example of a collaborative application for the development of digital didactic content is represented by the Padlet application (https://padlet.com), accessible from Google Play or the App Store, which allows the collaborative development of digital content that can be illustrated through images.

Figure 4. *Padlet landing page*

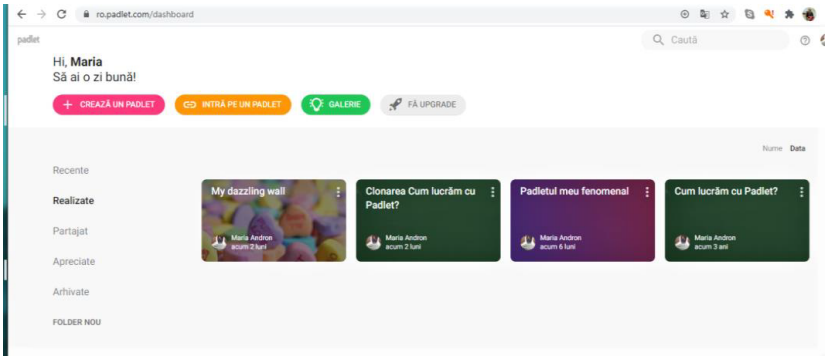


This makes the Padlet application useful both for the teacher, in a more motivating approach to teaching, but especially for the students, who have the opportunity to complete the assignments in an attractive format (figure 4). The application is particularly intuitive, versatile, and allows creativity not only in customizing the writing formats but especially in the possibility of illustrating the elaborated materials. The application allows not only the collaborative editing of text, as in the case of Google Document, but more creativity by illustrating this text with images (photos, selfies), videos, interviews, drawings, etc. It is a good way to present the results of a team project, through which students can be assessed in an efficient, creative and above all motivating manner.

The app allows for very simple crafting and rich illustration. It requires an account, but there is a sufficiently generous free account option, and once the account is created, a creative product can be generated immediately (figure 5). All created products remain in the user's account, from where they can be reused, modified, cloned/duplicated.

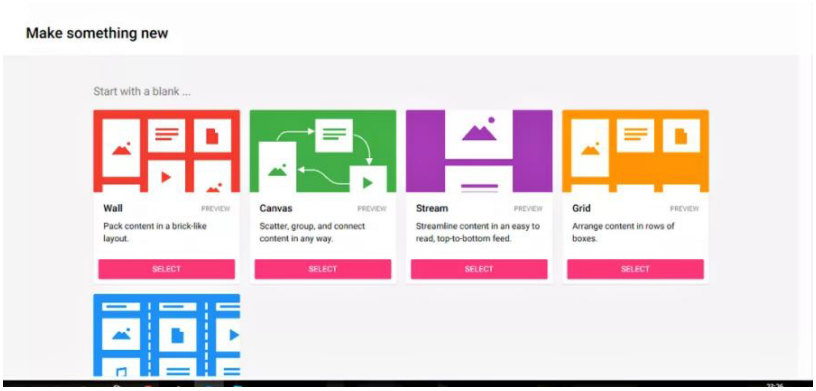
Accessing the archived products is simple, they are visible as soon as the user account is accessed.

Figure 5. *Account home page*



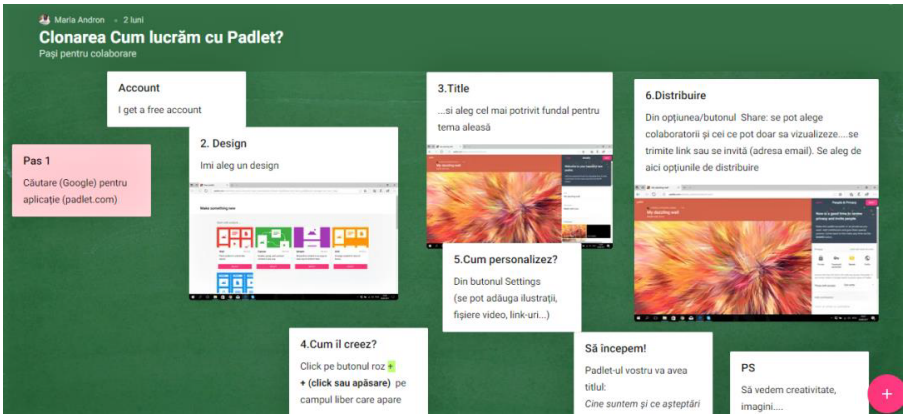
To generate a new product, choose the option +Create a Padlet, and immediately available themes/backgrounds are exposed, on which the content or story can be inserted, on the model of creating a poster. Also, the most appropriate display scheme for text boxes and images can be chosen (poster type – Wall, sequence/logical scheme – Canvas, vertical flow – Stream, sections, etc.) (figure 6).

Figure 6. *Content presentation options*



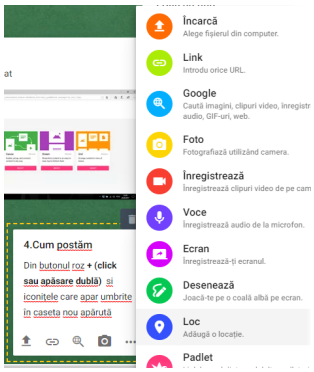
After choosing the design, uploading content is very simple; access the pink button marked with the + sign in the lower right corner of the screen and then click on the box that opens automatically, to insert text and/or images, links, and a variety of media products (figure 7).

Figure 7. *How to work in the Padlet application*



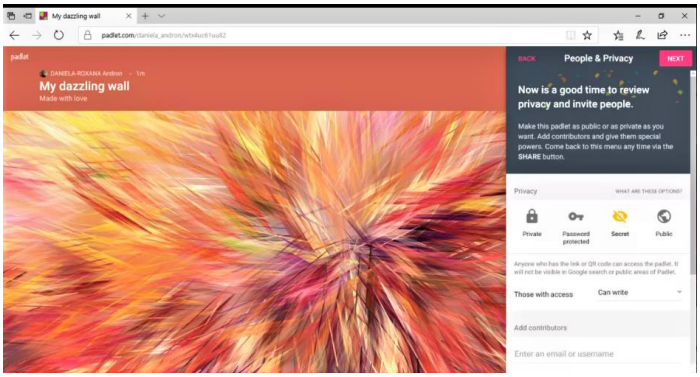
The insertion options are accessed by clicking on the symbols at the bottom of the text box that opens (download, link, search, image). Additionally, by clicking on the button... (others) opens a box that allows the selection of options as in figure 8.

Figure 8. *Upload options*



At the end, you can review the presentation and then choose the sharing option, from the Privacy menu (figure 9).

Figure 9. *Sharing the Product Made*



The product can be done individually, by the teacher, or assigned as a homework – with individual or team work – so the sharing settings can be chosen according to the proposed objective.

References

Alsadhan, A. O., Alhomod, S., & Shafi, M. M. (2014). Multimedia based E-learning: Design and integration of multimedia content in E-learning. *International Journal of Emerging Technologies in Learning* (Online), 9(3), 26.

Aparicio M., Bacao F., & Oliveira T. (2016). An *e-learning theoretical framework*. *Educational Technology & Society*, 19 (1), 2016, pp. 292-307

Arkorful, V., & Abaidoo, N. (2015). The role of e-learning, advantages and disadvantages of its adoption in higher education. *International journal of instructional technology and distance learning*, 12(1), 29-42.

Bostan C.G., (2010). The new technologies in teaching and learning Physics. *GIREP-ICPE-MPTL Conference* 2010.

Brecht, H. D. (2012). Learning from online video lectures. Journal of Information Technology Education. *Innovations in Practice*, 11, 227.

Bower M., & Torrington J. (2020). *Typology of Free Web Based Learning Technologies.* Educause Report. https://library.educause.edu/resources/2020/4/typology-of-free-web-based-learning-technologies.

Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, *24*(4), 2523-2546.

Clark, R. C., & Mayer, R. E. (2016). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. John Wiley & Sons.

Holotescu, C. (2004). *e-Learning Guide.* Solness Publishing House, Timişoara.

Liu, Z. Y., Lomovtseva, N., & Korobeynikova, E. (2020). Online learning platforms: Reconstructing modern higher education. *International Journal of Emerging Technologies in Learning* (iJET), 15(13), 4-21.

Mąkosa, P. (2013). *Advantages and disadvantages of digital education*. Biuletyn Edukacji Medialnej, (2), 21-31.

Khan, N. A., Brohi, S. N., & Zaman, N. (2020). Ten Deadly Cyber Security Threats Amid COVID-19 Pandemic (Version 1). TechRxiv. https://doi.org/10.36227/techrxiv.12278792.v1

Kant, N., Prasad, K. D., & Anjali, K. (2021). Selecting an appropriate learning management system in open and distance learning: a strategic approach. *Asian Association of Open Universities Journal*.

Kahiigi, E. K., Ekenberg, L., Hansson, H., Danielson, F. T., & Danielson, M. (2008). Exploring the e-Learning State of Art. *Electronic Journal of e-learning*, 6(2), pp149-160.

Khademi, M., Haghshenas, M., & Kabir, H. (2011). A review on authoring tools. In Proceedings of the 5th *International Conference on Distance Learning and Education*, IPCSIT (Vol. 12, pp. 40-44).

Kwall, R. R. (2001). Copyright issues in online courses: Ownership, authorship and conflict. *Santa Clara Computer & High Tech*. LJ, 18, 1.

Singh V., & Thurman A. (2019). How Many Ways Can We Define Online Learning? A Systematic Literature Review of Definitions of Online Learning (1988-2018). *American Journal of Distance Education*, 33(4), 289-306.

Tabor, S. W., & Minch, R. P. (2013). Student adoption & development of digital learning media: Action research and recommended practices. *Journal of Information Technology Education*, 12.

Urokova, S. B. (2020). Advantages and disadvantages of online education. *ISJ Theoretical & Applied Science*, 9(89), 34-37.

Yadav, S., & Chakraborty, P. (2021). Designing digital content for children: Understanding children's capabilities. *Childhood Education*, *97*(1), 75-78.

e-teach
Upskilling Digital Pedagogy

Chapter 4: Teachers' Digital Pedagogical competence

University of Helsinki

CHAPTER FOUR: Teachers' Digital Pedagogical competence

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Abstract

This chapter analyses teachers' digital pedagogical competence that is employed while integrating digital pedagogies into teaching and learning. Consequently, we analyse the teachers' digital competences or knowledge they employ when they plan and implement their lesson and how teachers can be supported to learn these competences. Our analysis is based on The Teachers' Technological Pedagogical Knowledge (TPACK) model. In TPACK Shulman's structure of pedagogical content knowledge (PCK), subject matter or content knowledge as well as knowledge and skills that are needed in using digi-tools and -platforms are incorporated. As a practical tool for planning the lesson a Content Representation through Technology (CoReTe) tool is introduced. This tool has origins in the CoRe-tool, introduced by Loughran, Mulhall and Berry in 2004.

1. Integrating Digital Pedagogies into Teaching and Learning

The need to integrate digital pedagogies into teaching and learning has been present in educational discourse for two decades. Developing digital competencies is seen as a prerequisite for successful digital transformation at the European level (Balanskat & Engelhardt, 2015). The EU Code Week is one example of a grass-roots level initiative set forth by The European Union (EU). These initiatives seek to further digital transformation goals, support teaching programming and the understanding of a digitalising society (Moreno-León & Robles, 2015). These developments and initiatives are driven by the digitalization of society and a need to develop teachers' ability to guide students in acquiring 21st-century competencies that include cross-cutting digital competences.

In this chapter we argue that integrating digital pedagogies in teaching and learning should be one of the key elements of teachers´ professional learning. We start this chapter by describing the nature of teachers´ professional learning and after that depict digipedagogigal elements needed in teachers´ professional learning from four perspectives. First, we look at teachers´ epistemic understanding of digitalization that forms the basis for the integration of digital pedagogies in to teaching and learning. Secondly, we review teachers´ technological pedagogical knowledge and skills (TPACK), which they apply while planning, implementing and assessing students' learning and their own teaching. Thirdly, we reflect on the enabling and challenging factors of teachers´ digi-pedagogical competence development. Lastly the chapter culminates in discussing the concept of teachers´ transformative digital agency.

2. Teachers´ Professional Learning

Teaching is complex and demanding work that requires specialised knowledge and skills or competencies to support student engagement and learning. However, these knowledge and skills are not stable, but continuously under the re-structuring and updating. Teachers' professional learning could be supported through professional learning activities and development projects, programs, training, and other types of activities. The results of research regarding teachers' professional learning emphasises continual nature of professional learning (Oliveira, 2010), the active role that teachers take in their professional learning (Garet et al., 2001), connecting learning to the classrooms and practical context, as well as collaboration and reflection with colleagues (Avalos, 2011; Desimone, 2009; Kitchen & Figg, 2011; Luft & Hewson, 2014; Mansvelder-Longayroux et al., 2007; Van den Bergh et al., 2015). Traditional short-term training fails often to take into consideration the way learning is ingrained in professional lives and conditions of work, i.e., teacher community and classrooms (Koffeman & Snoek, 2019).

Active in professional learning is manifested in teachers when they regulate their own learning by setting goals, reflecting on and self-assessing the processes and products of their own learning. Sharing beliefs and/or experiences and learning from experiences are enabled by collaboration during reflection (Hiebert et al., 2002).

3. Teachers´ Epistemic Understanding of Digitalization

We argue that teachers need knowledge about digitalisation itself. Epistemic understanding of digitalisation creates the foundation for competence to teach digital skills. It is noteworthy that there is an absence of a definition of digitalisation in educational discourse. There is often talk in the educational context about digitisation rather than digitalisation (Korhonen et al. 2021). Digitisation refers to a technical process of transforming information into digital form, while digitalisation pertains to changes in ways of working that utilise digital technology (Tilson et al., 2010). Barras (1986, 1990) views digitalisation on three levels. 1) On the first level, the efficiency of existing services is enhanced by using technology. 2) On the second level, quality in addition to efficiency is improved by technology. 3) On the third level, completely new or adapted services or ways of acting are created by technology (Barras, 1986; Barras, 1990). It has been noted that in the current educational context teachers have been found to practice and act on the first level of digitalisation. To promote pedagogically meaningful utilization of digitalization of school practices more teachers must acquire better digi-pedagogical competencies, that is competencies that combine technological expertise with the ability to apply and innovate in a blended school context (Korhonen et al. 2021).

On the third level of digitalization (Barras 1986, 1990), technology in education is seen as an object of learning and not merely a tool for teaching, learning, interaction and innovation (Korhonen & Lavonen, 2017). Moreover, the digi-pedagogical competence required of teachers in the 21st century includes teachers' epistemic knowledge of digitalisation, for instance, teachers' knowledge and beliefs (Ertmer et al., 2014) about digitalisation, digital technology, and the aforementioned's teaching benefits, as well as its impact on society. Additionally, teachers' awareness regarding digitalization, overall technological development, technology itself and increased awareness and increased competence in innovative technologies are important factors in developing teachers' epistemic knowledge regarding digitalisation (Korhonen et al, 2022). These have an impact on teachers' attitudes towards digitalization in the educational context (Korhonen et al., 2021) and the teachers' ability to innovate with technology and adapt its use in a pedagogically meaningful way (Korhonen & Lavonen, 2017).

4. Teachers´ Technological Pedagogical Knowledge and Skills

In addition to epistemic understanding of digitalisation, teachers need knowledge and skills for the instructional design, including knowledge and skills required in using educational technology that is needed for supporting various learners' learning, engagement and well-being. *Technological Pedagogical Content Knowledge* (TPACK) has been designed as such a knowledge base (Mishra & Koehler, 2006). TPACK combines Shulman's structure of pedagogical content knowledge (PCK), content or subject matter knowledge as well as knowledge and skills needed for the use of digi-tools and -platforms.

Shulman's original model divides teacher knowledge into subject matter (content) knowledge (CK or SMK), pedagogical content knowledge (PCK), and general pedagogical knowledge (GPK) (Carlsen, 1999; Hashweh, 2005), that align with various other authors' model for knowledge structure, such as Verloop et al. (2001). In addition to these three areas of knowledge, teachers require contextual and curriculum knowledge (Gess-Newsome & Lederman, 1999).

CK or SMK includes the conceptual, factual, and procedural knowledge belonging to a certain SMK domain, such as physics. A teacher needs to understand the epistemological and ontological aspects of the subject matter that make up its nature (Shulman, 1987).

PCK is the synthesis of the combined knowledge required to teach a topic or an amalgam of SMK and knowledge of pedagogy (Carlsen, 1999). PCK is "the knowledge that teachers bring forward to design and reflect on instruction" (Gess-Newsome, 2015, p. 36) and includes, for example, the subsequent domains of teacher knowledge: knowledge about 1) strategies related to instruction, teaching, assessment and collaboration (shortly teaching methods); 2) students' motivation and interest, as well as about learning of conceptual and procedural knowledge and skills; 3) learners, (mis)conceptions, experiences and thinking skills, and affective and cognitive demands of the tasks; 4) the available resources for supporting teaching and scaffolding learning; 5) curriculum knowledge and goals set for student learning (Loughran et al., 2008).

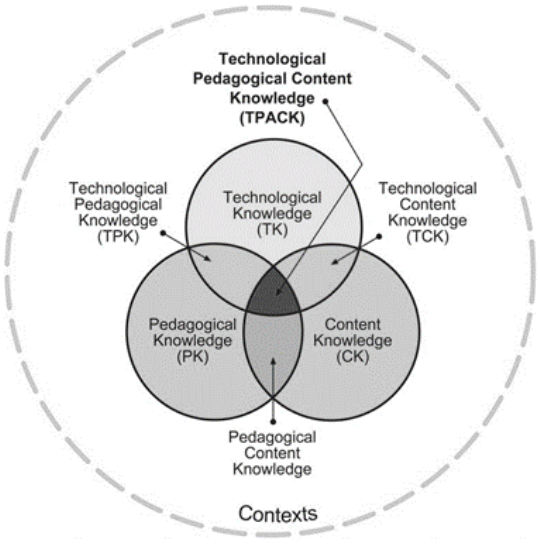
Carlson & Daehler (2019) detail the complex layers of experience and knowledge that outline and inform teachers' work throughout their careers: collective PCK (cPCK), personal PCK (pPCK), and enacted PCK (ePCK). Because of this collective nature of PCK, it is common in teacher education that student teachers guide discussions and reflections among their peers, mentor-teachers and university teachers. The term "didactics", or more precisely, "didactical transformation" (in German, didaktische transformation) (Kansanen, 2002) present in the European tradition, especially in Germany, France, and the Nordic countries, including Finland, refers to processes that bear similarity to those included in PCK.

General pedagogical knowledge (GPK) (Gore & Gitlin, 2004) is the third category of teacher knowledge. Morine-Dershimer and Kent (1999) argued that general pedagogical knowledge consists of three knowledge areas: 1) classroom management and organisation; 2) instructional models and strategies; and 3) classroom communication and discourse.

TPACK describes the knowledge base teacher needs for effectively teaching with technology (see Figure 1). Three main teacher knowledge types are combined in TPACK (content, pedagogy, and technology). The main idea of TPACK is stated as follows:

> *"The basis of good teaching with technology requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face. (Mishra and Koehler, 2006, pp. 1028–1029)".*

Figure 1. *The TPACK framework*



Source: Mishra & Koehler, 2006

The original 16 years-old definition of TPACK is based on a teacher-centred view of teaching and learning. However, the learning science research and curriculum documents emphasise student to student interaction in addition to traditional teacher to student interaction as well as the students' active role in learning and their collaboration or working in smaller groups, such as break-out rooms

Several researchers have characterised the seven domains of TPACK (Mishra and Koehler, 2006; Lin et al., 2013; Koehler et al., 2017). From the perspective of versatile teaching and learning using educational technology, teachers should be familiar with each domain of knowledge in the TPACK model. It is noteworthy that the models of teacher knowledge are challenging because of the complexity of teachers' work. Three domains, or SMK, PCK and GPK, were already introduced above.

Technological knowledge (TK) is knowledge about the use of technology such as the operating system environment and laptops, smart phone, types software or programs (e.g. word processors, spreadsheets, browsers, Zoom, Microsoft Teams, social media, and e-mail) in teaching and learning specific topic in the classroom (Fuad et al., 2020). Technological content knowledge (TCK) is in turn knowledge about applying technology

to represent CK, without relation to its pedagogical purpose. An example of TCK is knowledge of using computer graphics to present the existence of mammoths in the ice age.

Technological pedagogical knowledge (TPK) is knowledge where various technologies are applied in pedagogy for teaching and learning all subject domains as opposed to focusing on specific content knowledge, such as using Zoom to organise students' lesson learning. Consequently, teachers employ TPK or Digi-pedagogy when they use technology or guide students in utilising educational technology in learning. This TPK includes TCK or the skills needed in using educational technology or digital tools, platforms, and digital environments for teaching and learning, as well as the knowledge and skills needed to support students' well-being, learning and engagement in digital environments (Greenhow, 2020).

Consequently, TPACK refers to knowledge about the use of educational technology in teaching and learning. Indicators for high level TPACK are described in Table 1. In general, a teacher has high level TPACK, when pedagogy, subject matter and technology are integrated well and facilitate students' engagement, learning and well-being in a specific context. Although this outline of TPACK seems teacher centred, it emphasizes teacher knowledge he/she employs when she/he guides students to work in a small group and be active in learning.

Table 1. *Indicators of TPACK*

Key ideas of TPACK	Indicators teacher's high quality TPACK
Use of educational technology to teach content or subject matter knowledge	- Ability to integrate teaching methods with the use of appropriate educational technology Use of educational technology (e.g. Facebook, Kahoot, Plicker, Prezi, Canva) for facilitating subject-specific activities in the classroom - Use of educational technology for supporting students to engage in knowledge practices, typical

	to discipline, such as observe, explore and modelling
Use of educational technology to support students' engagement, learning, and well-being	- Ability to design collaborative and interactive activities which are mediated through the use of appropriate technologies. - Ability to use learning management systems, such as, Google Classroom, Moodle, or Courseville, to teach subject matter knowledge. - The use of social media (e.g. Facebook, chat programs, blogs, wikis) to support communication.
Use of educational technology to enhance students' existing and prior knowledge or develop new knowledge	- Use of educational technology to address learner misconceptions related to a subject area, for example use of short questionnaires, created by socrative. - Develop alternative assessment strategies with technology by focussing on authenticity rather than technocentricity.
Take into account different backgrounds of students in the classroom, including prior experience and experiences of the use of educational technology	- Before designing the teaching and learning activities, teachers survey the states, problems, and limitations of students in the area of readiness of using technology and technological equipment.
Different content concepts and student skill levels; educational technology can help in these areas	- Design the activities using educational technologies to teach students which are suitable for their age and skill.

5. Planning of teaching and learning with technology

Loughran, Mulhall and Berry (2004) have suggested a list of eight questions, supportive for the planning of lessons and named the collection of questions as *The Content Representation (CoRe) tool*,which could be used for structuring pedagogical content knowledge (PCK) in order to make instruction coherent. We slightly modified this tool for better taking into account TPACK. The modified CoRe or the Content Representation through Technology (CoReTe) is:

- What do students need to learn about the topic or what are the core ideas/big ideas/key concepts and models related to the topic? Do you have specific aims related to the use of technology in learning?
- Why is it important (meaningful and relevant) for students to learn this topic (need-to-know)? Why/Why don't students need to use technology in learning?
- What else do you know about this topic - not going to teach students (the level of content)?
- What do you know about students' everyday experiences in the area of the topic? What experiences students have about the planned use of technology (know based on previous studies or need to ask students during previous lesson)
- What do you know about students' conceptions/ misconceptions related to the topic and how does it affect the teaching of the topic?
- How does context influence the teaching of this topic? (student, classroom and school context). What kind of technology is available at school considering your aims? Do you need to book the technology beforehand?
- What kind of pedagogy you are planning to use, and how well the pedagogy suited for the topic and planned technology? (Knowledge-in-use)?
- How are you going to evaluate student learning, including the use of technology (knowledge-in-use)?

6. Enabling and Challenging Factors of Teachers´ Digi-pedagogical Competence Development

The core challenge in integrating digital pedagogies into teaching and learning is the simultaneous process where teachers are starting to teach 21st-century competencies to their students while at the same time trying to learn and acquire those 21st-century competencies that will enable them to do so (Korhonen & Lavonen, 2017). In addition to the need for teachers´ and students´ simultaneous competence development, there are several enabling and challenging factors affecting teachers´ digi-pedagogical competence development. In this chapter we depict the most common factors: attitudes and emotions, tools and services and opportunities for professional learning.

We look at enabling and challenging factors from the point of innovation diffusion theory (Rogers 2003). The development of digi-pedagogical competencies can be seen as a situation where a teacher is adopting an innovation i.e. new ways of working. Rogers' (2003) theory on the diffusion of innovation provides an opportunity to define and look at the characteristics of innovations as well as the innovations' diffusion process. Innovation as defined by Rogers (2003) is an idea, object, or practice that appears new to an individual or group. According to Serdyukov (2017), educational innovations must induce significant change in teaching and learning and can present themselves as for instance a new *pedagogical* theory, teaching method, tool or institutional structure.

6.1. Attitudes and emotions

Teachers' commitment to change is impacted by their attitudes and emotions and these have been studied previously in relation to school reforms (Hargreaves, 2014; Lasky, 2005). Educational innovation requires teachers to adopt practices in which they feel less competent and give up familiar practices in which they have high levels of competence. This leads teachers to experience feelings of insecurity. Innovations also necessitate changes in teachers' attitudes as the roles and relationships between teachers and their pupils and the traditional ways of teaching are altered (Serdyukov, 2017).

6.2. Tools and services

The most common challenges in digi-pedagogical advancements are lack usable and pedagogically relevant tools and services for teaching and learning. For example, equipment availability, network connections, software and service user experience, and service access can enable or hinder the development of digi-pedagogical competencies (Korhonen et al. 2021).

6.3. Opportunities for professional learning

There are various opportunities for professional learning for teachers through in-service training, however, participation in training can be occasional and lack continuity and long-term development plans (OECD, 2020). For instance, participation in in-service training is voluntary in Finland, aside from a couple of mandatory training days a year. 20% of teachers do not participate in any kind of in-service training in Finland. Funding, organizing substitute teachers and motivating teachers are some of the barriers to participation (Ministry of Education and Culture, 2016). To meet these challenges it has been suggested that in-service training should utilise networks and sharing best practices and be developed so that it is tied to the daily work of schools (Lavonen et al. 2021, OECD, 2020).

7. Teachers´ Transformative Digital Agency

Teachers´ epistemic understanding of digitalization, technological pedagogical knowledge and skills (TPACK) and the enabling and challenging factors of teachers´ digi-pedagogical competence development culminate into the discussion on the concept of teachers´ *transformative digital agency*. Lund & Aagaard (2020) depict the digital dimension in teachers' transformative agency and state that in the educational field, technology has been traditionally seen to mediate and serve people in certain contexts and in specific ways. In fact, there has been less focus on seeing the change potential that digital technology has and how change can occur in educational settings. Lund and Aagaard found that a special need for teachers and teacher educators to look at transformative agency through digitalization and the digital realm is created by the impact

of digitalization causing changes in the environment, social practices and concept of knowledge and thus to the individual and community. How phenomena are digitally represented, how communicative spaces emerge, how problem-solving becomes collective and collaborative, and how suspending constraints in space and time to explain why digitalization impacts our epistemic practices are trends described by Lund and Aagaard.

Further, Lund and Aagaard (2020) characterize *transformative digital agency* by looking at the competence requirements for agency. Focal issues facing teachers' and teacher-educators' agency is their ability to identify educationally demanding situations and to transform these situations into constructive teaching by utilising digital resources. From the teachers' and teacher-educators' professional learning perspective, transformative digital agency has a pivotal role in recognizing epistemic changes brought on by digitalization. It is also important to recognize competences that relate to digital technology and the technology itself and furthermore the adaptive competence of using digital technology in a pedagogical way in teaching and interaction. It is vital to think about how technology is present in the aims and goals set for teaching and learning, and whether digitalization and technology are viewed also as objects of learning and not merely as a tool for learning. Teachers should be able to position both the instruments and content of these elements into their multimodal teaching and interaction in a meaningful way.

A study by Korhonen et al. (2022) on teachers' professional learning experiences reflected on Lund and Aagaard's (2020) aforementioned focal goal for transformative digital agency that is the ability to identify and transform educationally challenging situations by utilising digital resources. The study confirmed that digital and epistemic knowledge is relevant to teachers' transformative agency. Digitalization and its continuously evolving digital technology demand teachers to acquire awareness of both the development of technology and the impact that it makes. One of the factors that enable teachers' transformative digital agency and promote the integration of digital pedagogies into teaching and learning is the epistemic knowledge of digitalization.

8. Cases

The two examples below outline two different classroom situations, which have been designed with the CoReTe-tool. The first example has been partly published in the project page of Material Science - project (http://www.felab.edu.uowm.gr/programs/material-science/). In the planning, a special emphasis has been to students' previous experiences and conceptions in the domain of the topic. The pedagogy used guides students to an active and collaborative learning process. The evaluation activities are formative and peer evaluation type and support the learning process.

Case 1 - Learning through using various sources of information and processing this information

Reading a text from different sources of information depicts an active process where new knowledge is constructed by the reader through processing the read text. When initially going over a text, a 'first interpretation' is created by the reader. This reinterpretation continues in subsequent readings. Creating and modifying meanings is involved in both reading and writing. Developing learning strategies heavily relies on developing metacognitive skills. This is, readers who are able to process a text thoroughly are also capable of examining those strategies that they use for text processing and thereby choose a suitable strategy.

Strategies for active reading of texts from various resources:

1. Preparing for reading. Preparing for reading involves activating background knowledge which means thinking about what one already knows about the subject. This information could be outlined by a mind map. Questions are generated simultaneously which can be then answered by reading the text. Preparing for reading makes the reading process easier. Preparations also help set goals for the reader, helping the reader in focusing on the subject at hand. The active readers can in this way optimally manage their personal capacities.

2. Taking notes. While reading, an active reader takes notes and writes down key words or creates a mind map that includes the most central themes in the text. The reader puts the contents in order by, e.g., recognising, classifying, comparing, and evaluating new information. In addition, the readers redefine the questions posed in the beginning and evaluate their own work.

3. Connecting previous knowledge with new information. Having read the text, the active readers combine their previous knowledge with new information. Combining can be facilitated either by writing about their own thoughts after reading or answering questions generated during the reading process.

Although writing serves as a natural way of creating meanings and viewing the world, writing tasks at school rarely motivate students. We all remember these all too familiar questions “How many pages?”, “Do I have to use full sentences?”, “Are bulleted lists allowed?” This apprehension to learning may also stem from how writing is equated with taking a test. The following ideas will help transform writing tasks at school into more pleasant experiences:

- Writing will not feel similar to taking a test as long as the atmosphere in class is such where it is easy to ask for help from classmates and the teacher.

- Writing is instructed to be done in small groups in class with ongoing conversation. Students are guided to give each other constructive feedback rather than focusing on the shortcomings of the writings. The students ask questions such as, *How would you create a more concise introduction? How would you emphasise the key concepts more?*

- Since talking (thinking out loud) aids understanding, students are guided to discuss the topics of their essays.

- Creating mindmaps or setting specifying questions are encouraged to structure the topic of an essay or an answer.

- Writing is given a purpose, in other words, in noting that the prospective readers are other than the merely the teacher.
- No rigid timeline is given for writing which means that writing is viewed as a message relayed to others rather than just a task that has to be completed.
- The class explores together how to analyse writing with mind mapping and organising information techniques.
- Writing is integrated with information and communication technology.

The most crucial issue in supporting the motivation for writing is to identify a recipient or at least an intended recipient and the way to publish the writings. The texts are, thus, created for peers or other potential readers rather than merely the teacher. The publication may present itself as a school bulletin, a booklet, or a webpage. Furthermore, the texts may be displayed in science classrooms, published in online learning environments or on other platforms on the Internet.

Writing skills can be developed, and process writing represents one way of developing writing skills. Process writing views writing as a process that involves writing, reading one's own text, having others read the text, receiving feedback and editing the text. This writing process may be divided into sub-processes which help in managing writing more easily than when dealing with enormous units of information. Linna lists the phases of process writing as follows:

1. Brainstorming and choosing the topic
2. Familiarising yourself with the topic (generating and choosing ideas, facts, views, goals, and visions)
3. Outlining the topic (analytic questions, mind maps) and sketching the structure for the text
4. Writing the first draft
5. Feedback (one's own views, peer feedback and teacher feedback)
6. Editing the text and thus creating the second draft

7. Creating the final publication version (double-checking language points and headings)
8. Publishing.

In fact, phases 2 and 3 serve in bringing about thoughts and ideas. The text is not supposed to be immediately ready as the goal is to first create an outline by using, for instance, the technique of mindmapping. During the brainstorming phase (1) it pays off to get feedback to be able to deepen the writing process and edit the text so that it can eventually be published.

Even though this model of process writing is only supposed to serve in visualising the steps involved in the writing process, this model may end up shackling the writing which, of course, does not serve the purpose. First and foremost, process writing is all about flexibility and emphasising the uniqueness of each student.

If students have no previous experience from their language classes of process writing, they have to be taught this technique by organising, for instance, short information sessions for this purpose. And even if the students master this technique, it still pays off to remind the students of the basic principles of process writing.

There are several forms for the text. Some ideas of different forms, which could be used in the class are outlined below.

Journals and blogs. A basic method to write a story is to connect the storyline with some sort of tangible action, and both journals and blogs fulfill this function. Small scale journals can be kept on themes that have been narrowed down. This sort of theme may in turn be connected with science themes, such as, for instance, “materials around us” or “the lifespan of a product”. The following tangible example represents the field of energy consumption: “*Create a report on the materials you use over the period of a week and the times you use these materials. First, take notes, and second, at the end of the week think about the order in which you have to discuss relevant issues in order to give the reader a clear picture of your use of these materials. Illustrate your points by using graphics, for instance bar diagrams*.”

Studies based on interviews. The previous example drew from the student's own actions as the source of information. Interviews are used to get information from other persons' actions. The following example features interview guidelines that have been formulated in accordance with the task prompts given for students. The media and daily discussions constantly keep bringing up the issue of recycling materials. Why and how materials should be recycled? "*Work with a partner and design an interview study. First, choose a viewpoint for recycling. Second, sketch 3-5 questions. Third, carry out interviews on your way home, on the street or at home to find out how people feel about recycling. Use an MP3 or a tape recorder, or take notes while interviewing. Report your results in class. You may also write an article based on the interview results. Or you may publish a special issue on recycling that features everybody's articles. Prior to writing the article take a look at the types of article entries featured in magazines and find out about the constituents of an article.*"

Reports on branches of the material science industry. When writing, information can be drawn from various course books and specialised publications, newspapers and magazines. Furthermore, on the Internet the home page of the company to be visited, as well as websites of various organisations, newspaper databases, and homesites of magazines and journals serve as excellent sources of information. In addition, information can be collected when visiting the industrial site. The following student instruction illustrates how writings can draw from written and digital sources.

Draft a report on a material science industry. *Collect relevant information on the field in course books, specialised publications, information booklets and home pages. Once you have gathered all the necessary information, organise this information. Think about the order in which you display information in the final report to ensure that your readers get a clear picture of the industry branch in question. You may orient your working process with the help of the following list of questions:*

Goal-setting:

- *Which topic do I choose?*
- *What is the function of my study?*

- *What do I know about the topic in advance? Do I know anyone who works for this industry branch?*
- *What do I need to know about this industry branch?*

Sketching the plan:

- *In which different ways can I collect information on this industry branch?*
- *Which questions/problems are answered and discussed in my study? How do I formulate these questions/problems?*
- *Who can I go meet and interview? Whom can I call?*
- *Which sources do I use? Am I sure that this information is reliable?*
- *How do I take notes?*
- *How do I organise information?*
- *How do I visualise my results? How do I create these visualisations?*
- *How do I publish the report? Do I know how to use information technology?*

Evaluation:

- *Is the topic interesting and do I have enough knowledge on the subject? Is there information available?*
- *What do I have? What do I still lack?*
- *How do I display information?*
- *How do I organise and analyse information?*

***Manuals*.** Our world abounds in various types of manuals. Once you create a manual for another person, you at the same time learn the topic in question. The following instructions apply to creating manuals on the following topics, among others: recycling materials, use of plastics, glass, metals, creating recycled paper. "*Work with a partner and create a manual on your topic. Before creating the manual, take a look at a manual, like on an electric appliance. Pay especially attention to visualisation and the layout."*

***Booklets*.** The idea of a booklet is identical to the manual discussed above. The following student instructions may be used when creating booklets on how to safely use materials at home. A booklet can also be created based on the site visit. "*Create an updated and localised booklet, a basic guide for dealing with materials at home. First, jointly discuss which issues need to be covered in the booklet. After this is done, divide the students into groups and allocate each group an area of responsibility. Before you create the booklet, take a look at a booklet published by authorities. Pay careful attention to the booklet's structure, foreword, headings, contents, visualisations and layout.*"

Case 2 - Example of employing TPACK in teaching and learning: Project-based learning

Project-based learning (PBL) has been suggested several times as an appropriate pedagogy for making progress in teaching and learning. However, the word "project" has several different meanings. All projects done at school may not be project-based learning. Project-based learning has its roots in John Dewey's experiments in the 1930s (Mayhew & Edwards, 1965). Blumenfeld et al. (1991) emphasise that in a PBL students are directed to participate in problem-centred and meaningful learning that continues over several lessons, i.e. to a project that helps students integrate knowledge with their previous knowledge while they work in a small group. The project aims for concrete output, which can be, for example, a report, a video, a poster, or a ppt presentation created with educational technology.

Let's consider first, a brief description of a distance teaching lesson related to the sustainability and climate theme, which proceeds according to the principles of project-based learning where technology is used in an appropriate way.

Teacher is organising online teaching through the Zoom. The lesson is started with the introduction of the topic of the lesson by the teacher: "We will look at issues related to air and climate." *The teacher shares his screen and shows pictures and/or headlines in newspapers about the drought and its increase, as well as rains/storms and their increase. The teacher asks students what they observed in the pictures. The student turns his camera on and replies: "Rainfall and drought are increasing at the same time on*

Earth." The teacher says that the aim will be to find out why storms and heavy rainfall and drought are increasing on Earth at the same time and how are these phenomena related to climate changes? We are going to find out about these phenomena related to climate change. The teacher says that the driving question of the next five lessons is: "What can I do to mitigate climate change?" [it could also be: How can I prevent climate change/ help achieve the carbon neutrality target]

The teacher directs students to break-out rooms having 3 — 4 students in the group and asks them to come up with questions and write the questions on an online learning environment to a common space or to a shared word document. The questions should be formulated in a way that they can be used as a starting point for acquiring knowledge about the climate change phenomenon and get an answer to the driving question. Teacher visits the rooms and asks questions to help students orient themselves in questioning:

- What do you know about the topic beforehand?
- What do you want to find out by studying the phenomenon? In what way should the question you ask be changed to make it clear to everyone what phenomenon you are going to investigate?
- Based on the question, is it clear what kind and where you intend to acquire knowledge?
- What are you reaching out to learn as you figure it out?

Students pose questions in break-out rooms in small groups and the teacher guides students working. The teacher discusses questions with the students and asks questions above to the pupils.

After generating the questions for about 10 - 15 minutes, the teacher invites students back to the common space. Students elaborate questions related to climate change (e.g. What could mitigate climate change? What are the consequences of climate change?) When the teacher notices that each group has written questions for an online learning environment, he or she announces that moving on to the next step. The teacher first asks students to categorise the questions asked in an e-learning environment in a

meaningful manner. The teacher says: “Once you have categorised the questions, present them to the other group and discuss the classification of each group. Draw up a joint classification that you present to others. The teacher asks students to select questions that can be used to search for an answer to a driving question. Moreover, the teacher asks students to consider what kind of additional information they need in order to answer the driving question. The teacher shows the instructions on the ppt slide through sharing his screen.

1. Classify the questions you have prepared in a meaningful way (5-8 min)
2. Get together with one of the other groups and present the classifications to each other. (5-8 min)
3. Compare classifications and draw up a common classification (5 min)
4. Present your own classification, namely the grading criterion and a few examples of each class to other students.

Each group presents to the whole class a classification criterion and examples of questions and justify why the question is good for the phenomenon under consideration or moves the process forward. For example, the questions are grouped into the following groups:

- What does climate change mean?
- What is its consequence or cause?
- What kind of examples/consequences are associated with climate change? and how can they be reduced?
- What methods can be used to curb or prevent climate change?

The teacher tells next that “we will start researching climate change based on questions. First, we select a question/questions that will help us to clarify the reasons for climate change. Later we will look at other issues.”

Let's agree on which way the data will be researched and reported. The report can be, for example, a written report, a video, a ppt presentation. There is a separate

instruction for project output. We will use the same groups as in the previous break-out session. What question does the first group take for closer analysis?

Teachers open the breakout rooms again and students begin to acquire knowledge in line with the questions. The teacher visits the rooms and directs the acquisition and processing of knowledge. The teacher guides students through appropriate questions, such as:

- What is your research question? Have you acted so that you get the answer to the question?
- What kind of search words are you planning to use on the internet? Does it give you an answer to the question you asked? Why? Why don't you?
- What kind of model have you created? What is its representation like?
- Why did you end up with this representation? Would there have been other possible representations
- What is the dataset? What are you claiming? What evidence is behind the claim? Does the data support that claim?

At the start of the next lesson, the groups present their results it has received to another group in the class. After the introductions, there will be a joint discussion with the aim to conclude.

Project-based learning is characterised by the same features as are characteristic of working life projects. The project has a goal and has stages. The project ends with a concrete outcome, which can be, for example, a report, a video or a presentation. Project-based learning cannot be defined by presenting an exhaustive description of its progress, as the model of project-based learning is flexible. Project-based learning is defined by giving characteristics of project-based learning. In the example described above, these characteristics will be analysed next.

First, project-based learning design is based on the objectives described in the curriculum. The Finnish curriculum emphasises:

- General aims

    - importance of students' own activities in 1) the sustainable use of energy (energy resources) and natural resources, 2) the mitigation of climate change
    - Students will become acquainted with research data and practices (scientific practices)
    - take into account the links between climate change and 1) environment and ecology, 2) economy and technology, and 3) politics, social and cultural dimensions of sustainable living
- Physics and chemistry aims:
    - The impact of energy production on the environment and climate change (physics)
    - The student recognizes the solutions offered by chemistry to various environmental challenges, such as climate change and the adequacy of natural resources. (chemistry)
- Aims related to the use of technology. The students learn to
    - collaborate in a break-out room
    - look for information and check the quality of information
    - prepare a presentation.

The driving question, guiding project-based learning expresses the overall aim for learning. It hints students, what are the core ideas and practices, students will work during the five lessons' period. The driving question contextualizes learning and shows the orientation or focus related to the phenomena under the study. The driving question guides students to study, use and save energy and raw materials and, for example, the impact that a person's choices can have on achieving the carbon neutrality goal. Attention is paid to heating, air conditioning, preparing and storing food, moving, etc.

The topics below are studied as part of project-based learning or are studied before the project-based learning period:

- the concept of energy, what energy is, the 1st law of thermodynamics
- principle of energy degradation, power and 2nd law of thermodynamics

- the operation principles of various power plants, the power plant converts energy from one form to another, energy resources and individual
- indirect and direct use of energy, conservation of energy/energy resources and raw materials

Asking a relevant driving question leads students to pose questions and design their study. The driving question contextualizes learning. This is thus the third key feature of project-based learning, since the question constitutes an anchoring phenomenon over which students study the phenomenon. The driving question guides students to explore, it leads to the asking of additional questions and connects the lessons to each other.

Fourth, students are active in learning. This feature of project-based learning involves the idea that students' previous knowledge and experiences of the field of the phenomenon under consideration is featured in learning. They come up, for example, when students formulate research questions, make observations or internet searches and compile summaries. All of these activities are guided by prior knowledge of students. The teacher must be able to raise students' previous knowledge for review. After all, it is well known that the many concepts of students are partly contradictory to those of science. Moreover, this feature of project-based learning involves the idea that students actively process information and knowledge through reading, observing and discussing information. Active learning is a common characteristic of learning emphasized in constructivist models of learning. According to constructivist models of learning, learning is the active cognitive activity of the learner, and not just the passive reception of information. The student's activity includes reflection of their own learning. Students are guided to analyse what they have learned or learned in the direction of the driving question and what should still be learned.

Fifth, students are actively interacting and collaborating during the project-based learning. Students construct knowledge based on their previous knowledge and experiences by interacting with other students, for example by asking, exchanging ideas, complementing the views of others, justifying their own views, linking concepts and things to other concepts and talking aloud about observations or conclusions. This interaction between students is similar to reflecting on different perspectives and testing claims or

developing solutions based on information and data, which is part of the work of scientists and engineers. Student interaction is highlighted in socio-constructivist models of learning.

The sixth principle is that different learning tools are integrated into the learning, such as digital tools, which can acquire and process different information, data sets, model or simulate phenomena. Different sensors provide real-time information about phenomena. This information can be represented and processed in a variety of ways. Macro and micro models explaining phenomena can be illustrated and their dynamics elucidated through various simulations. Students can build models using programs for molecular modeling, for example. An online learning environment or a common online document is suitable for sketching notes and patterns of phenomena and sharing information.

Seventh, working with concrete artifacts, texts, videos or patterns is integrated into project-based learning. Such artifacts include, for example, a list of possible research questions or a representation of a model describing the phenomenon under consideration. The purpose of producing artifacts is to inspire students to engage in processes similar to when researchers get excited about conducting research. Interacting with artifacts is common and conducive in learning, emphasized in contextual and situational models of learning. According to these models, learning occurs through interaction with social and cultural context and artifacts and participation in activities and practices in these contexts (Hakkarainen, 2003; Lehtinen 1997). Such models complement models of learning, which state that learning is a cognitive process within the mind. Artifacts also help the teacher evaluate students' learning process and learning, as they make the students' thinking visible.

Also, reflexivity can be read as a feature of project-based learning. Reflection is a general concept for those cognitive and affective functions by which an individual seeks to elucidate their experiences with the goal of constructing knowledge or finding new perspectives. With reflection, students make themselves and others visible to their own thinking and actions. It is an exploration and awareness of the basics of one's thinking

and action, first-hand insight. The reflexive process involves recalling experiences to mind and recounting or telling others. During project-based learning, students use artifacts to present their own and group thinking and activities within the group and between groups. As the teacher tours class, he or she asks students what they have done by then and what they plan to do next. The questions are meant to support student reflection. The teacher's questioning helps students become aware of their own actions and is able to develop their actions based on their own reflections and feedback. Consequently, a student is also able to apply his previous experience in new situations.

It is central to project-based learning that students' learning is supported (scaffolded) to enable them to participate in activities in the proximal zone. In the example above, there are several situations in which the teacher guides learning. For example, in situations that the teacher knows to be challenging for students, he or she will provide instructions using the pp slide. The teacher's guidance is in several situations by asking for guidance. The teacher instructs students to look at a phenomenon or matter being studied from different angles, such as asking, “what is the information or data you are aiming to conclude?” ; “what are you claiming? What is your argument based on?”

There are three criteria as a prerequisite for engaging students in learning: the students’ interest in the topic, the amount they feel they are skilled to carry out the task related to learning, and the amount the task produces challenges. The task associated with learning can be, for example, monitoring the teacher's presentation, interpreting observations or measurements, obtaining information from a variety of sources. These three criteria are based on widely known research on 'flow' experiences in which a person experiences a high level of ability and challenge equivalence at the same time, so that neither side of the experience (ability or activity challenge) is too high or low, but are in the appropriate relative to each other. In addition to this, in learning situations, the students' interest in the subject or task to be learned is also an important prerequisite for enthusiasm.

Studies related to project-based learning have found that students’ engagement is linked to tasks. For example, when students develop models describing the phenomenon

under consideration or construct explanations for the phenomena they study, they more often experience enthusiasm compared to other activities in science lessons. Also, doing assignments and obtaining knowledge from a variety of sources can inspire students to learn.

References

Amhag, L., Hellström, L. & Stigmar, M. (2019) Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education, 35*(4), 203-220, DOI: 10.1080/21532974.2019.1646169

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10–20. https://doi.org/10.1016/j.tate.2010.08.007

Balanskat, A., & Engelhardt, K. (2015). *Computing our future: Computer programming and coding – Priorities, school curricula and initiatives across Europe*. European Schoolnet. http://fcl.eun.org/documents/10180/14689/Computing+our+future_final.pdf/746e36b1-e1a6-4bf1-8105-ea27c0d2bbe0

Barras, R. (1986). Towards a theory of innovation in services. *Research Policy, 15*(4), 161–173.

Barras, R. (1990). Interactive innovation in financial and business services. The vanguard of the service revolution. *Research Policy, 19*(3), 215–237.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, *26*(3-4), 369-398.

Boyd, D. (2014). *It's complicated*. Yale University Press.

Carlsen, W. (1999). Domains of teacher knowledge. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 133–144). Kluwer Academic Publishers.

Carlson, J. & Daehler, K. R. (2019). The refined consensus model of pedagogical content knowledge in science education. In A. Hume, R. Cooper and A. Borowski

(eds.) *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science* (77–92). Springer Nature.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher, 38*(3), 181–99. doi:10.3102/0013189X08331140

Emirbayer, M., & Goodwin, J. (1994). Network analysis, culture and the problem of agency. *American Journal of Sociology*, *99*, 1411–1454.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., & Tondeur, J. (2014). Teachers' beliefs and uses of technology to support 21st-century teaching and learning. In H. Fives, & M. G. Gill (Eds.), *International handbook of research on teachers' beliefs* (pp. 403–418). Routledge.

Fuad, M., Ariyani, F., Suyanto, E., & Shidiq, A. S. (2020). Exploring teachers' TPCK: Are Indonesian language teachers ready for online learning during the COVID-19 outbreak? *Universal Journal of Educational Research*, *8*(11B), 6091–6102.

Garet. M., Porter. A., Desimone, L., Birman, B. &Yoon, K.S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Education Research Journal, 38*(4), 915–945. https://10.3102/00028312038004915

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK Summit. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 38–52). Routledge.

Gess-Newsome, J., & Lederman, N. G. (Eds.). (1999). *Examining pedagogical content knowledge: The construct and its implications for science education.* Kluwer Academic Publishers.

Gore, J., & Gitlin, A. (2004). [Re]visioning the academic-teacher divide: Power and knowledge in the educational community. *Teachers and Teaching: Theory and Practice, 10*(1), 35–58. https://doi.org/10.1080/1354060032000017091 8

Greenhow, C., Lewin, C. & Willet, K. B. S. (2020). The educational response to Covid-19 across two countries: a critical examination of initial digital pedagogy adoption. *Technology, Pedagogy and Education,* DOI: 10.1080/1475939X.2020.1866654

Greenhow, C., Lewin, C., & Willet, K. B. S. (2020). The educational response to Covid-19 across two countries: A critical examination of initial digital pedagogy adoption. *Technology, Pedagogy and Education.* https://doi.org/10.1080/1475939X.2020.1866654

Hakkarainen, K. (2003). Kollektiivinen älykkyys. Psykologia 38, 6, 384-401

Hakkarainen, K., Lonka, K. & Lipponen, L. (2004).Tutkiva oppiminen: Järki, tunteet ja kulttuuri oppimisen sytyttäjinä. 6. uudistettu painos. WSOY.

Hargreaves, A. (2014). The emotions of teaching and educational change. In A. Hargreaves, A. Lieberman, M. Fullan, & D. W. Hopkins (Eds.), *International handbook of educational change* (pp. 558–570). Springer.

Hashweh, M. Z. (2005). Teacher pedagogical constructions: A reconfiguration of pedagogical content knowledge. *Teachers and Teaching*, *11*(3), 273–292.

Hiebert, J., Gallimore, R., & Stigler, J. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher, 31*(5), 3–15. https://doi.org/10.3102/0013189X031005003

Hoffman, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. *Learning and Instruction, 12*, 447–465.

Inkinen, J, Klager, C, Juuti, K, Schneider, B. Salmela-Aro, K., Krajcik, J. & Lavonen, J. (2020). High school students' situational engagement associated with scientific practices in designed science learning situations. *Science Education, 104*(4), 1–26. https://doi.org/10.1002/sce.21570

Inkinen, J., Klager, C. Schneider, B., Juuti, K., Krajcik, J., Lavonen, J. & Salmela-Aro, K., (2018) Science Classroom Activities and Student Situational Engagement. *International Journal of Science Education, 41(3)*. 10.1080/09500693.2018.1549372, (1-14),

Jonassen, D. H. (1995). Supporting Communities of learners with Technology: A vision for Integrating Technology with Learning in Schools. Educational Technology 35 (4).

Kansanen, P. (2002). Didactics and its relation to educational psychology: Problems in translating a key concept across research communities. *International Review of Education, 48*(6), 427–441. https://doi.org/10.1023/A:1021388816547

Kitchen, J., & Figg, C. (2011). Establishing and sustaining teacher educator professional development in a self-study community of practice: Pre-tenure teacher educators developing professionally. *Teaching and Teacher Education, 27*(5), 880–890. https://doi.org/10.1016/j.tate.2011.02.003

Knorr-Cetina, K. (2001). Objectual practices. In T. Schatzki, K. Knorr-Cetina, & E. Von Savigny (Eds.), *The practice turn in contemporary theory* (pp. 175–188). Routledge.

Koehler, M., Mishra, P., & Cain, W. (2017). What is technological pedagogical content knowledge (TPACK)? *Journal of Education*, *193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Koffeman, A. & Snoek, M. (2019) Identifying context factors as a source for teacher professional learning. *Professional Development in Education, 45*(3), 456-471, https://10.1080/19415257.2018.1557239

Korhonen, T., & Lavonen, J. (2017). A New Wave of Learning in Finland: Get Started with Innovation! In S. Choo, D. Sawch, A. Villanueva, & R. Vinz (Eds.), *Educating for the 21st Century: Perspectives, Policies and Practices from Around the World* (pp. 447–467). Springer. https://doi.org/10.1007/978-981-10-1673-8_24

Korhonen, T., Juurola, L., Salo, L., & Airaksinen, J. (2021). Digitisation or Digitalisation: Diverse Practices of the Distance Education Period in Finland. *CEPS Journal*, *11* (Sp.Issue (2021): Education in the Covid-19 Era), 165-193. https://doi.org/10.26529/cepsj.1125

Korhonen, T., Salo, L. & Packalén, M. (2022, in print). Developing teachers' transformative digital agency through invention pedagogy in-service training. In T. Korhonen, K. Kangas, L. Salo, (Eds.) *Invention pedagogy: the Finnish approach to maker education.* Routledge.

Korhonen, T., Salo, L., Seitamaa, A., Sormunen, M., Kukkonen, M., & Forsström, H. (2021). 21st century curriculum reform in Finland: Teachers adopting programming into teaching. Manuscript submitted for publication.

Krajick, J., & Merritt, J. (2012). Engaging students in scientific practices: What does constructing and revising models look like in the science classroom?

Understanding a framework for K–12 science education. *Science Teacher*, *79*(3), 38–41.

Kurt, S. (2018, May 12). TPACK: Technological pedagogical content knowledge framework. In *Educational Technology*. https://educationaltechnology.net/technological-pedagogical-content-knowledge-tpack-framework/

Lasky, S. (2005). A sociocultural approach to understanding teacher identity, agency and professional vulnerability in a context of secondary school reform. *Teaching and Teacher Education*, *21*(8), 899–916. https://doi.org/10.1016/j.tate.2005.06.003

Lavonen, J., Byman, R, Juuti, K. Meisalo, V., & Uitto, A. (2005). Pupil Interest in Physics: A Survey in Finland. *Nordina 2*(1), 72-85.

Lavonen, J., Mahlamaki-Kultanen, S., Vahtivuori-Hanninen, S., & Mikkola, A. (2021). Implementation of a national teacher education strategy in Finland through pilot projects. *Australian Journal of Teacher Education (Online), 46*(10).

Lehtinen, E. (1997). Tietoyhteiskunnan haasteet ja mahdollisuudet oppimiselle. Teoksessa Lehtinen, E. (toim.) Verkkopedagogiikka. Helsinki: Oy Edita Ab

Lin, T. C., Tsai, C. C., Chai, C. S., & Lee, M. H. (2013). Identifying science teachers' perceptions of technological pedagogical and content knowledge (TPACK). *Journal of Science Education and Technology*, *22*(3), 325–336.

Loughran, J., Mulhall, P., & Berry, A. (2008). Exploring Pedagogical Content Knowledge in Science Teacher Education. *International Journal of Science Education*, *30*(10), 1301–1320. https://doi.org/10.1080/09500690802187009

Luft, J. A., & Hewson, P. W. (2014). Research on teacher professional development programs in science. In S. K. Abell & N. Lederman (Eds.), *Handbook of research in science education* (2nd ed., pp. 889-909). Taylor and Francis.

Lund, A., & Aagaard, T. (2020). Digitalization of teacher education: Are we prepared for epistemic change? Nordic Journal of Comparative and International Education (NJCIE), 4(3–4), 56–71. https://doi.org/10.7577/njcie.3751

Mansvelder-Longayroux, D. D., Beijaard, D., & Verloop, N. (2007). The portfolio as a tool for stimulating reflection by student teachers. *Teaching and Teacher Education, 23*(1), 47–62. doi:10.1016/j.tate.2006.04.033

Markauskaite, L., & Goodyear, P. (2017). *Epistemic fluency and professional education: Innovation, knowledgeable action, and actionable knowledge.* Springer.

Mayhew, K. C. & Edwards, A. C. (1965). The Dewey Schoo. – the Laboratory School of the University of Chicago 1896 – 1903. Routledge.

Mezirow, J. (1996). Uudistava oppiminen. Helsinki: Painotalo Miktor.

Ministry of Education and Culture (MEC). (2016). *Opettajankoulutuksen kehittämisen suuntaviivoja. Opettajankoulutusfoorumin ideoita ja ehdotuksia*. [Guidelines for developing teachers' pre- and in-service education. Ideas and suggestions.]. Opetus- ja kulttuuriministeriön julkaisuja 2016:34. http://urn.fi/URN:ISBN:978-952-263-426-9

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Moreno-León, J., & Robles, G. (2015). The Europe code week (CodeEU) initiative shaping the skills of future engineers. In *2015 IEEE global engineering education conference (EDUCON)* (pp. 561–566). https://doi.org/10.1109/EDUCON.2015.7096025

OECD. (2012). *Connected minds: Technology and today's learners*. OECD.

OECD (2020), *Continuous Learning in Working Life in Finland, Getting Skills Right*. OECD Publishing. https://doi.org/10.1787/2ffcffe6-en

Oliveira, A. W. (2010). Improving teacher questioning in science inquiry discussions through professional development. *Journal of Research in Science Teaching, 47*(4), 422–453. https://doi.org/10.1002/tea.20345

Opetushallitus (2019a). Lukion opetussuunnitelman perusteet 2019. Helsinki: Opetushallitus. https://www.oph.fi/sites/default/files/documents/lukion_opetussuunnitelman_perusteet_2019.pdf

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Schneider, B. Krajcik, J., Lavonen, J., & Salmela-Aro, K. (2020). Learning Science: The Value of Crafting Engagement in Science Environments. New Haven: Yale University Press.

Schneider, B., Krajcik, J., Lavonen, J. M. J., Salmela-Aro, J. K., Broda, M., Spicer, J., Bruner, J., Moeller, J., Inkinen, S. J. M., Juuti, K. P. T. & Viljaranta, J. H. (2015) Investigating Optimal Learning Moments in U.S. and Finnish Science Classes. *Journal of Research in Science Teaching, 53*, 400–421.

Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning*, *10*(1), 4–43.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of new reform. *Harvard Educational Review*, *57*, 1–22. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Stetsenko, A. (2017). *The transformative mind: Expanding Vygotsky's approach to development and education.* Cambridge University Press.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Digital infrastructures: The missing IS research agenda. *Information Systems Research, 21*(4), 748–759.

Thomas, J. W. (2000). *A review of research on project-based learning*. San Rafael, CA: Autodesk Foundation.

Van den Bergh, L., Ros, A., & Beijaard. D. (2015). Teacher learning in the context of a continuing professional development programme: A case study. *Teaching and Teacher Education, 47*(1), 142–150. https://doi.org/10.1016/j.tate.2015.01.002.

Verloop, N., Van Driel, J., & Meijer, P. C. (2001). Teacher knowledge and the knowledge base of teaching. *International Journal of Educational Research, 35*(5), 441– 461. https://doi.org/10.1016/S0883-0355(02)00003-4.

e-teach
Upskilling Digital Pedagogy

Chapter 5:
Processes of learning and teaching in hybrid and blended education

Społeczna Akademia Nauk

CHAPTER FIVE: PROCESSES OF LEARNING AND TEACHING IN HYBRID AND BLENDED EDUCATION

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Abstract

Blended and hybrid learning, which have emerged as the latest educational concepts, have gained significant prominence in the teaching and learning processes. The global outbreak of COVID-19 has compelled educators, trainers, and students worldwide, at every level of education, to embrace online learning as part of their daily routine, even if they were not previously used to do so. Although online learning presents numerous challenges, problems, and potential threats, it also offers a host of advantages and areas for future development. As a result, the education system is actively attempting to integrate new technologies and explore novel methods for providing quality educational opportunities. This chapter delves into the limitations and benefits of blended and hybrid learning, with particular emphasis on digital teaching methods and their practical applications.

1. Hybrid and Blended Learning

Technology has become an integral part of education, regardless of whether instructors choose to incorporate it into their teaching methods. Students are exposed to technology from a young age, and they are comfortable with using it in their daily lives. As such, teachers are encouraged to use technology to improve teaching and learning experiences, and explore innovative ways to incorporate it into their classrooms (European Commission, 2020).

Hybrid and blended learning have emerged as innovative and effective teaching methodologies that combine traditional classroom instruction with online learning. The

COVID-19 pandemic has accelerated the adoption of these methodologies, as schools and universities have been forced to embrace online learning as a means of delivering education (Pokhrel & Chhetri, 2021). Hybrid and blended learning provide a flexible and efficient way to deliver educational content, enhance student engagement, and facilitate collaboration among students and instructors. Blended and hybrid learning are expected to become increasingly essential in the future of education as technology gains more significance in the field of teaching and learning. (Singh et al., 2021).

1.1. Defining Hybrid and Blended Learning

The concepts of hybrid and blended learning are often confused, as both teaching styles incorporate traditional methods of learning with technology to offer the advantages of flexibility, accessibility, and scalability (O'Byrne & Pytash, 2015).

Hybrid learning is a unique educational approach that combines both in-person and online learning. In this model, some participants attend the class in person while others participate remotely via technology like video conferencing (Linder, 2017). Instructors and facilitators teach both groups simultaneously, creating a seamless learning experience for all. The hybrid model offers trainees the choice to physically attend classes or follow them virtually from anywhere they choose, making it a convenient alternative for busy individuals or those residing far away from the physical classroom (Singh et al., 2021). In hybrid learning teaching methods are not necessarily predetermined, and teachers are given the flexibility to design their lesson plans and pedagogical approaches. Although the teaching approaches may vary, they are heavily dependent on communication technologies such as Zoom and Microsoft Teams, as well as educational technologies like e-Learning tools (Hwang, 2018). Hybrid learning can take many forms, such as a conference where most participants attend the event in person while others participate remotely through a livestream (Swenson & Redmond, 2009). In a classroom setting, hybrid learning allows facilitators to answer questions from students who are present physically in the classroom, as well as those submitting questions through online video conferencing software.

Blended learning is a teaching approach that integrates conventional classroom teaching with online learning techniques. (Valverde-Berrocoso & Fernández-Sánchez, 2020). Blended learning provides a flexible and adaptable way to deliver education, allowing teachers and students to benefit from the best of both worlds (Garrison & Kanuka, 2004). In blended learning, students can engage with learning materials and participate in activities online, and also attend in-person classes with their teachers and peers (Serrano et al., 2019).

The aim of blended learning is to provide a customized and interactive learning experience, enabling students to take charge of their learning and progress at their own pace (Singh et al., 2021). This approach allows teachers to tailor their instruction to the needs of individual students, providing targeted support where it is needed most (Castro, 2019).

One common example of blended learning is when students are asked to complete an online module before attending a face-to-face seminar. This allows them to engage with the course materials and prepare for the seminar ahead of time. Additionally, it allows the instructor to optimize the time spent in class by focusing on discussion, problem-solving, and other interactive activities that leverage the students' prior knowledge.

Another example of blended learning is when students complete self-paced online modules, which can include videos, quizzes, and other interactive elements. These modules can be accessed at any location and at any time, enabling students to study at their own rhythm and according to their own timetable. Once students complete the online module, they can then meet with a mentor or instructor for face-to-face discussions, to ask questions and receive feedback on their work.

1.2. The Advantages and Disadvantages of Hybrid Learning

In recent years, hybrid learning has gained popularity as a pedagogical approach to provide learners with a more flexible and personalized experience. While there are many benefits to this approach, such as increased access to resources and enhanced

student engagement, there are also some potential drawbacks that need to be considered.

One of the key advantages of hybrid learning is its flexibility, which enables learners to create a customized schedule that accommodates their work and family obligations. It also provides instructors with the opportunity to create and deliver content in a variety of formats to suit different learning styles (O'Byrne & Pytash, 2015). Hybrid learning combines the benefits of in-person and online learning, providing learners with access to a wider range of resources and learning opportunities, including online videos, interactive activities, and digital textbooks, as well as hands-on activities, discussions, and group projects (Singh et al., 2021). Personalized learning is another significant advantage of hybrid learning, which enables learners to select their preferred format and progress at their individual speed, and instructors to personalize content to suit the needs of individual learners (Linder, 2017). Hybrid learning can also increase student engagement and improve learning outcomes, as interactive activities such as quizzes, games, and simulations can be used to encourage student participation and collaboration. Additionally, hybrid learning can be more cost-effective than traditional in-person learning, as it allows institutions to make more efficient use of resources and facilities, and eliminates some of the costs associated with commuting and housing for learners who may live far from campus (Hwang, 2018).

However, there are also some potential drawbacks of hybrid learning that must be taken into account, as identified by Shimkovich and colleagues (2022). Heavy reliance on technical resources and equipment can be a significant barrier for students who may lack access to necessary resources or equipment, hindering their ability to participate fully in the learning experience. Additionally, hybrid learning may pose a challenge for learners with low IT literacy, who may find it challenging to keep up with the course requirements, especially when it comes to online components of the learning. Collaborative group work can also be challenging in the hybrid learning model, as the online setting may make it difficult for students to collaborate effectively with their peers and complete group assignments. Some students may fall behind in their studies due to the hybrid learning model, particularly those who struggle with the online components of the course or who have difficulty managing their time effectively. Providing effective feedback in hybrid

learning can be more time-consuming and expensive for instructors compared to traditional in-person teaching methods. Additionally, hybrid learning requires instructors to pay attention to the potentially conflicting needs of two groups of learners, those in-person and those online, which can make it challenging to deliver good instruction and facilitation to both groups at the same time. Lastly, enforcing completion of work can be a challenge in hybrid learning, as learners need to understand the importance of each component of the learning experience and be motivated to complete it on time.

1.3. The Advantages and Disadvantages of Blended Learning

Blended learning has been widely acknowledged as a more effective pedagogical approach compared to traditional face-to-face or online classes (Rao, 2019). Nevertheless, it is crucial to carefully consider the pros and cons of this method to make an knowledgeable decision regarding its implementation.

One of the primary benefits of blended learning is that it permits students to work at their own pace and in their own preferred learning style in the online environment, which can be beneficial for those who need more time to review or practice a concept before moving on to the next topic (Singh et al., 2021). Additionally, blended learning provides the opportunity for face-to-face interactions with instructors, enabling students to ask questions, receive feedback, and engage in discussions or group activities (O'Byrne & Pytash, 2015). As students can access a variety of resources and work at their own pace, blended learning can lead to higher levels of motivation and engagement (Serrano et al., 2019). Blended learning also allows for customized instruction that better meets the individual needs of each student (Castro, 2019). Moreover, virtual learning environments can connect professors and students regardless of their physical location, making education more accessible for those with distance or other limitations. Financially, blended learning can reduce educational expenses by shifting the classroom experience online and replacing expensive textbooks with electronic devices (Celestino & Noronha, 2021). Finally, blended learning can foster the development of valuable skills such as self-directed learning, goal-setting, and reflection, in a way that neither fully in-person nor fully online learning can achieve (Valverde-Berrocoso & Fernández-Sánchez, 2020).

Despite its advantages, blended learning also has several disadvantages. Technical difficulties can disrupt the learning experience, especially if there are internet connectivity problems or hardware malfunctions (Singh et al., 2021). Blended learning often involves less face-to-face interaction than traditional classroom learning, which can lead to a sense of isolation for some students (Celestino & Noronha, 2021). Additionally, blended learning requires self-discipline and strong time management skills, which not all students possess. Teachers and students need appropriate training and support to effectively use the technology and tools involved in blended learning, and without proper training and support, the blended learning experience may be frustrating and ineffective (Pokhrel & Chhetri, 2021). Finally, the digital divide may emerge as not all students have equal access to the required technology and resources needed to partake in blended learning. It can exacerbate existing educational inequalities (European Commission, 2020).

2. Managing Hybrid and Blended Classrooms

The EDUCAUSE Centre for Applied Research (ECAR) study presented the following ways of supporting learning process by instructional technology:

- Technology facilitates the management and regulation of the learning environment.
- Technology can improve communication with professors and classmates.
- Technology can enhance access to class materials and online resources.
- Technology in courses is valuable when integrates practical technology applications relevant to future career.
- Technology can promote student learning when utilized efficiently by instructors (Salaway & Caruso, 2007).

According to Salaway and Caruso (2007), the use of electronic devices can present a significant distraction for individuals, which can pose a challenge to maintaining student engagement and motivation during online learning sessions. Choosing online

learning engagement strategies and proper management of virtual classrooms are potentially defining factors in the success of hybrid and blended courses. There's a wide range of technics teachers can use to capture student attention.

First of all, it's necessary to establish the structure and expectations early on and follow them consistently throughout the course. Students tend to feel comfortable and confident when teachers reach out to them prior to the start of the course. Mailing, newsletter or platform can by use to welcome students to online course environment, introduce the teacher and pass along any basic information they will need to succeed (info about technical requirements, the course textbook or any other materials they may need, scheduled class meetings, course quick guide with a list of due dates etc.) Making the course available early on the platform can also help students to become familiar with the interface and navigate the course more easily. Setting office hours and holding them regularly provides an opportunity for students to reach out to teachers for help, and for teachers to check in with students and hold smaller online group meetings.

Another important task is to set academic expectations and ensure that online students understand the goals, tasks, and expected outcomes. Exercises should be straightforward, instructions clear and simple, and tasks should be understandable. Students need to keep up with the lesson plan without feeling lost or overwhelmed. Starting each class by presenting learning objectives helps learners to understand what they will be doing and why, and what they will be able to achieve as a result.

Teachers also need to build an engaging online environment by using various means to introduce the content and increase learner engagement and attention. This can involve providing more than just lectures with facts and instructions. Exploring the internet to find suitable online teaching tools, platforms, and apps can help to enhance the learning experience. However, the sheer number of online tools available can be overwhelming, so teachers need to put in significant effort to investigate and compare available options to select the most suitable solutions.

During hybrid and blended learning, lecturers can use mixed media to enhance engagement, such as using a digital whiteboard to present information and solve

problems together with students, showing pictures and charts, sharing songs, music videos, or even gifs and memes.

The rapid development of technology, reinforced by the necessities that arose during the pandemic, has resulted in a plethora of various online tools. The challenge for teachers is not a lack of resources, but rather, selecting the proper tools and effectively implementing them in the digital classroom (Pokhrel & Chhetri, 2021).

3. Digital Teaching Methods and Techniques in Blended Education

Digital teaching methods and techniques are becoming increasingly prevalent in blended education, offering a multitude of benefits for both educators and learners. These strategies have been shown to promote collaboration and creativity among all participants while fostering the development of critical thinking and evaluation skills (Castro, 2019). There are a variety of digital tools available to educators, including software that offers features such as virtual hand-raising, chat box group conversations, and breakout rooms for smaller group discussions (Pokhrel & Chhetri, 2021). Zoom's breakout rooms, for example, allow teachers to create separate virtual spaces for students to engage in discussions and other cognitive work. Similarly, Google Classroom is a VLE that provides teachers with tools to manage lessons, exams, questionnaires, and assignments, as well as enabling the sharing of materials and communication with students or creation of debate groups. It also provides a cloud-based space for students to access and work on documents, with real-time feedback from teachers through Google documents.

The first step in implementing digital teaching methods and techniques is to review and digitize all teaching and learning materials. This process involves assessing the effectiveness of existing materials and modifying them as needed, with a focus on making them easily accessible for online use. Uploading files as Word documents, PDFs, or PowerPoint files may require additional software for students to access, so consideration should be given to using cloud software or platforms provided by the school/university (Rao, 2019).

Consolidating digitized materials into one learning hub is also important, as it ensures students have easy access to all course materials. This can be achieved through the use of a single website or blog where materials are saved and embedded, or through the use of cloud-based platforms. Teachers can continue to modify, enrich, and diversify the design of teaching materials based on student performance, tailoring their approach to ensure optimal learning outcomes for each individual student (Poon, 2013).

Overall, the incorporation of digital teaching methods and techniques in blended education has the potential to significantly enhance the learning experience for students. By utilizing a range of digital tools and platforms, educators can foster collaboration, creativity, critical thinking, and evaluation skills, while providing students with a more accessible and streamlined learning experience.

4. Transforming Traditional Approaches in Blended Education

The trend towards online and blended courses is gaining momentum due to the increasing popularity of these modes of learning. However, traditional teaching methodologies may not be effectively translated in online settings. Therefore, it is essential to conduct a comprehensive analysis of student behavior and learning needs to tailor course content for digital delivery. By adopting student-centered approaches, the overall learning experience can be enhanced, and students' performance can exceed expectations (O'Byrne & Pytash, 2015).

Access to technological infrastructure is a critical factor that can determine the success of online and blended learning. The integration of technology tools has been observed to enhance the overall learning experience beyond just meeting course outcomes. Walters and colleagues (2009) identified specific components that can be embedded into the course design to ensure successful integration of technology. These include well-defined goals, teaching methodologies that align with the objectives, a focus on engaging learning activities, integrated evaluations, and frequent specific feedback.

In addition to course design, technology platforms and online assets should be dependable, easy to use, and up-to-date to meet the demands of students for a

consistent, high-quality multimedia learning experience. Therefore, when transitioning to a blended learning platform, it is essential to consider the campus network's ability to handle increased traffic and to secure student data and course materials (Linder, 2017). Group work, assignments, grading procedures, and suitable video conferencing and chat options should also be considered to ensure a successful transition.

Finally, it is crucial to understand that blended learning cannot be uniformly applied to all situations. Different courses may need varying blended learning approaches (Rao, 2019). Therefore, teachers need to be flexible and adaptive in their approach and tailor their teaching methods to the specific course and student needs. By doing so, teachers can transform traditional approaches to education and create a more engaging and effective learning environment for their students.

5. Teacher's pedagogical and digital competences in blended education

The growing prevalence of blended education in recent years has led to increased attention on the competencies required of teachers for effective implementation of such models. The Handbook of Technological Pedagogical Content Knowledge (TPCK) published by the American Association of Colleges of Teacher Education's (AACTE) Innovation and Technology Committee in 2008 highlights the importance of teachers embracing technology as a tool for discovering content and knowledge through effective pedagogy and practice (TPACK). The TPCK framework emphasizes that technology should not be viewed as an all-encompassing solution but rather as a means of acquiring knowledge empowers educators and learners to explore solutions, resolve issues, and exchange concepts.

In response to the need for teachers to possess a high level of competency with technology, the International Society for Technology in Education (ISTE) revised the National Educational Technology Standards for Teachers in 2008, setting a higher bar for teacher competency with technology. This poses a challenge for universities and other higher education institutions to train educators who can exemplify and implement these standards in designing, implementing, and assessing learning experiences. Through this process, teachers can involve students, enhance learning achievements, enrich their own

professional development, and act as exemplary role models for their peers and communities.

Despite the potential benefits of blended education, it is important to recognize that no single model exists that can balance face-to-face and online learning in every situation. As such, teachers require pedagogical autonomy to use conventional classroom techniques alongside advanced instruction to cultivate skills customized for online and blended learning settings. Kennedy and Archambault (2011) argue that this training should include communication skills, time management, and planning, as well as the ability to recognize and accommodate diverse learning styles and abilities by customizing online content for students with physical or learning impairments.

In conclusion, the successful implementation of blended education models requires teachers to possess a range of competencies that extend beyond traditional pedagogical practices. To ensure effective integration of technology into the classroom, institutions must prioritize the development of teachers' digital competencies and provide them with the necessary training to adapt their teaching practices to blended learning environments.

6. Cases

Case 1 - Adjusting the curriculum to remote delivery as blended learning: example of Burnley College in Burnley, UK (Department of Education, 2021)

Context:

An example of Burnley College shows the way of adapting course content to an online learning environment in order to guarantee that students stay interested and capable of advancing. National lockdown during COVID-19 pandemic forced students and teachers to stay at home.

Art and Design Department at Burnley College identified three obstacles in moving their provision into online environment:

- use of paper-based materials: sketch books and portfolios

- limited access to professional equipment such as cameras and laptops and materials including paint, brushes and other stationeries.
- access to particular areas for practicing

Experience:

Besides providing the students with the necessary resources and supplies needed to continue the education (oil paints, brushes, coal pieces, oasis blocks) , the school also assessed accessibility to IT equipment and any support students needed (on an individual basis via a survey). Supplies and equipment were provided to students via a COVID-19 secure collection service and delivered before classes. The IT department ensured all students had the necessary professional software to participate in their courses from a distance: Photoshop, InDesign, Lightroom and Illustrator as well as an access to the general teaching platforms used by the College.

The crucial issue was to redesign tasks and assessments to include materials students typically possess at home. During the carving and sculpture classes use oasis, cardboard and 'junk modelling' were implemented. Moreover, all students were prompted and assisted to digitize their sketchbooks. Portfolios were photographed and added to slides to create the "digital portfolio". To demonstrate advancement over a period of time, reflections, joint efforts, links to other projects, and feedback were incorporated.

Google Meet was used for online tutorials to ensure that students remained engaged in sessions, by providing visual collaborative support similar to that of in-person instruction. For group work, collaboration activities and feedback sessions break out rooms were used. By Google Forms students were able to indicate their requirements, and their responses could be immediately reviewed to assess their impact.

Last but not least, teaching staff were trained and supported in using new digital tools and platforms. Teachers also had access to remote live and pre-recorded training on different topics from teaching, learning and assessment strategies to digital tools. Supporting each other and sharing good practice were also very valuable.

Results:

Google Classroom was found to be an efficient and user-friendly platform both by tutors and students. It allows posting classwork, links to online tutorials, communicating, presenting and discussing student work effectively and providing peer review which is a crucial component of the creative process. The use of digital platforms such as Adobe Photoshop and Lightroom via remote desktop maintained students' learning, improved their skills, and, above all, allowed them to successfully finish their courses and have a positive educational experience. Following the successful implementation digital portfolios, digitisation of student work and assessment pieces have been mandated across all art and design courses. The College will continue to organize virtual exhibitions for students to showcase their work.

Exercise:

Some curriculums are harder to adapt to blended learning than others. Think about some examples and discuss the solutions to transfer traditional courses into online ones.

Case 2 - The flipped classroom as a method of blended learning- Case Study of teaching science

Context:

Dr Matt Mason and colleagues (2019) from University of Cambridge experienced flipped learning long before Covid-19 pandemic, when it entered into everyday use due to restrictions on the number of students present in one room at the same time. He had a chance to trial the flipped classroom method in 2018, giving three lectures about nutrient acquisition to 187 first-year Natural Science students. Later on, in 2020 he developed the approach during digestive physiology courses given to more than 400 students. In collaboration with Dr Angela Gayton, he conducted a research project which involved gathering feedback through questionnaires and interviews. Physiology News published a preliminary report.

Experience:

Researchers investigated whether flipped classrooms can be used to teach large groups of science students. This approach is commonly employed in Social Sciences, as it involves more open-ended questions that allow for student discussion. Both qualitative and quantitative data showed positive reactions of students- they felt they learned more than they would have from the conventional lecture format. Students also claimed that they understood the topic better and they felt better prepared for the exam. Students also appreciated a transcript of the videos was prepared. It was useful not only for those who had problems with the audio or students with hearing impairments, but also other students who preferred to read through the transcript instead of watching the videos. Some students complain, that, because of extra preparation time required, they put a lot more time into this course than they ordinarily would.

Results:

Even though there are some challenges in applying flipped classrooms, especially into STEM (science, technology, engineering, and mathematics) it's worth the effort. The flipped classroom, with its use of videos that engage and focus student learning, offers us a new model for case study teaching, combining active, student-centered learning with content mastery that can be applied

References

Caruso, J. B., & Salaway, G. (2007). The ECAR study of undergraduate students and information technology, 2007. *Retrieved December*, *8*, 2007.

Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, *24*(4), 2523-2546.

Celestino, E. H., & Noronha, A. B. (2021). Blended learning: a systematic review of advantages and disadvantages in students' perceptions and impacts on higher education institutes. *Administração: Ensino e Pesquisa*, 22(1), 31-63.

Department of Education (2021) *FE remote and blended learning case studies Good practice developed during the coronavirus (COVID-19) pandemic.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966511/FE_remote_and_blended_learning_case_studies.pdf

European Commission. (2020). *Digital Education Action Plan 2021-2027: Resetting education and training for the digital age.* European Union. Retrieved from https://ec.europa.eu/education/sites/default/files/document-library-docs/deap-communication-sept2020_en.pdf

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The internet and higher education*, *7*(2), 95-105.

Herreid, C. F., & Schiller, N. A. (2013). Case studies and the flipped classroom. *Journal of college science teaching*, *42*(5), 62-66.

Herring, M.C., Koehler, M.J., Mishra, P., & Published by The AACTE Committee on Innovation and Technology, (Eds.). (2008). Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators (1st ed.). Routledge. https://doi.org/10.4324/9781315759630

Hwang, A. (2018). Online and hybrid learning. *Journal of Management Education*, 42(4), 557-563.

International Society for Technology in Education (Ed.) (2008). *National educational technology standards for teachers (NETS-T) and performance indicators*.

Kennedy, K., & Archambault, L. (2011, March). The current state of field experiences in K-12 online learning programs in the US. In *Society for Information Technology & Teacher Education International Conference* (pp. 3454-3461). Association for the Advancement of Computing in Education (AACE).

Linder, K. E. (2017). Fundamentals of hybrid teaching and learning. *New directions for teaching and learning, 2017*(149), 11-18.

Mason, M.J. & Gayton, A.M. (2019). *Flipping physiology: can we teach physiology in a different way?* Physiology News, 116:31-33.

O'Byrne, W. I., & Pytash, K. E. (2015). Hybrid and blended learning: Modifying pedagogy across path, pace, time, and place. *Journal of Adolescent & Adult Literacy*, *59*(2), 137-140.

Pokhrel, S., & Chhetri, R. (2021). A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning. *Journal of Education and Practice*, 12(7), 16-22.

Poon, J. (2013). Blended learning: An institutional approach for enhancing students' learning experiences. *Journal of online learning and teaching*, *9*(2), 271.

Prieto R.,(2021) webinar *"Hybrid learning, license to skill DIGITALLY*", Vet4Europe, retrieved from https://hub.vet4eu2.eu/blog/webinar/hybrid-learning-license-to-skill-digitallyfrom-face-to-face-learning-to-hybrid-learning-evolution-considerations-and-challenges-for-vocational-education-and-training/

Rao, V. Chandra (2019) *Blended Learning: A New Hybrid Teaching Methodology*. Journal for Research Scholars and Professionals of English Language Teaching. Issue 13, Vol. 3

Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The flipped classroom: An opportunity to engage millennial students through active learning strategies. Journal of Family & Consumer Sciences, 105(2), 44-49.

Serrano, D. R., Dea Ayuela, M. A., Gonzalez Burgos, E., Serrano Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, 54(2), 273–286. https://doi.org/10.1111/ejed.12330

Shimkovich, E., Makhmutova, G., Ivanova, D., & Urunova, R. (2022). Advantages and Disadvantages of Hybrid Learning for International Students. *ARPHA Proceedings*, 5, 1533-1544.

Singh, J., Steele, K., & Singh, L. (2021). Combining the best of online and face-to-face learning: Hybrid and blended learning approach for COVID-19, post vaccine, & post-pandemic world. *Journal of Educational Technology Systems*, 50(2), 140-171.

Swenson, P. W., & Redmond, P. A. (2009). Online, hybrid, and blended coursework and the practice of technology-integrated teaching and learning within teacher education. *Issues in Teacher Education*, *18*(2), 3.

Valverde-Berrocoso, J., & Fernández-Sánchez, M. R. (2020). Instructional Design in Blended Learning: Theoretical Foundations and Guidelines for Practice. In *Blended Learning: Convergence between Technology and Pedagogy* (pp. 113-140). Springer, Cham.

Van Gorp, M. J., & Boysen, P. (1997). ClassNet: Managing the virtual classroom. *International Journal of Educational Telecommunications*, *3*(2), 279-291.

Watson, J. F. (2007). A National Primer on K-12 Online Learning. *North American Council for Online Learning*.

e-teach
Upskilling Digital Pedagogy

Chapter 6: Emerging new technologies and application in digital education

Baltic Education Technology Institute

CHAPTER SIX: EMERGING NEW TECHNOLOGIES AND APPLICATION IN DIGITAL EDUCATION

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Abstract

This chapter provides an extensive review and classification of new emerging technologies (ETs) that are relevant to both formal and non-formal education. These technologies include augmented and virtual reality, mixed reality, artificial intelligence, as well as video lessons and digital content. Furthermore, the chapter offers a comprehensive overview of the virtual learning environment - Moodle, including its usage possibilities, incorporated tools, and other pertinent information for teachers. It serves as a valuable guide to assist teachers in their decision-making process when incorporating technologies in the classroom and selecting appropriate tools to facilitate this integration. The chapter also emphasizes the importance of hybrid learning and its principles and scenarios, while providing guidance on adapting hybrid learning for classroom settings. Finally, this chapter presents two case studies on how to use virtual reality for the chemistry classroom.

1. Organization and management of the learning process in the virtual learning environment

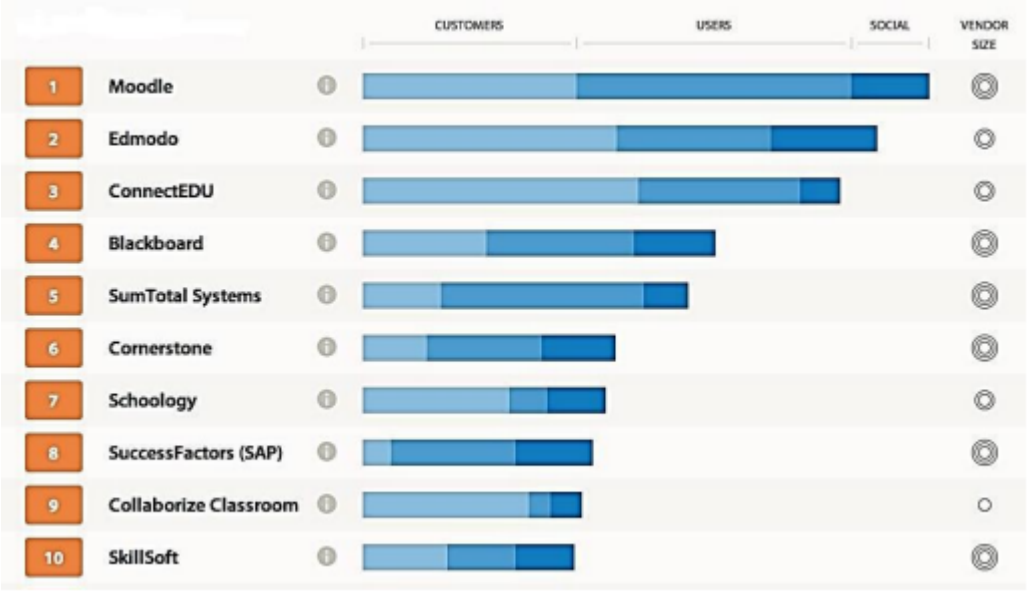
Online teaching and online learning have become an established educational paradigm all around the world in different educational sectors. Information and Communication Technologies became a ‘must’ and are adopted in different educational fields through an online learning environment ("Platform") and used globally to deliver the full courses or enable users to create and deliver courses worldwide themselves (Alam, 2021). During the COVID-19 pandemic, all the European schools and universities were forced to use online learning environments and to teach and learn online all year long. A significant lack of skills for teachers was seen and this caused a lot of different training

providers to create courses on how to manage people online, and how to create courses, tasks, quizzes, and virtual classrooms online. Despite the fact that a lot of different virtual learning environments are being created and offered online, the trendiest and easy-to-use virtual learning environment is an open-source course management system – Moodle. Moodle is available for free download, installation (PHP and MySQL are required), hosting, updating with the most recent updates, and use in educational and community settings. Constructivist ideas served as the foundation for their design. It aspires to create and sustain thriving online learning communities and give educators access to tools that enable creative design (Abdula, et al. 2022).

"Modular object-oriented dynamic learning environment" is what the acronym "MOODLE" stands for. Moodle provides a platform that facilitates the implementation of the constructivist method and can be expanded to include social interaction for the benefit of the instructor (Ismatovna, 2021). Tools that support interactive activities including assessment assignments, discussion forums, chat rooms, journals, quizzes, glossaries, and Wikipedia's are included as part of its feature set.

Moodle is a well-scaled multi-user system, meaning that it is suitable for usage by a wide variety of users, including community organizations, schools, and even major universities (Shekhmirzova & Gribina, 2021). Maintenance of the system is streamlined and straightforward to carry out. Both instructors and students have considerable rights inside the online learning environments in which they are engaged because they are participants and contributors.

Figure 1. *Top LMS platform*



Moodle is distinguished from other learning management systems (LMSs) by a number of essential features, including the following (Shofiyuddin et.al. 2022):

- Putting together classes using previously developed materials is a simple process.
- Importing courses from several other platforms, such as Blackboard, WebCT, and so on, is simple and straightforward.
- The sign-up procedure is uncomplicated and completely safe.
- Both students and instructors will have an easy time navigating its user-friendly web management.
- Plugins are what allow for the expansion of existing functionality. These are created by a coder who works independently.
- It is possible to alter both the appearance and the functioning of the website by simply installing a new theme, which is one of the features that it includes.
- There are approximately 70 different language options to choose from.
- There is a sizable user and developer community, both of which work together to assure quality customer service and the ongoing development of new capabilities.
- It is free to use
- it is compatible with mobile platforms and devices.

2. Useful features of the learning management systems

2.1. Reading materials

The reading materials for the course could include a variety of lectures, reports, e-books, and even additional types of materials. Additionally, it can be of great assistance in organizing the content of the course into a number of distinct categories (Palau, et.al. 2021). The creation of a grouping of sets of courses under an organizing title is facilitated by the use of course categories. For instance, there may be a category that is referred to as "Lifesaving & First Aid," and inside that category, there may be various courses that may be added, like "Basic First Aid," "CPR," "Search and Rescue," and "Advanced Lifesaving."

Once the courses have been sorted into their respective categories, the course settings can be used to manage the courses. In this section, the instructor can establish parameters such as the format of the course, the duration of the course, the start and finish dates of the course, and a variety of other variables (Nilsson & Karlsson, 2019).

After the course has been published by the teacher, it is still capable of being altered, withdrawn, or have new information added to it. Additionally, new courses may also be added in accordance with the needs of the students.

2.2. Papers and projects

The instructor's papers and projects, as well as the previous tasks of students who have handed them into the institute (or the instructor), have the potential to be published and made accessible to the students currently enrolled in the course. Because these pupils have registered with the site, it is possible that they will be given permission to read and study the contents on their own time for their own benefit (Kumar, 2019). Additionally, because of this, it is an excellent database for preserving the projects and papers that were handed to the instructor or the institute.

2.3. Discussions on the course concepts

It is possible to implement a chat window or an area for discussions regarding the site's topic or course. Where both the instructor and the student can freely interact with one another to foster a discussion environment (Gu & Xu, 2022). Additionally, students may be able to connect with one another through this part. Such a part can enhance the learning of the course to a higher degree because the students can digest the material through these dialogues.

2.4. Forums relating to courses

A frequently asked questions section can be added to a forum if one chooses to create one in the same manner as a discussion section (qizi Nasimova, 2022). This will cut down on the amount of time a teacher and some students need to spend participating in the discussion of topics related to the frequently asked questions. Additionally, topics that are similar but not covered in the course might be placed on the forum for debate by the instructor and students in a form that is extremely straightforward (Khatser & Khatser, 2022).

2.5. Conduction of quizzes

Usually, all learning management systems allow for the addition of tests and quizzes to the site, which may then be used to evaluate the students. The site allows for the administration of a wide variety of tests, such as essay questions, questions requiring a brief answer, and questions requiring multiple choices (Morze, et.al. 2022). The instructor is required to use different types provided for the purpose of administering tests, quizzes, essay questions.

2.6. Distribution, collection, and evaluation of assignments

The distribution of assignments to pupils is one of the activities that can be organized by the teachers and falls under a variety of different categories of activities. Choosing the appropriate activities and then the appropriate assignments is one way to do this. After that, a teacher might devise an assignment for a course that will be given to

the pupils (Ismail, 2022). After that, the instructor can send the students an email informing them of the assignment that they need to do. After that, the students will be able to access the assignment on the site, at which point they will be able to submit their work. (Mustapha, et.al. 2023).

The site can then gather these assignments to add them to the database, and the teacher can evaluate them using the site after they have been added. Along with the assignment that was turned in by each student, the teacher can also enter grades for the assignment for that student into the database (Horbatiuk, et.al. 2022). These grades will be maintained alongside the work.

2.7. Keeping track of class attendance

Most of the learning management systems enable an online active engagement of the course by the instructor, which allows for the maintenance of a class attendance record (Ji, Y. P., et.al. 2022). Because every student has to log in to attend the class, it is simple to use this functionality to monitor who was present in each individual student's session.

2.8. Recording of grades

Using the database on the site, the instructor may do something that is analogous to recording the students' attendance (Dahal,et. al. 2022): he or she can compile and record the grades that they have given to each student based on the tests, quizzes, and assignments that have been handed in. because the site keeps a record of each student's grades as well as their attendance.

3. Principles and scenarios technologies for digital teaching and learning

It is not enough to simply use any old hybrid learning tool; rather, hybrid learning is a methodology that is founded on principles. The growing body of information around hybrid learning has resulted in the emergence of six principles, each of which can be applied to a variety of settings (Winterhagen & Hedderoth, 2022):

- They are the outcomes that we would anticipate seeing as a result of hybrid learning, and as such, they show us what a good and effective approach to hybrid learning looks like.
- During the process of establishing our hybrid learning strategies, we should use them as guides or signposts to navigate the process.
- They give lenses through which we may regularly look at our designs for hybrid learning and implementation of hybrid learning, in order to analyze and reflect on the impact that these designs have on various groups within our own school communities. When we think about hybrid learning, these principles should always be at the forefront of our minds.

3.1. Equity

Hybrid learning can help students overcome barriers to education, such as geography, illness, or handicap, and keep learning going amid disruptions. To achieve equity, all students must have fair access to high-quality learning opportunities regardless of their circumstances—when, where, or how they learn (Ciolacu & Svasta, 2021). Whether online or on paper, the goal should be to provide a high-quality learning program that meets student needs and improves their education. To support ongoing teacher-student interactions and self-directed learning, students should have access to synchronous and asynchronous learning opportunities regardless of mode (Fawns, et.al. 2022). Some kids may need frequent speaker phone calls to discuss. High-quality learning considers the whole person, including social and emotional wellness.

3.2. Inclusion

Hybrid learning is three-fold. Community first. Every student must feel included. This demands careful planning, especially for students without digital gadgets, the internet, a peaceful home learning space, time to study as they must work to support their families, etc (Fleaca & Stanciu, 2019). Inclusion needs access to learning. They'll feel excluded otherwise. This involves balancing challenge and reachability. Asynchronous learning requires self-directed and agentic students. Teachers must scaffold students who lack this competence. Some students need more check-ins. Others hurry. Inclusion

requires understanding students' future learning steps, learning styles, and curricula. Inclusion demands participation. Relevant, engaging, accessible, and culturally sensitive instruction ensures students feel respected and included (Tursunovich, 2022).

3.3. Transparency

Transparency requires visible learning. This is simpler with online resources, but it's essential for equity and inclusion regardless of how kids learn. Making learning visible encourages kids and families to take charge of their education. Teachers need visible learning and transparency. Teacher planning, student data, and information must be available to leaders and instructors 24/7 in a disrupted learning environment. Instructors may teach their lessons from home or have other teachers teach them (Borodina & Ivashkina, 2022). Second, teachers must know their students' learning levels to create hybrid learning programs that meet their needs. Learning progressions, student learning profiles, and a shared, visible understanding of what causes learning are crucial (Makhubele & Makonye, 2022). Finally, since hybrid learning is new to most people, communication with students and teachers must be straightforward and honest to reduce anxiety. Transparency builds trust, which enhances learning.

3.4. Responsiveness

In times of uncertainty and when venturing into uncharted terrain, there is only one thing to do: get started utilizing the best information available at the time, continuously collect data and feedback, and adapt your actions accordingly (Jović, 2022). This must occur at the level of the individual student, the class, and the school. Communication is an essential administrative activity for which to solicit input. Continuous feedback loops are fundamental to a responsive strategy. This enables learning programmes to be sensitive to the requirements and circumstances of learners, with adequate design flexibility to accommodate changes in circumstances or needs (Zulfikar & Dewi, 2022). Additionally, responsiveness supports efficiency. The greater the degree to which supply meets demand, the less waste there will be in the system.

3.5. Coherence and connectedness

Hybrid learning engages students wherever, whenever, and however they learn. This requires a linked learning ecosystem where students stay engaged to their studies and classmates. Remote students should receive the same assignments as on-campus students, although they may access them differently. Kids should work in groups and be socialized. This may take time. Efficiency and durability require coherence (Mpungose & Khoza, 2022). Hybrid learning should incorporate the school's vision, values, and principles into its structures, procedures, systems, and practices. Hybrid learning programs should incorporate each notion and weave them together.

3.6. Efficiency and sustainability

This learning philosophy is a blended learning approach, with online learning serving as the backbone of the learning program for both on-site and remote students. Though converting to enriched virtual learning may appear to be a tiny adjustment (that is, it may appear to be a slight difference), it has a profound impact on hybrid learning (Ally, 2022)., as the inclusion of remote learners becomes a simple matter of including online learning as the program's backbone. In this model, the same instructor serves as both the online and face-to-face instruction.

4. Video lessons and digital content development

Creating videos for your students to watch while they are participating in remote learning is a fantastic method to support them, especially the one in five students who study and think in a unique way. Creating your own videos can provide you with a lot of useful benefits. Additionally, the more you record, the more proficient you'll become in the process (Papadima-Sophocleous & Antoniou, 2023).

- **Decide which type of video to make.** Teachers make "talking head" or screencast videos. Goals determine video genre. Talking head videos feature a speaker addressing the camera. If you want students to focus during class, make this video. Good reasons to choose this video style: to engage with your students

and demonstrate a physical action like a science experiment. Screencasts record your voice and computer screen. If showing presentations, papers, or interactive whiteboards up close helps your learning objective, make a screencast movie (Zglinski, 2022). To illustrate how to use assistive technology, explain assignment instructions, solve a math problem, and use this sort of video. Screencasting tools abound. Screencast videos may show your talking head in the corner, depending on the technology. This option customizes the video. Zoom can make a screencast video. Share your screen and film a meeting with yourself or a co-teacher.

- **A video per topic.** Remember that many online lessons recommended practices apply to videos: Limit to six minutes and focus on one subject. This helps kids with concentration and working memory. Time your script. Split long videos into segments. To clarify why students should watch the movie, state the learning purpose at the start (Yavan & Gökçe, 2022). Clearly demonstrate or teach a skill or subject. Prepare questions to engage, guide, and assess pupils. Pause between questions and topics. Poorly processing students need these intervals. Students need takeaways and next steps at the end.

- **Equipment and lightning.** Laptop, tablet, or smartphone with "talking head" camera. Vertical or horizontal phone videos. Record horizontally for website embedding. Record vertically for phones. Screencasts are camera-free. Use your laptop or tablet's camera for your screencast's talking head. Tripod-shot videos are distracting. If you record within arm's reach, use the phone, tablet, or laptop's microphone. Earphones with microphones minimize background noise (Tan et.al. 2022). Move close to the mike while recording. See your students. Particularly "talking head" videos. Open curtains, lights. Record without windows. Face the sun outdoors. Experiment with lighting.

- **Background.** Simpler videos are easier to make and less distracting: Dress simply. Avoid wearing stripes, textures, and intricate designs. Locate somewhere quiet. Tell others you're recording. With so many home-based workers, no one expects complete peace (Ding et.al. 2022). Simplify background. Check that

anything in the camera's view is worth recording. Screencast videos require a tidy desktop and no pop-ups. Keep everything, including a glass of water, handy. Test yourself. Inspect the background, lighting, and audio briefly. Show your whole face. Make sure lettered props are visible on camera.

- **Available video**. Two ways to caption videos: Upload to YouTube. Automate closed captioning. Captions will have errors. Use the caption editor to edit captions. After clicking the "more" icon next to your movie, pick "Open transcript" to get a transcript. (To create a transcript, create a new document, copy and paste the preceding text, and hit "Enter." G Drive (Prepare a transcript. Video upload. "Manage caption tracks" is in the top-right menu. Adding a transcript file generates captions.

5. Artificial intelligence for teaching and learning

Artificial intelligence (AI) is the creation of machines that can do human jobs by mimicking human intelligence. AI can improve education, support educators, and enable personalized learning (Chai et.al. 2021). Chatbots, virtual tutors, and adaptive learning tools employ AI in education.

Personalization is AI's main value for education. AI systems collect massive amounts of data on each student's learning style, preferences, and performance to customize training. This method boosts student motivation, engagement, and performance. AI can assist teachers identify struggling kids and provide targeted interventions.

AI automates education. Grading, reporting, and record-keeping involve time and resources. Teachers can focus on class planning, student mentoring, and professional development when AI automates these tasks (Yang, et.al. 2021). AI makes education accessible. AI-powered assistive devices help disabled and learning-difficult kids. Speech-to-text and text-to-speech software can help dyslexic and other struggling readers.

School AI raises concerns. Discrimination is a big issue (Flogie & Aberšek, 2022). Skewed data may increase inequality in AI systems. Concerns include student data privacy and AI system hacking.

To overcome these challenges, AI ethics in education must be developed. This framework should address data privacy and security, decision-making openness, and bias and discrimination. Educators should also learn about AI ethics and help design and implement AI-powered systems.

6. Augmented Reality, Virtual Reality and Mixed Reality

AR overlays reality. AR employs a device's camera to overlay a virtual layer over the user's real reality. The user's screen movement controls the digital overlay. The US Air Force invented AR in the early 1990s, but mobile devices have made it widespread (Maskati et. al. 2021). Pokémon Go, released in 2016, had 45 million daily users at its peak. 1,7 billion AR users are expected by 2024.

Using real-world settings, AR accomplishes three primary tasks:

- It incorporates both real and virtual objects;
- It arranges the objects;
- It permits real-time engagement.

AR enhances real-world vision and information. Because many augmented reality apps can be used on smartphones and tablets without headgear, schools worldwide have adopted AR.

VR is virtual reality. Virtual reality headsets filter out the "actual world" and replace it with the screen. Virtual reality uses headsets and hand-held controllers. The headset's pictures move with the user (Buentello-Montoya, et.al., 2021). Virtual reality immerses users in a synthetic world, unlike augmented reality.

Mixed reality, sometimes known as MR, is a technology that combines augmented and virtual realities. MR creates an environment in which digital and physical elements

can communicate with one another by inserting digital items into the actual world. zSpace, a company that specializes in educational technology that blends AR and VR components, is a good illustration of this concept. zSpace consists of a monitor, a stylus, and specialized 3D glasses. Users are able to manipulate virtual components that appear to burst out of the screen by using the pen in conjunction with the monitor (Bos, Miller, & Bull, 2021).

6.1. The significance of Augmented Reality (AR)

The hybrid virtual/reality experience allows students to investigate and visualize subjects in ways not possible without AR. AR can show change over time, unlike a textbook (Marín-Díaz, Sampedro, & Figueroa, 2022). Augmented reality reinforces information, and virtual reality lets students interact with digital and physical objects.

A review of AR in medical education found that students find it interesting and funny. "AR-based learning boosts outcomes in numerous critical components of training, including professional knowledge, cognitive and practical abilities, social skills, innovation, competence, and creativity," the researchers concluded.

According to the findings of a number of research, augmented reality encourages greater participation from students and piques their academic curiosity (Kaviyaraj & Uma, 2022). Students are better able to remember the material when they are able to visualize it and interact with virtual body parts in the anatomy course. For instance, delicate organs can be identified and handled with the use of AR, however, if the same thing were to be attempted with a real corpse, the organs would quickly lose their shape.

6.2. Using AR in the (digital) classroom

Teaching preparation may vary each augmented reality app. Aurasma was used by many schools to produce augmented reality (AR) experiences. These apps set visual triggers and define what appears on the digital overlay. For example, if the iPad camera identifies a textbook image, the AR overlay displays a GIF (Henthorn, 2023). Visible Body's Human Anatomy Atlas doesn't need setup.

AR allows teachers to spend more time coaching students through activities and less time lecturing. AR challenges the "master on the stage" approach of instruction and needs student engagement (Habiddin, et. al. 2022). AR learning is immersive and adaptable to flipped classrooms.

An instructor should prepare students for augmented reality (AR) activity by providing an overview of the topic they will learn and demonstrate how to use the technology.

Regardless of the augmented reality application they are utilizing, pupils should be provided with a list of activities or objectives to complete while using the program. Exploration is valuable, but students must maintain concentration on the intended lesson.

AR scavenger hunts are an easy way to incorporate gaming into the classroom. In addition to introducing an element of play, gamification can stimulate collaboration and challenge students to see information in new ways.

AR can aid in the development of specific technical skills among students. For instance, several medical schools use AR and VR technologies to teach surgical techniques. Several studies suggest that augmented reality (AR) can help students acquire skills more efficiently, as AR overlay permits the presentation of supplemental information alongside the real world.

AR can also be used during field trips. Some museums, like the Smithsonian, the Kennedy Space Center, and the Franklin Institute, include augmented reality and quick response (QR) codes in their exhibits. When you return to the classroom, you can use augmented reality to summarize the class's new knowledge (Martins et.al. 2022). Dr. Susan Yoon of the Graduate School of Education at the University of Pennsylvania states that augmented reality can enhance learning because it can display the same information in different situations.

Last but not least, AR can be utilized to perform labs efficiently. AR applications can enhance hands-on labs or provide lab experiences that do not require setup or clean-up, but still get students moving and investigating.

6.3. Online resources for VR use in a classroom

With Share My Lesson, educators may access a library of webinars, online lesson plans, and PowerPoint slideshows developed and shared by their peers. For teachers of elementary school through high school levels, Share My Lesson has a wealth of useful materials. Teachers are invited to share their own creative materials with the community by uploading them to the site. The community of educators on Share My Lesson is robust and encouraging.

When it comes to educating children, are you prepared to take things to the next level of engagement by putting them in a virtual reality environment they can access from the convenience of their own homes? (Juraev, 2022). ClassVR is here to assist you in this endeavor. ClassVR provides dozens of free lesson ideas and case studies for instructors to use with their virtual reality headsets. ClassVR has a growing library of downloadable virtual lesson plans. We feel that some of these lesson plans and worksheets can still be converted for online classes even if you do not have the cash to acquire the hardware.

ReadWorks is a nonprofit organization that provides online curriculum materials and instructional strategies to K-12 educators. ReadWorks includes not only science, technology, engineering, and mathematics, but also poetry, history, and literature. Anyone in the education community, including teachers, students, and parents, can access ReadWorks's materials.

Through the National Council of Teachers of English, English teachers collaborate to disseminate information regarding numerous educational tools. This organization focuses mostly on the English language. The NCTE website allows teachers of all grade levels, from kindergarten to college, to communicate with one another. The National Council of Teachers of English provides teachers with lesson plans that are comprehensive in nature (NCTE). This lesson plan for '3-2-1 Vocabulary' has eleven lessons, each of which includes evaluation instructions for instructors. If you are interested in acquiring an understanding of how other teachers have structured their classrooms, you should peruse this website's extensive collection of lesson plans.

It is common knowledge that The New York Times is famous for the investigative journalism it publishes as well as the extremely challenging crossword puzzles it publishes. Nevertheless, were you aware that The New York Times provides access to a page brimming with various educational resources? The teachers, not the students, are the intended audience for these tools, which provide ideas for how to incorporate news items from The New York Times into classroom instruction. Students will be able to draw from a variety of perspectives with the help of these lesson plans, which contain discussion questions, web resources, videos, and essays. There are also many well-thought-out reflection questions at the end of each segment for teachers to use any way they see fit. These questions may be found at the conclusion of each section.

PBS is another news network that, like The New York Times, produces lesson plans designed expressly for classroom use. The grade levels covered by these online lesson plans range from prekindergarten through senior year of high school. Educators can access the extensive collection of lesson plans, worksheets, and documentaries after creating a free account on the website. PBS Learning Media is also compatible with the online learning management system Google Classroom. This is one of the most extensive teaching resources available, encompassing a vast array of topics, including but not limited to Life Science, Algebra, Literature, and Consumer Health.

Almost certainly, you have heard of Khan Academy and its seemingly limitless supply of educational films. These lessons are self-paced and designed for distant students. You may have even incorporated some of these videos into your classes, or your students may have used Khan Academy to complete their calculus assignments. However, few individuals are aware that Khan Academy offers instructional tools for parents and educators. These weekly lesson plans are designed for students in grades three through twelve. Khan Academy is a fantastic, reliable resource for teachers that require a more comprehensive lesson plan. Khan Academy also releases free daily lesson plans that include hour-by-hour detailed activities. These daily lesson plans are designed for students in kindergarten through grade twelve.

6.4. The Significance of Mixed Reality (MR)

With mixed reality, you are able to inspect both physical and digital objects, such as a real-time cloud-based collaborative document or a digitally interfaced prototype. Physical objects include things like desks and chairs, while digital examples include these and more.

Mixed reality (MR), which is more advanced than augmented reality, involves the addition of information to a physical setting. Real-life and computer-generated imagery are brought together in mixed reality. The use of MR muddles reality. Nevertheless, MR calls for a wearable device, whereas AR is dependent on smartphones and the cameras they contain. Some examples of mixed reality technologies include the following (Morimoto, et.al., 2022):

- Acquiring knowledge of the environment requires mapping a region and superimposing both virtual and actual content.
- The technology known as human comprehension makes use of sensors and cameras to recognize the actions, words, and inputs of individuals.
- The term "spatial sound" refers to the digital audio settings that include a full 360 degrees.
- XR technology is capable of understanding both its own position and the position of the user simultaneously.
- Content in three dimensions that can be experienced in its native setting The term "hologram" is frequently used to refer to these assets.

6.5. MR for education

There are currently a lot of mixed reality goods on the market that can be found in the education sector. These devices are revolutionizing the ways in which students learn and teachers educate. to assist in providing a clearer picture of the ways in which MR is (Ryan & Callaghan, 2022) reshaping the field of education. In this section, we will provide the top five mixed-reality apps that are now available for purchase and download on the market.

HoloStudy, a mixed reality learning tool for Microsoft HoloLens 2, may be used anywhere to learn about humanity. HoloStudy supports Microsoft HoloLens 2. (Chu & Li, 2022). It simplifies physics, biology, chemistry, geology, and medicine and engages students in new ways.

HoloTour is another groundbreaking HoloLens 2 app. Mixed reality transports users through history with this software. These mixed realities allow students to experience immersive learning and educational field trips to diverse places and major events in human history without leaving their classrooms (John & Kurian, 2022).

HoloHuman allows students to study human anatomy using accurate, under-the-skin holographic reconstructions. This interactive experience lets students explore life-sized bodies and learn how they work.

Lilique and Microsoft HoloLens created a unique tool for schools, students, and teachers to engage with a 3D model. Mixed reality models and lesson plans enable Lilique bring education to life and engage students in ways that were previously inconceivable.

We've seen a lot of mixed reality educational apps for the Microsoft HoloLens 2. The cause? Microsoft leads the MR business, so software developers feel safer betting on a sure thing. But, as the MR business grows and more competitors enter the scene, we can expect future MR applications to support more headsets and be more innovative.

7. Cases

Case 1 - ESCAPE THE LAB: Chemical experiments in virtual reality for educational purposes

Application:

The Unity 3D Video Game engine was used to construct the basic environment concept, which was inspired by the Kaunas University of Technology Chemistry faculty labs. These facilities have become a gamified virtual reality "escape room" based on

chemical research with novel features. Escape the lab within the time limit. Players must find clues and perform chemical experiments to progress in the virtual world. Three experiments are currently available: mixing dry ice with liquid, the "blue fire" experiment (mixing hydrogen chloride (HCL), copper sulfate (CuSO4), and aluminum (Al) inside a container, then exposing the compound to fire to cause a chemical reaction), and the "chameleon" experiment (mixing potassium permanganate (KMnO2) with sodium hydroxide (NaOH) and sugar). The player obtains a three-digit code after finishing the relevant experiment or activity. The player can finish the simulation by entering the code into a virtual console after collecting all code components.

To enhance the simulation, the virtual world is fully interactive. The player can interact with all scene objects.

Environment testing

"GameON" attendees saw a virtual reality instructional game. An HTC Vive headset and a three-meter-by-three-meter room-scale play environment were used during the show presentation. Two Vive Base Stations, one on a tripod and one on a stand frame, were placed transversely at opposite corners of the play area at a height of about two meters with their front faces facing each other. The headset's desktop computer's GTX 1080 TI graphics card provided visuals.

Any convention attendees could play the game. Before using the VR game, the supervisor gave the participant a synopsis and instructions. In case of safety issues or accidents, the supervisor monitored the trial participants.

Experience:

This VR game teaches. Gamifying learning is the goal of this journey. Again, the learning game appealed. At "GameON," its virtual world and gaming interactivity drew attention. Every conference attendee saw the competition differently. They focused on virtual environments. Adults and teens searched for clues and performed chemical experiments in the VR game. VR could teach and test chemistry. The game simulates chemical reactions based on research. Virtual environments educate chemical processes

without chemicals. The demo addressed game dangers. Virtual reality made some players forget where they were. By violating virtual safety norms or leaning on virtual things, they fell. VR may influence how much these problems matter. Chemical experiments are risk-free in the game.

VR technology is widely used in education and training. At "GameON," the virtual reality (VR) educational game "Escape the Lab" showed that these games may appeal to a wide audience.

Educational and engaging activities improve learning. If the instructional game is fun, the student may be more interested in the topic. Because the learner enjoys learning. Due to its overall excellent reception, this instructional VR game can be improved in the future.

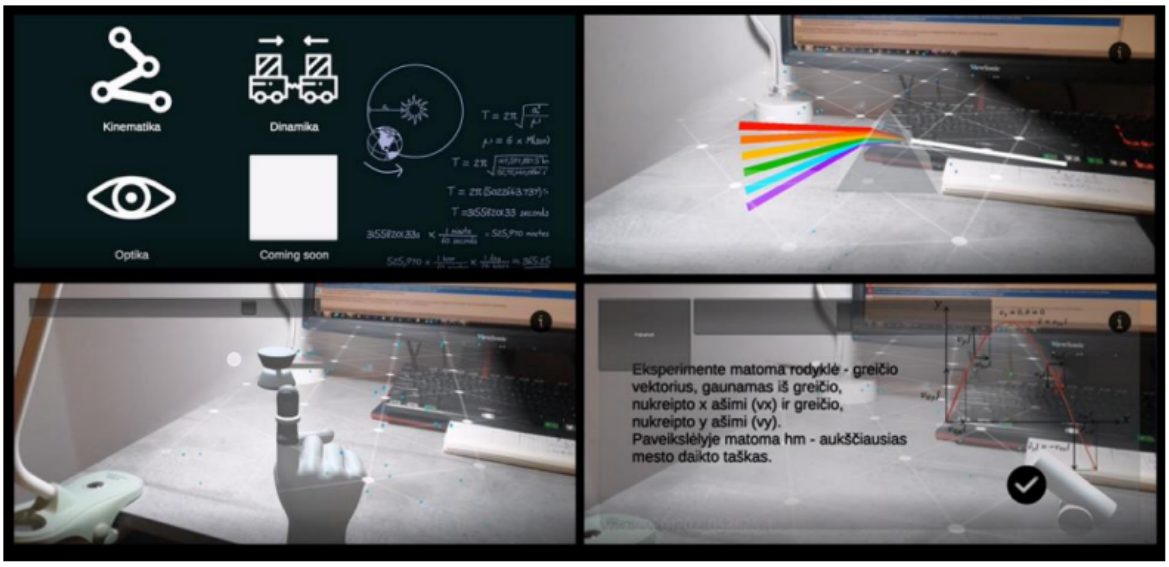
Case 2 - VIRTUAL AND AUGMENTED REALITY IN EDUCATION - APPILCATION

Prototype:

The research generated an augmented reality learning environment prototype. The prototype demonstrates Bloom's Taxonomy's practical use.

Application:

Unity 3D and various Android phones were used to construct the app for Windows 10 64-bit. AR technology used Google AR Core library. Model-based application. The software lets 9th–12th graders explore and observe physical processes in AR to learn physics. The application covers kinematics, dynamics, and optics. Each topic has subtopics—experiments that let learners choose their topic. Kinematics has a cannon-shot ball experiment that shows how the vector of velocity varies. After the experiment, the student can see a recording and use a slider to slow or speed it up. Two dynamics experiments. One is an automobile coasting downhill. This experiment shows how gravity, friction, and support reaction effect the car. Moving a slider controls the experiment, as in the first experiment. Another dynamics experiment is a string-attached yoyo that circles a finger, displaying the string tension force vector and orbital velocity vector. The slider also controls this experiment. The learner controls the yoyo's speed around the finger, resulting in varying vectors of force. Optics, the final topic, comprises two experiments: a ray of light travelling through a prism creates a rainbow, and a positive/converging lens changes an object's position and size. These experiments are interactive without sliders. The student can zoom in by sliding their phone closer to the AR projection at any time. Each topic's experiments feature a I button in the corner that opens a text box explaining why and how the items react. When learning a new topic, this window lets the reader watch the experiment in progress.



Implementation

The prototype demonstrated how AR/VR integrates technology, education, and knowledge transmission. The program uses a camera and phone screen for input and the phone screen for output. The application teaches memorizing, comprehending, and analyzing as the user learns basic information from the information window, remembers it, and then understands it while watching the experiment. After learning the essentials, the student can analyze by pausing the experiment, looking closely, or repeating it. Application content, theme, and interactivity cover educational context. The content branch is achieved by allowing the learner to repeat the experiment and access the information window anytime they don't grasp it. Subtopics complete the theme. Finally, AR technology allows users to move closer to the experiment and examine it from all angles, change the tempo of the trials, and choose themes. The third stage, knowledge transfer, uses visual, read/write, and kinesthetic sensor modalities. Visual is from graphs and schemes in the information window of any experiment and from showing the experiment.

Finally, the information window requires reading to comprehend the experiment/subtopic. The model's components are linked as they are implemented. Kinesthetic, knowledge-transferring input from the technology element usually comes from a student choosing a topic or interacting with an experiment. Technology outputs

visual, read/write, or kinesthetic knowledge. Based on the branch, the education and instructional contexts follow. We remember educational context content if the output branch is read/write. If the knowledge-transferring branch was visual, it would lead to the topic and subsequently to comprehension. If it was kinesthetic, it would most commonly result in interactivity (topic and content might also be incorporated) in an educational setting, which would lead to pedagogical analysis. This only applies to this AR application, thus various technology, implementations, and fields of science would yield different results, but the approach would still work.

References

Abuhlfaia, K., Mohamed, M., & Abusenina, A. (2022, May). Assessing the Usability and Perceived Usefulness of a Moodle Platform Within Libyan Higher Education Institutions. In 2022 IEEE 2nd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA) (pp. 242-247). IEEE.

Abdula, A. I., Baluta, H. A., Kozachenko, N. P., Kassim, D. A., & Zhuravlev, F. M. (2022). The use of Moodle in the teaching of philosophy and distance learning. *AET*, 616.

Alam, A. (2021, December). Designing XR into Higher Education using Immersive Learning Environments (ILEs) and Hybrid Education for Innovation in HEIs to attract UN's Education for Sustainable Development (ESD) Initiative. I*nternational Conference on Advances in Computing, Communication, and Control (ICAC3, 2021*) (pp. 1-9). IEEE.

Ally, S. (2022). Review of Online Examination Security for the Moodle Learning Management System. *International Journal of Education and Development using Information and Communication Technology*, 18(1), 107-124.

Anatolievna, P. E. (2022). Moodle as a Base for University System of E-learning and formation of electronic information educational environment. *Проблемы современного педагогического образования*, (74-2), 173-176.

Borodina, M., Ivashkina, T., Golubeva, T., Afanasiev, O., Pronina, Y., & Berlov, K. (2022). Changes in the use of the moodle platform by students at different levels of training depending on the period of restrictions due to Covid-19. *Revista Conrado*, 18(88), 125-132.

Bos, D., Miller, S., & Bull, E. (2021). Using virtual reality (VR) for teaching and learning in geography: fieldwork, analytical skills, and employability. *Journal of Geography in Higher Education,* 1-10.

Buentello-Montoya, D. A., Lomelí-Plascencia, M. G., & Medina-Herrera, L. M. (2021). The role of reality enhancing technologies in teaching and learning of mathematics. *Computers & Electrical Engineering*, 94, 107287.

Chai, C. S., Lin, P. Y., Jong, M. S. Y., Dai, Y., Chiu, T. K., & Qin, J. (2021). Perceptions of and behavioral intentions towards learning artificial intelligence in primary school students. *Educational Technology & Society*, 24(3), 89-101.

Chu, F., & Li, W. (2022). Data-Driven Image Interaction-Based Software Infrastructure for Graphic Design Research and Implementation. *Scientific Programming*, 2022.

Ciolacu, M. I., & Svasta, P. (2021, April). Education 4.0: AI empowers smart blended learning processes with Biofeedback. *IEEE Global Engineering Education Conference* (EDUCON-2021) (pp. 1443-1448). IEEE.

Dahal, N., Luitel, B. C., Pant, B. P., & Rajbanshi, R. (2022). Enhancing student-teachers assessment skills: A self-and peer-assessment tool in higher education. *International Journal of Education and Practice*, 10(4), 313-321.

Ding, S., Li, M., Yang, T., Qian, R., Xu, H., Chen, Q., ... & Xiong, H. (2022). Motion-aware contrastive video representation learning via foreground-background merging. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 9716-9726).

Fawns, T., Markauskaite, L., Carvalho, L., & Goodyear, P. (2022). H 2 m pedagogy: Designing for hybrid learning in medical education. In E. Gil, Y. Mor, Y. Dimitriadis & C. Koppe (Eds.), *Hybrid Learning Spaces* (pp. 61-76). Springer.

Fleaca, E., & Stanciu, R. D. (2019). Digital-age learning and business engineering education–a pilot study on students' E-skills. *Procedia manufacturing*, 32, 1051-1057.

Flogie, A., & Aberšek, B. (2022). Artificial intelligence in education. LutsenkoO. LutsenkoG.(Eds.), Active Learning: Theory and Practice, 97-118.

Florjančič, V., & Wiechetek, Ł. (2022). Using Moodle and MS Teams in higher education-a comparative study. *International Journal of Innovation and Learning*, 31(2), 264-286.

Grigoryeva, N. V., Melikov, I. M., Palanchuk, N. V., Kokhanovskaya, I. I., & Aralova, E. (2021). Opportunities for organizing distance learning presented by the moodle platform: experience in the conditions of the covid-19 pandemic. *Propósitos y Representaciones*, 9(SPE3), 1259.

Govender, R. G., & Khoza, S. B. (2022). First-hand user experience: can Kaltura video come to the rescue of Moodle during/post COVID-19? *African Identities*, 1-18.

Gu, X., & Xu, H. (2022). Engaging teachers in a DBIR community to develop ICT-enabled problem-solving skills. In A. C. Superfine, S.R. Goldman, M. M. Ko (Eds) *Teacher Learning in Changing Contexts* (pp. 196-214). Routledge.

Habiddin, H., Ashar, M., Hamdan, A., & Nasir, K. R. (2022). Digital Comic Media for Teaching Secondary School Science. *International Journal of Interactive Mobile Technologies (IJIM)*, 16(03), 159-166.

Henthorn, J. (2023). Using GIFs to Position Students as Scholars. *Prompt: A Journal of Academic Writing Assignments*, 7(1).

Horbatiuk, R. M., Dudka, U. T., Kabak, V. V., Rebukha, L. Z., Serdiuk, O. Y., & Riznitskii, I. G. (2022). Using the Learningapps. org online service in the Moodle system in the process of training of specialists in economic specialties. In Proceedings of the 1st Symposium on Advances in Educational Technology (Vol. 2, pp. 403-415).

Ismail, H. (2022). A Bibliometric Analysis of Moodle E-learning: Evidence from 2011 to 2021. *Indonesian Research Journal in Education*| *IRJE*|, 6(2), 292-304.

Ismatovna, A. Y. (2021). The Method of Using the Moodle Platform for the Organization of Teaching in Education (The Introduction of Distance Learning Technologies in the Educational Process). *International Journal of Innovative Analyses and Emerging Technology*, 1(4), 30-46.

Yang, S. J., Ogata, H., Matsui, T., & Chen, N. S. (2021). Human-centered artificial intelligence in education: Seeing the invisible through the visible. *Computers and Education: Artificial Intelligence*, 2, 100008.

Yavan, M. A., & Gökçe, G. (2022). YouTube as a source of information on adult orthodontics: a video analysis study. *Journal of the World Federation of Orthodontists*, 11(1), 41-46.

Ji, Y. P., Marticorena-Sánchez, R., Pardo-Aguilar, C., López-Nozal, C., & Juez-Gil, M. (2022). Activity and dropout tracking in Moodle using UBUMonitor application. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 17(3), 307-317.

John, B., Kurian, J. C., Fitzgerald, R., & Lian Goh, D. H. (2022). Students' Learning Experience in a Mixed Reality Environment: Drivers and Barriers. *Communications of the Association for Information Systems*, 50(1), 28.

Jović, M. (2022). THE USE OF MOODLE IN AN ESP CONTEXT: ADVANTAGES AND LIMITATIONS. In INTED2022 Proceedings (pp. 9937-9943). IATED.

Juraev, M. M. (2022). Prospects for the development of professional training of students of professional educational institutions using electronic educational resources in the environment of digital transformation. *Academicia Globe: Inderscience Research*, 3(10), 158-162.

Kaviyaraj, R., & Uma, M. (2022, January). Augmented Reality Application in Classroom: An Immersive Taxonomy. In 2022 4th International Conference on Smart Systems and Inventive Technology (ICSSIT) (pp. 1221-1226). IEEE.

Khatser, G., & Khatser, M. (2022). Online Learning Through LMSs: Comparative Assessment of Canvas and Moodle. *International Journal of Emerging Technologies in Learning (Online)*, 17(12), 184.

Kumar, A. (2019). Design of secure image fusion technique using cloud for privacy-preserving and copyright protection. *International Journal of Cloud Applications and Computing (*IJCAC), 9(3), 22-36.

Marín-Díaz, V., Sampedro, B., & Figueroa, J. (2022). Augmented reality in the secondary education classroom: Teachers' visions. Contemporary Educational Technology, 14(2), ep348.

Martins, N. C., Marques, B., Alves, J., Araújo, T., Dias, P., & Santos, B. S. (2022). Augmented reality situated visualization in decision-making. Multimedia Tools and Applications, 81(11), 14749-14772.

Maskati, E., Alkeraiem, F., Khalil, N., Baik, R., Aljuhani, R., & Alsobhi, A. (2021). Using Virtual Reality (VR) in Teaching Students with Dyslexia. *International Journal of Emerging Technologies in Learning* (IJET), 16(9), 291-305.

Makhubele, Y. E., & Makonye, J. P. (2022). The Designing of a Learning Theory to Promote a Classroom Pedagogy for Moodle Self-Directed Learning. *JETL (Journal of Education, Teaching and Learning)*, 7(1), 73-82.

Makruf, I., Rifa'i, A. A., & Triana, Y. (2022). Moodle-Based Online Learning Management in Higher Education. *International Journal of Instruction*, 15(1), 135-152.

Morimoto, T., Kobayashi, T., Hirata, H., Otani, K., Sugimoto, M., Tsukamoto, M., ... & Mawatari, M. (2022). XR (extended reality: virtual reality, augmented reality, mixed reality) technology in spine medicine: status quo and quo vadis. *Journal of Clinical Medicine*, 11(2), 470.

Morze, N., Kuzminska, O., Glazunova, O., Korolchuk, V., Mokriiev, M., Varchenko-Trotsenko, L., & Zolotukha, R. (2022). Moodle Tools for Educational Analytics of the Use of Electronic Resources of the University's Portal. In Proceedings of the 1st Symposium on Advances in Educational Technology AET-20. (No. 2, pp. 444-451). *Science and Technology Publications*, Portugal.

Mpungose, C. B., & Khoza, S. B. (2022). Postgraduate students' experiences on the use of Moodle and Canvas learning management system. *Technology, Knowledge and Learning*, 27(1), 1-16.

Mustapha, A. M., Zakaria, M. A. Z. M., Yahaya, N., Abuhassna, H., Mamman, B., Isa, A. M., & Kolo, M. A. (2023). Students 'Motivation and Effective Use of Self-regulated Learning on Learning Management System Moodle Environment in Higher Learning Institution in Nigeria. *International Journal of Information and Education Technology*, 13(1).

Nilsson, P., & Karlsson, G. (2019). Capturing student teachers' pedagogical content knowledge (PCK) using CoRes and digital technology. *International Journal of Science Education*, 41(4), 419-447.

Palau, R., Fuentes, M., Mogas, J., & Cebrián, G. (2021). Analysis of the implementation of teaching and learning processes at Catalan schools during the Covid-19 lockdown. *Technology, Pedagogy and Education*, 30(1), 183-199.

Papadima-Sophocleous, S., & Antoniou, S. (2023). Teacher Self-Training in Creating Moodle Quiz Constructivist L2 Activities During the COVID-19 Era: Lessons learned. In *Research, Practice, and Innovations in Teacher Education During a Virtual Age* (pp. 35-52). IGI Global.

Prasetya, R. E. (2022). Implementation Interactive And Collaborative Online Learning English For Foreign Language Moodle-Based. Eternal (English, *Teaching, Learning, and Research Journal*), 8(02), 21-32.

Ryan, G. V., Callaghan, S., Rafferty, A., Higgins, M. F., Mangina, E., & McAuliffe, F. (2022). Learning outcomes of immersive technologies in health care student education: systematic review of the literature. *Journal of Medical Internet Research*, 24(2), e30082.

Shekhmirzova, A. M., & Gribina, L. V. (2021). Organization of Independent Wprk of Bachelors Using Distance Learning Environment Moodle. *Сборники конференций НИЦ Социосфера (*Vedecko vydavatelske centrum Sociosfera-CZ sro.), 31, 24-31.

Shofiyuddin, M., Mustofa, M., Umam, M. R., & Elfiyanto, S. (2022). POSTGRADUATE STUDENTS'PERCEPTIONS ON MOODLE AS LEARNING MANAGEMENT SYSTEM FOR ONLINE ENGLISH LANGUAGE LEARNING DURING COVID-19 PANDEMIC. *Research and Development Journal of Education*, 8(2), 580-590.

Sinaga, R. R. F., & Pustika, R. (2021). Exploring Student's Attitude towards English online learning using moodle during COVID-19 pandemic at smk yadika bandarlampung. *Journal of English Language Teaching and Learning*, 2(1), 8-15.

Su, Z., Wang, Y., & Wang, D. (2022). Learning Management System in Higher Education: Promoting Hybrid Learning of Postgraduate Taught Students through Optimised Moodle Module Design. *Journal of PGR Pedagogic Practice*, 2, 86-92.

Tursunovich, K. R. (2022). Advantage of moodle in organization of distance education in universities. *Galaxy International Interdisciplinary Research Journal*, 10(1), 795-806.

Zglinski, J. (2022). Rules, standards, and the video assistant referee in football. Sport, Ethics and Philosophy, 16(1), 3-19.Tan, Y., Chen, P., Shou, W., & Sadick, A. M. (2022). Digital Twin-driven approach to improving energy efficiency of indoor lighting based on computer vision and dynamic BIM. Energy and Buildings, 270, 112271.

Zhou, Y. (2022). The Application Trend of Digital Finance and Technological Innovation in the Development of Green Economy. *Journal of Environmental and Public Health*, 2022.

Zulfikar, A. R. L., & Dewi, N. R. (2022). The Development of Moodle-Based Self-Assessment to Measure Students' Metacognition Ability. *Unnes Science Education Journal*, 11(1).

qizi Nasimova, Z. I. (2022, March). APPLICATION OF MOODLE SYSTEM AND ITS CAPABILITIES. In Euro-Asia Conferences (pp. 75-77).

Winterhagen, M., Hedderoth, A., Srbecky, R., Fischman, F., Wallenborn, B., Then, M., ... & Hemmje, M. (2022). Enabling adaptive courses in moodle. In *Edulearn22 Proceedings* (pp. 4707-4713). IATED.

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Chapter 7: Measurement and Evaluation of Performance in Digital Education

Vrije Universiteit Brussel

CHAPTER SEVEN: MEASUREMENT AND EVALUATION OF PERFORMANCE IN DIGITAL EDUCATION

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Abstract

The integration of technology in education has transformed traditional learning systems to modern learning systems, creating new possibilities for communication, learning, and assessment. Using digital technology in assessments provides numerous advantages such as choice, self-paced, self-directed, and self-motivated learning environments. Additionally, online assessment provides equitable education through a variety of assessment activities that offer multiple indicators and alternative tools for students to demonstrate their abilities. Digital tools support collaborative work, making assessment less individualistic and more relevant to real-life problem-solving skills. The use of digital technology in assessment also allows for the assessment of cognitive skills and provides immediate feedback to improve students' understanding. However, using digital technology in assessments also presents challenges and threats such as collecting and analyzing data, ethical concerns, lack of cultural integration, and social exclusion. This chapter explores the concept of assessment in a digital environment, highlighting the key issues and functions of assessment in digital environments, as well as the opportunities and challenges presented by digital technology in assessment.

1. Digital Technologies, Learning and Assessment

Over the years, digital technology has become an integral part in education which transforms traditional learning systems to modern learning systems (Sarker, Wu, Cao, Alam, & Li, 2019). In traditional learning, learners are restricted in time and space which burdens them to satisfy the learning environment. In response to that issue, digital technology is a tool to reach the requirements of the learning environment and resolve the problems of learning (Nganji, 2018). The integration of technology into education is an effective tool to gain knowledge and enhance the capacity for learning (Sarker, et al.,

2019). The advent of digital technology has created new opportunities for communication, experiential learning, and assessment.

Indeed, digital technology facilitates student engagement through debates and discussions and thereby enhances the learning experience (Duţă & Martínez-Rivera, 2015). Jian-Hua and Hong (2012) point to the digital platforms that allow immediate feedback to students and keep students engaged and motivated to learn. The integration of digital technology in education has brought about automated feedback mechanisms that allow students to reflect on their learning progress independently. According to a recent study, the use of regular assessments encourages learners to monitor their progress, increases their motivation to study, and positively affects their perception of their learning experience. Additionally, teachers also benefit from regular assessments as they can accurately measure their students' progress and adjust their teaching strategies accordingly for better results (McCallum & Milner, 2020).

Digital technology provides automated feedback to students, allowing them to reflect independently on their learning progress. According to a recent study, regular assessment helps learners monitor their progress, increases motivation, and improves their perception of learning. Teachers also benefit from regular assessments as they can measure what students have learned and adjust their teaching methods accordingly (McCallum & Milner, 2020). Using digital technology within the assessment is not a new technological introduction to education. In one form or another, digital technology and assessment have been around for more than two decades. Early applications of technology aimed to improve efficiency and reduce costs in testing (Pellegrino & Quallmalz, 2010). Another early innovation concerned the delivery, recording and analysing of assessment data (Bull & McKenna, 2004). Throughout its lifetime, scholars have argued that it is a potential catalyst for change in traditional assessment practices and a response to growing assessment challenges (e.g., distance learning, objective and high-quality feedback, higher-order thinking) (Whitelock & Watt, 2008).

Despite recognizing the potential of technology in education, there is a limited implementation of technology-based assessment practices. This implementation mainly focuses on efficiency, standardization, grading, and data recording (Timmis, Broadfoot, Sutherland & Oldfield, 2016). Shute and Kim (2013) critique the literature, pointing out

that the over-emphasis on technology is hindering the development of more imaginative and creative possibilities in learning and assessment. Although the impact of digital technology on education practices is still not entirely clear, the emergence of various interactive technologies presents an excellent opportunity for more engaging pedagogy and innovative assessment methods (Timmis et al., 2016). To explore this potential further, the following section highlights some of the key areas where technology is currently demonstrating its potential in assessment.

2. Assessment in Digital Learning Environments

Assessment is a core component of learning since it allows to measure how much the target outcomes are achieved (Narciss, 2012). As identified by Ausebel (1968), assessment is the most influential element affecting learning for teachers. The author indicates that teachers might decide on the current knowledge of the learners and thus teach accordingly. Including students, Black and Wiliam (1998) describe assessment as any kind of activity which provides information for a source of feedback both for teachers and students. Despite the various ways it may be described, The term "assessment" encompasses the process of collecting, interpreting, and utilizing data to make informed decisions about a learner's educational achievements and performance (Harlen, 2007).

Assessments have evolved over the years to not only measure what students know, but also how they acquire knowledge and how they can apply it. In the nineteenth century, knowledge was viewed as a fixed and unchanging truth, and assessments reflected this perspective (Perry, 1968). However, in the 20th century, the idea of multiple perspectives and relative truths emerged, and assessments began to reflect this shift in societal views. (Perry, 1968). With the emergence of social media, algorithms, and the availability of instant information in the 21st century, the understanding of knowledge and truth is also changing (Barnett, 2017).

Although societal views on knowledge and truth have evolved, traditional assessment methods remain largely unchanged. These methods typically involve demonstrating knowledge through tests, quizzes, and essays, which can be easily compared and graded. However, in the current age where information is readily

accessible, these assessments may be missing the point. They often place a heavy emphasis on recall and offer limited opportunities for students to provide their own input or make choices (Bearman & Ajjawi (2018). In order to better engage learners in the assessment process and promote learning, there has been a departure from traditional testing methods and a shift towards aligning with current trends in teaching and learning to keep up with the 21st-century skills that are expected from learners (Rusman et al. 2014). The emergence of the internet and innovations in information and communication technology (ICT) there has been an increased integration of technological tools in teaching and learning processes to keep up with 21st-century skills expected from learners (Rosenbusch, 2020).

In addition, the Covid19 pandemic forced many educational institutions to accelerate their transformation towards technology integration, resulting in new learning environments both inside and outside the classroom. This change has necessitated a shift in assessment processes as well, since it was neither appropriate nor effective to use only traditional pen and paper testing. In response, technology-enhanced assessment methods have become an integral part of teaching and learning, bringing about radical changes in assessment practices. The rise of e-learning and technology-enhanced assessment methods reflect the need to align with current developments in both technology and pedagogy, and this has transformed the teaching and learning landscape (Whitelock & Brasher, 2006).

Several studies, including those by Alruwais et al. (2018), Jordan (2013), Cazan and Indreica (2014), and Timmis, et al. (2016), agree that digital assessment has the potential to generate novel forms of learning that may not occur in traditional contexts. It is thus digital assessment is more interactive, entertaining, and adaptive than traditional assessment methods (Simin & Heidari, 2013; Alruwais et al. 2018). Furthermore, computer-based assessment is easier to use and rapidly analyzes, corrects, and stores papers and scores, with an unlimited capacity to handle large data. The results of computer-based evaluation are seen to have increased accuracy and reliability compared to traditional assessment methods. It is also less strict in terms of duration, with no pressure of time, and invigilation can be withdrawn in an e-assessment environment. (Simin & Heidari, 2013). The adoption of e-assessment is driven by practical and

pedagogical reasons. The former relates to its efficiency in dealing with the increased number of students and the enduring time reserved for their assessment, while the latter relates to its ability to adequately meet the principles that guide an assessment activity in relation to validity, reliability, efficiency, and diagnosticity (Al-Smadi & Guetl, 2008). Instructors find it burdensome to correct students' answers and store their marks, especially when dealing with large-scale data Appiah & Tonder (2018). The limitations of traditional assessment methods, such as insufficiency of direct feedback and lack of creativity, have rendered learners restricted only to the task, decreasing their self-confidence and motivation Timmis et al. (2016), Pearse-Romera & Ruiz-Cecilia (2019). Yet, these scholars don't deny the potential of traditional assessment. Instead, they believe combining technology with assessment has brought about new skills based on online collaboration, exchange, interaction, and peer assessment, which are important to cope with the changing world (Alruwais et al., 2018; Jordan, 2013; Cazan & Indreica, 2014; Simin & Heidari, 2013; Timmis et al., 2016).

Fundamentally, either traditional or digital, assessment is about making judgements about students' learning on the basis of evidence. These judgments are made with various functions and are distinguished as assessment of learning (AoL), assessment for learning (AfL), and assessment as learning (AaL) (Deeley, 2019; Yan&Boud, 2021), which will be discussed below.

2.1. Assessment of learning (AoL)

As Deeley (2009) suggests, summative assessment is considered for measuring students' learning at the end of a course or an instructional unit (Deeley, 2019) This may also mean checking if desired learning objectives have been achieved or documenting the achievement of required skill levels by someone external to the learner (Gikandi, Morrow & Davis, 2011; Earl, 2013). The primary aim of summative assessment is to assign a grade or some other form of recognition to a student. Summative assessment, which is considered the traditional type of assessment, typically involves objective testing, predetermined objectives, and fixed content that results in a standardized approach. It typically focuses on general/broader content for certifying learners' final achievements

(Oosterhof et al. 2008). Indeed, according to Smith, 2007; Tshibalo, 2007, traditional assessment methods assess declarative skills and core performance without providing evidence of learners' deep understanding and personal reflection. Due to these limitations, formative assessment is required to support learners to develop deep and higher-order skills Gikandi, Morrow &Davis, 2011)

2.2. Assessment for learning (AfL)

Formative contributes to students' learning for learning, not typically to students' final grades; (Deeley, 2019). It involves assessing learning that takes place during teaching to enhance teaching and learning (Oosterhof et al., 2008). Formative assessment is an integral part of the learning process which takes place throughout learning cycle. During the formative assessment, learning evidence is collected and shared to support and advance learning by both teacher and student (Black& Wiliam, 2009).

Formative assessment activities include diverse practices to monitor learning, understand learners' level of understanding to modify instruction and give timely feedback. In describing those activities, According to Black and Wiliam (2009), the evidence of student achievement can be considered formative when teachers, students, or peers analyze and utilize it to make decisions about the following steps. By expanding on these definitions, Bennett (2011) describes formative assessment as making decisions on learners' improvement instead of only focusing on the expected learning objectives. To elaborate, formative assessments serve various purposes, including involving students in the learning process, adjusting teaching strategies, evaluating individual or peer progress, and providing prompt feedback. Thus, formative assessments are accepted as a tool to aid learning instead of just assigning grades (Bloom, et al.,1971).

2.3. Assessment-as-learning (AaL)

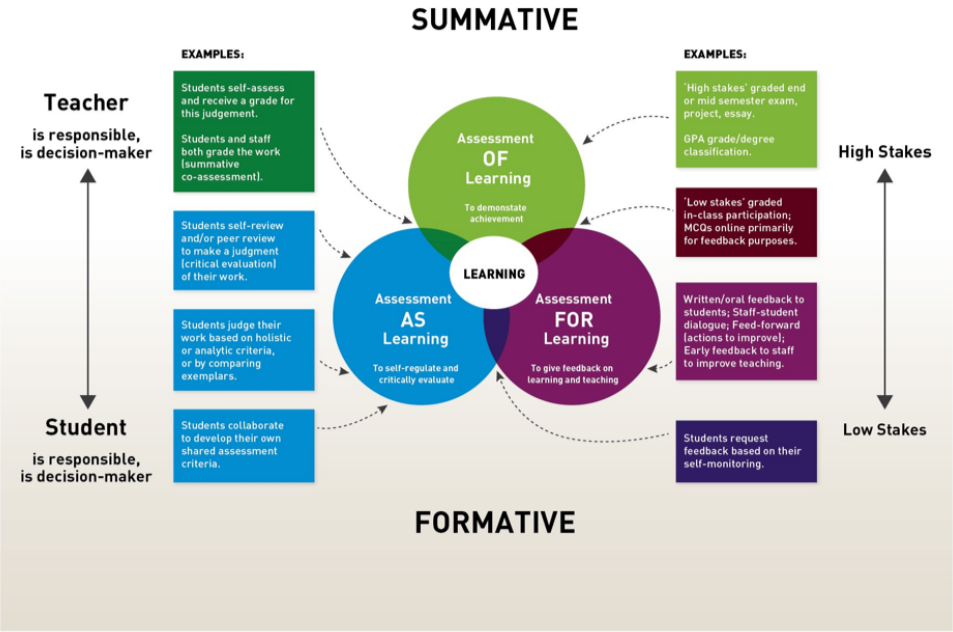
In assessment as learning, students are the active agents in the assessment criteria. Therefore, they are expected to set success criteria, assess their peers and themselves, and use activities and feedback to improve learning (Earl, 2013). The first

widespread use of the term assessment-as-learning appeared at Alverno College. That college (1974) defined assessment as learning as an integral process balancing formative and summative assessment. To evaluate student performance, they followed a process which includes observing, analyzing, and interpreting the results based on publicly defined criteria. This process also involves self-assessment and providing feedback to the student, ultimately confirming their achievement.

Mentkowski, 2006 states that this is an efficient way to confirm student achievement and provide feedback for improving teaching and learning. Later, the idea of assessment-as-learning gained more attention in pedagogical applications. Lorna M. Earl (2006), with her timely contribution, wrote a book about this process. She argued that assessment as learning is associated with metacognition. According to her, when students are more enactive, engaged and critical assessors of their own learning, they understand the information better, connect it with the prior knowledge and use it for new learning opportunities. Similarly, Berry (2008) states that learners become more autonomous and get an active role in learning.

The roles and interactions of the various assessment types and the individuals involved are depicted in the following figure.

Figure 1. *Types of Assessment*



Source: "The National Forum for the Enhancement of Teaching and Learning in Higher Education, 2017"

What stands out in this figure is that moving from assessment of learning to assessment for learning and eventually to assessment as learning can lead to more profound learning experiences and offer authentic opportunities for students to have a say and take ownership of their learning. This shift also supports learners in digital environments, as emphasized by Reich (2020) in his recent book. He also demonstrates that learners who are self-directed, self-paced and self-motivated will be successful in digital learning environments as they can learn and evaluate their work's quality.

Digital assessment has become more widely accepted and commonly used in educational institutions, leading to an increase in research on the development of a conceptual framework for digital assessment. Tinoca et al. (2014) proposed a four-dimensional framework, consisting of a set of sub-criteria, for high-quality digital assessment in higher education. The dimensions include authenticity, consistency, transparency, and practicability. Isaias et al. (2017) presented a framework for an

effective digital assessment system based on design options, scalability, security, access and usability, feature feedback, personalization, cost, and interoperability. They found that design options were considered the most crucial criterion by participants worldwide. In another study, Whitelock et al. (2006) suggested that a digital assessment system follows a cycle similar to traditional assessment, beginning with motivation and followed by design and creation. After the assessment task is developed, they are tested and delivered to students, which are then subjected to the data retrieval, processing, and feedback stages. The evaluation of results leads to general feedback that contributes to teaching, learning, and assessment processes.

2.4. Common uses of online assessment

The introduction of digital assessment has led to significant changes, including the use of various assessment instruments for both formative and summative purposes, such as e-portfolios, adaptive tests, and interactive case studies and scenarios (Doğan et al., 2020).

Benson and Brack (2010) categorize the use of online environments for formative and summative assessment into four distinct groups: submissions of items for assessment, automated assessment, online discussions, and web publishing. In the case of submissions of items for assessment, assessment tasks such as essays, reports, and presentations are submitted using technology, but the assessment process is still done manually by teachers and not automated. Online environments are commonly used for both formative and summative assessment, and they can be classified into four main categories: submissions of items for assessment, automated assessment, online discussions, and web publishing. The section below will delve into each of these categories in detail, as originally presented by Benson and Brack in 2010.

a. ***Submissions of items for assessment.*** As the name refers, assessment tasks such as essays, reports, and presentations are simply submitted through the use of technology, but the assessment process is not automated and has to be done by teachers

b. ***Automated assessment.*** Automated assessment involves the automatic delivery of items, scoring, and providing feedback to students with automatic feedback. Quiz is one of the most commonly used forms of automated assessment which may include several types of questions such as multiple choice, short answer, matching, calculation, fill in the blanks, and true/false. Quizzes are a popular type of automated assessment which may include various question types, such as multiple-choice, short answer, matching, calculation, fill in the blanks, and true/false. This type of assessment provides instant feedback, supports self-assessment; however, it restricts creativity, assesses low-order skills that can be marked by computers. Another type of automated assessment is multimedia options which is built into interactive multimedia applications in Learning Management System sites. Some examples may include drag and drop, Matching questions and simulations. They allow consistency, easy progress check and update; but they require a lot of time, technical knowledge and to develop and design.

c. ***Online discussions*****.** Online discussion is an easy process which requires online communication and collaboration and may encompass individual, peer and group assessment. Some examples are allocated roles, debates, forums and role plays. It is advantageous because it allows everybody to see different opinions, facilitates peer, group assessment, and support shy learners. Despite those advantages, it may be time-consuming, require careful planning, limits spontaneous interaction and lack social cues.

d. ***Web publishing.*** It includes contexts which are open to the World. Depending on the task, teachers may need to teach students how to write on the web. It is possible to create and publish content for e-portfolios, blogs, wikis, shared documents and student podcasting online. Web publishing for assessment is quite beneficial in self-assessment, group work, interactivity, peer learning and web publishing skills. It is challenging as it is time intensive and creates a risk for plagiarism.

3. Key issues of assessment in digital learning environments

It is important to address key assessment issues to achieve desired outcomes in digital learning environments which is similar to those in traditional face-to-face learning environments. These issues are validity, reliability and dishonesty that take on new dimensions due to the interaction between students and teachers in digital (Oosterhof et al., 2008). According to Wolsey (2008) and Hargreaves (2008), it is necessary to meticulously differentiate between validity and reliability concerning assessment for learning and assessment of learning. Formative assessment requires multifaceted contexts and alternative approaches to address the challenges related to validity and reliability in digital learning environments (Blair & Monske, 2009), and entails both the learning products and processes (Sorensen & Takle, 2005; Vonderwell et al., 2007). The upcoming sections will showcase the features of formative assessment in digital environments concerning academic dishonesty, as well as the significance of validity and reliability.

3.1. Validity

In summative assessment, the concept of validity encompasses the evaluation of the extent to which test scores reflect the intended construct, and the inferences drawn from the scores align with the expected characteristics. According to Shaw and Crisp's definition (2011), validity requires sufficient evidence that test scores are measuring what they are supposed to measure, and that they are related to other variables as predicted. Following this unified conception, Gikandi, Morrow and Davis (2011) assert that validity considers multiple measures and multiple sources of evidence over a continued period. In the current digital era, validity is related to the efficiency of significant assessment activities and feedback that promote inquiry-based learning, contextualization, and multidimensional viewpoints while offering ample support to learners. In line with these concepts, digital formative assessments must satisfy specific standards, such as authentic assessment activities, efficient formative feedback, diverse perspectives, and learner assistance (Deeley, 2019).

3. 2. Reliability

Reliability in the context of digitalization involves the ability of students to demonstrate their progress and achievements through the documentation of evidence of their learning. Obviously, this provides opportunities for the monitoring of individual progress and identification of strengths and weaknesses, which can aid in taking measures to achieve the desired level of knowledge (Chung et al., 2006). Driessen et al. (2005) conducted a study aimed at redefining reliability in the context of formative assessment. They introduced a new concept wherein reliability in digital formative assessment pertains to the reliability and sufficiency of what is being evaluated to determine the level of knowledge structure being established. Using this definition, Deeley (2019) identified several attributes linked to reliability in online formative assessment, which include provisions for recording and tracking proof of learning, various sources of evidence of learning, and clear learning objectives and rubrics with shared definitions.

3.3. Dishonesty

In digital formative assessment, the issue of academic dishonesty is closely connected to both the validity and reliability of assessments. As implied by Oosterhof et al. (2008), increasing the level of validity and reliability can help minimize instances of dishonesty. Previous studies on the topic of dishonesty (Mackey (2009), Mackey & Evans (2011), Sorensen (2005), and Sorensen & Takle (2005), have highlighted the need for authentic assessment activities and adequate learner support for meaningful interactions and building students' confidence in digital settings.

As discussed above, validity, reliability, and dishonesty issues in digital learning environments, when compared to face-to-face environments have gained new dimensions. One of these different features is the types of interactions that differ with face-to-face settings. Therefore, the formative assessment of online environments should be designed to overcome potential risks. For example, Wolsey (2008) gave the effect of adequate feedback for negative communication due to inadequacy of physical interaction between students and teachers An additional feature that sets online learning environments apart is the importance of structured dialogue between feedback providers

and teachers. In other words, feedback should create continued student support and more opportunities for learning. It is also very important that students get quick online feedback and have sufficient time to respond. As noted by Vonderwell et al. (2007), this balance is required to create a more comprehensive and qualified discussion environment because students should first understand the topic well and organize their thoughts, and then respond to other online participants.

Incorporating the characteristics of digital formative assessment will create a shift in the conceptualization of validity, reliability, and dishonesty, thereby enhancing the functionality of digital formative assessment as an innovative pedagogical approach.

4. Opportunities offered by digital assessment

Digital technologies offer many opportunities for innovation in assessment. Below are the areas discussed with relevant literature.

4.1. Student Engagement with critical learning processes

Student engagement, initially defined as the student energy for academic experience (Astin, 1999), currently refers to the time, energy, and resources devoted to activities to enhance learning in educational settings (Dunne & Owen, 2013). Student engagement is a tool for learning. As defined by Garrison and Akyol (2009), student engagement is achieved when they progress from basic interactions to meaningful discussions that are essential for constructing knowledge and understanding. The findings of previous studies (Angus & Watson, 2009; Lin, 2008; Wang et al., 2008) also confirm the importance of students' engagement in blended learning environments. They agreed on the fact that engagement has increased through three types of meaningful interactions: interaction with content, interaction with others, and interaction with oneself. To enable meaningful interactions with content, a unique context is needed that provides students with materials and/or tools related to online formative assessment, a variety of challenging and engaging activities, and authentic circumstances. In order to take advantage of these contextual opportunities, a range of distinctive learning and assessment tasks, projects, and example scenarios may be required. Linked to that,

students need to utilize online tools that facilitate collaborative inquiry, computer-based simulation tools (such as avatars), information search and presentation tools, and/or rich databases of information. Many studies have provided case studies of real-life situations that encourage learners to be more self-directed and increase their participation. The results revealed that interactions related to content have been shown to promote enduring engagement and significant learning experiences that enhance the learner's capacity to apply knowledge in new situations (Correia & Davis, 2008; Crisp & Ward, 2008; Lin, 2008; Mackey, 2009).

In their study of meaningful interactions between students, tasks, and technological resources, Herrington et al. (2006) have shown that authentic tasks can foster in-depth understanding, increase students' ability to apply knowledge to practical situations, and encourage lifelong learning. Similarly, Lin (2008) and Wang et al. (2008) found that when students interact with process-oriented e-portfolios, this approach fosters a realistic learning environment that promotes collaborative learning and assessment through activities such as working together, documenting progress, sharing ideas, and reflecting on outcomes. It enables collaborative development of a shared understanding of expected performances, continuous monitoring and documentation of learning processes and outcomes, and offers a unique way to develop and evaluate student knowledge. By using this approach, students can take ownership of their learning and value their educational experience.

Similar to other scholars (Wolsey, 2008 & Vonderwell et al., 2007), Sorenson (2005) has shown that online environments can facilitate social interactions between students and teachers. He further added that when students share their work, views, and experiences in such environments, it creates dynamic opportunities for ongoing monitoring and evaluation, as well as diverse learning and assessment activities. This also expands the possibilities for identifying students' needs and providing ongoing support. Sorensen argues that participating in social contexts is a fundamental aspect of true professional practice which fosters the development of relevant and transferable skills for real-world situations.

While determining the outcomes of technology mediated interactions, teachers and students as human agents play an important role; however, it should be noted that

technology itself can also influence the possibilities for shaping these outcomes. To fully understand and leverage the potential of e-tools in formative assessment, it is necessary to situate them within a comprehensive and broader understanding of effective learning (Patchker, et al., 2010). The authors propose that giving shared responsibilities to students can establish genuine settings that motivate them to participate in reflective and collaborative conversations within an online learning community. Mackey's research in 2009 also revealed that blending face-to-face professional work with online classroom contexts allows students to interact with others and facilitates peer formative assessment. In peer review process, students question or respond to the views of others who may have different or similar perspectives, both in online and real-world settings. This study also demonstrates that an authentic, collaborative, and reflective learning environment can be created through online formative assessment which allows students to share their learning experiences. These experiences replicate real communities of apprenticeships and enhance students' skills to use this knowledge in their professional practice.

In formative assessment, students take the opportunity to interact with self in online learning environment. This is due to extensive and flexible capabilities for documenting and describing evidence of student progress and achievement. Thus, teachers and students can monitor student progress. As mentioned earlier, this is consistent with previous scholars (Mackey, 2009; Mackey & Evans, 2011, and Vonderwell et al., 2007). Their findings indicate that students engage in self-evaluation by reflecting on their own process while carrying out learning and assessment activities. This, in turn, facilitates students in reflecting on and taking ownership of their work, as well as evaluating it. Moreover, the teacher can also use these insights to reflect on students' needs. In addition, Lin (2008) reports that students reflect on and evaluate the Works of their peers when they participate in training-oriented e-portfolio processes which facilitates their further learning. Online self-assessment questionnaires provide an additional avenue for individuals to enhance their self-interactions within digital environments. A case study by Smith (2007) showed that students' value and benefit from receiving immediate feedback through self-tests. With this feedback, they may engage in self-assessment, reflect on their own learning and revisit the content for improvement.

4.2. New tools for assessment

The advent of technology has led to a growing utilization of digital tools such as text, images, videos, audios, data visualizations, and haptic feedback. These new tools offer various possibilities for demonstrating achievement in education and enable assessments to be designed in diverse ways. Moreover, they empower students to document their success and progress using various formats over different durations. Some examples of new tools include:

1. ***Interactive quizzes and assessments*.** These tools are types of interactive tests and examinations that typically involve multiple-choice, short-answer and drag-up questions. The use of digital quizzes and assessments allows for greater flexibility in administering and completing tasks as well as providing immediate feedback for student's performance. They can also provide self-paced learning and adaptive learning experience (Lopes, & Soares, 2022).
2. ***Gamified assessments***. These tools are game-like elements in assessments to make them more engaging and interactive for students. They also increase student motivation and learning outcomes. Some examples include points, badges and leaderboards (Boudadi & Gutiérrez-Colón, 2020).
3. ***AI powered assessments.*** These tools use artificial intelligence (AI) to automatically grade a wide range of students' work including multiple choice tests, short answer questions, coding assignments, essays and even hand-written exams (Sánchez-Prieto, Cruz-Benito, Therón Sánchez & García Peñalvo, 2020).
4. ***Virtual reality assessments***. Virtual reality technology is used to create immersive assessment environments. These environments can be used to assess spatial awareness, problem-solving and decision-making skills. VR assessments have the potential to provide a more realistic and engaging assessment experience. Simulations, virtual worlds and VR games are some of the examples of VR assessment forms (Molina-Carmona, Pertegal-Felices, Jimeno-Morenilla, & Mora-Mora, 2018).

Those tools integrate assessment into learning activities and assessment in digital environments includes addressing real-life problems within a virtual world. They also have the potential to make assessment more efficient, effective and engaging for students and teachers. However, it is important to note that these tools are not a replacement for human teachers, they are tools to assist the teachers and improve the assessment process.

4.3. Fostering equal opportunities in education

Digital formative assessment has the potential to promote equitable education by offering various learning opportunities according to the unique needs of individual students. In Gikandi, Morrow and Davis' view (2011), it enables adaptive teaching and assessment approaches for the individual needs and also promotes the continual growth and improvement. This may result in increasing equity for online students.

As described in Jenkins (2005)'s review, effective online formative assessment should focus on the strengths of students and their capacity to improve through targeted interventions rather than focusing on their weaknesses. According to Sorensen, 2005; Sorensen & Takle, 2005, formative assessment emphasizes that all students are potential experts and allow opportunities to all the students to demonstrate their expertise. Moreover, online formative assessment creates supportive and collaborative environments where students can easily express their thoughts, ask questions and/or engage with different perspectives of their peers . This is certainly evident in Vonderwell et al. (2007) and Fornauf and Erickson's (2020) studies. To facilitate online peer and self-assessment, a collaborative learning approach was employed by the researchers. Vonderwell et al. (2007) highlighted that various assessment activities can be helpful for advancing equitable education as they offer diverse indicators and alternative tools for students to present their own abilities. Lin (2008) found that students evaluate their own learning and accomplishments and determine areas which require improvement in order to reduce performance gaps, thereby fostering equal opportunities in education.

4.4. Supporting and enhancing collaborative learning and assessment

Van Aalst and Chan (2007) noted that the rise of Networked and Web 2.0 technologies provide opportunities for collaborative learning and assessment approaches, including co-evaluation and peer assessment. With the support of digital technologies, individuals can engage in peer-to-peer data sharing, collaborative knowledge construction, and peer review.

Therefore, it becomes possible for learners to collect, share and comment on the data using synchronous and asynchronous technologies (De Alfaro & Shavlovsky, 2013). As discussed above, the use of digital resources can help students collaborate in different ways both inside and outside of formal education environments. Timmis et al. (2016) argue that this collaborative work can help to move assessment from individualistic approach to more practical one that aligns with real World problem solving.

4.5. Assessing higher-order skills

In the relevant literature, it is mentioned that digital assessment creates opportunities to assess cognitive skills (Brown, 2012) spanning from lower-order thinking skills (LOTS) to more advanced higher-order thinking skills (HOTS). Some projects (Pellegrino & Quellmalz, 2010) use simulations and immersive environments to assess higher-order skills such as hypothesis testing, role-playing and problem-solving. In addition, the literature frequently emphasizes the potential of digital technologies for assessment, particularly in relation to immersive and game-based environments.

In those environments, teachers may give direct online feedback and direct online feedback may be given by teachers and assessment teachers may give direct feedback online and collect assessment data. Implementing such an approach has the potential to enhance both student engagement and performance in their coursework, as suggested by Hickey et al. in 2009. However, these methods are limited in traditional classroom settings due to the challenge evaluating performance in contextual scenarios such as risky scientific experiments, natural phenomena, or fictional situations (Pellegrino & Quellmalz, 2010).

4.6. Enhancing immediate feedback

Digital technologies have improved and provided opportunities for immediate feedback. As demonstrated by Wolsey (2008), providing immediate (formative) feedback helps students in revising their work and enhancing their comprehension. As a result, it may allow students to gain self-engagement and self-regulation skills. Similarly, Formative feedback can promote student motivation and engagement, resulting in better academic performance (Crisp & Ward, 2008). Upon reviewing the literature on formative assessment and its diverse opportunities, Sorensen and Takle (2005) recognized that interactive and collaborative online learning communities foster dynamic and meaningful interactions. Linked to that, Vonderwell et al. (2007) focused their research on collaborative learning as a strategy for implementing peer and self-assessment for formative purposes. Their study also indicated that asynchronous discussions gave students enough time to compose and share their ideas. As a result, this approach promoted reflective and self-assessment procedures. When compared to traditional f2f settings, the effectiveness of immediate feedback in digital educational settings has many characteristics. Koh's (2008) review revealed that in online learning settings, immediate feedback can facilitate deep learning, motivation, self-esteem, self-regulated learning, and transferable skills. Additionally, Wolsey (2008) demonstrated how computer applications and software can enhance the effectiveness of feedback in online environments, enabling more thorough and comprehensive written feedback that is integrated into student work. These aspects are critical in fostering meaningful dialogue between teachers and students.

In consistent with what Wolsey (2008) suggests, Gikandi, Morrow and Davis (2011) demonstrate that teachers can monitor and thus identify the weaknesses and strengths of students and provide immediate feedback which is visible to all (scaffolded interventions). Such opportunities can support learning processes that allow more student engagement.

5. Challenges and risks of digital assessment

The preceding section highlights the significant areas where digital assessment can introduce innovative approaches to enhance learning and assessment, along with the advantages offered by digital technologies. However, it is also crucial to acknowledge the potential challenges and risks they bring, particularly when used in assessment that involves the collection and analysis of data. Assessment plays a critical role in determining learners' futures and raises various ethical concerns. This section provides a brief overview of the potential hazards linked to the use of digital technologies in assessment.

It is equally apparent hat digital technologies can also pose both challenges and threats. This is especially the case when utilized for assessment purposes. Collecting and analyzing data is a critical aspect of assessment that can significantly impact a learner's future, thereby raising several ethical concerns. This section provides a brief overview of the potential risks associated with the use of digital technologies.

5.1. The role of technology in assessment

The assessment aspect in digital innovation is still underdeveloped, with technology dominating the use of on-screen testing. According to Winkley (2010), multiple-choice questions and automated marking are the most commonly used methods for assessing students. Mansell (2009) echoes similar sentiments, highlighting that on-screen testing is not yet widely adopted for external examinations and is primarily known within the enthusiast community. Whitelock and Watt (2008) argue that assessment in digital environments often follows a "transmission" model of teaching and learning, which focuses on delivering information rather than promoting active knowledge building of students.

Even in areas of accepted innovation, designers of digital learning environments tend to overlook the importance of assessment. Shute and Kim (2013) observed that existing immersive games lack adequate assessment infrastructure, limiting their potential for maximizing learning outcomes. Simulations use various and costly technologies. According to Gee and Shaffer (2010), when it comes to immersive

environments and educational computer games, the assessment process often lags behind the design of the environment and learning tasks. Therefore, they suggest that the development of games for assessment purposes should be prioritized. If not, as stated by Winkley (2010), assessment in games can become excessively implied, leading students to overlook crucial details in the outcomes they receive.

5.2. The lack of engagement in assessment

There are problems in culture, expertise and inertia in the integration of technology into assessment. Timmis, et al. (2016)) arguably find that a lack of engagement among innovators, designers, educators, and researchers in the assessment process is the root of the problem. Consistent with that, Van Aalst and Chan (2007) note that there has been little emphasis on evaluating the collaborative aspect of computer-supported collaborative learning (CSCL), leading to incompatible assessment practices. They argue that a collaborative culture of assessment is necessary, where learning and assessment are integrated, not focusing on individual competition and performance. The perception that collaborative or peer assessments are unfair and unequal is held by many institutions, teachers, and students. This perception acts as a significant obstacle to the implementation of more innovative forms of collaborative assessment, as noted by Ferrell (2012).

5.3. Risks of adopting digital assessments

There is a concern that the advancement of digital technologies may result in a shift towards technology-centric design of assessments. This was exemplified in the work of Sutherland et al. (2012). They indicated that computer scientists initiated digital assessments with little consideration for educational purposes, potentially leading to the risk of technology driving educational and assessment practices. Instead of taking a technology-centric focus, some scholars have stressed the importance of cultural, social and institutional context while looking at any innovation (James, 2014). Others focus on the role of feedback in assessment and connect it to research. These authors advocate

for models that prioritize pedagogy, enabling students to take charge of their own learning and promoting reflection (Whitelock & Watt, 2008; Boud & Molloy, 2013).

An even more concerning risk is the common use of digital data for assessing school performance and improvement in many countries. It is believed that this is a positive development because it may lead to an objective and thorough understanding of student progress (Sutherland, 2013). However, there is a growing debate on the assumption of learning analytics, data collection and interpretation of large data sets. The increased use of digitized assessment data in education is raising awareness of potential threats. Foley and Goldstein (2012) challenges the notion that "data deluge" is wholly advantageous, given that the analysis of such data (e.g., exam results, league tables) can be flawed and prejudiced.

5.3.1 Ethical issues associated with implementing digital assessment

The use of technology in education has potential risks, including ethical challenges associated with "big data." These challenges include concerns about consent, data protection, ownership, and information control. These ethical responsibilities are important for educators to consider when implementing technology in the classroom (Facer, 2012). As technology enables the assessment of a wider range of skills and attributes, questions arise as to what data should be collected and what is considered acceptable or desirable to measure. These questions should guide the development of assessment tools and resulting practices (Oldfield, Broadfoot, Sutherland & Timmis, 2012).

5.3.2 The risks of social exclusion associated with digital assessment

The emergence of digital cultures and social networking can bring about issues of labeling and social exclusion, potentially exacerbating existing inequalities. One example is the use of Web 2.0 technologies, which provides learners with fresh opportunities to actively participate in creating content, sharing information, communicating, and collaborating. According to Boyd (2011), the benefits may not be equally distributed

among students. This is because the online space replicates offline social dynamics, and students need to feel a sense of trust in the learning environment. Jenkins et al. (2006) refer to this phenomenon as the "participation gap." This gap is also relevant to digitally enhanced assessment, which is often integrated into online group activities using wikis or discussions. As contributions are visible, this can limit participation in formative assessment (Timmis et al., 2016). Furthermore, online summative assessment can exacerbate achievement differences and reinforce social divisions (Dawson, 2010). It is important to recognize that students may not have equal participation or benefit from online activities in the same manner. Therefore, the potential risks of social exclusion should be taken into account when designing any digital assessment (Timmis et al., 2016).

6. Cases

Case 1 - "WebCEF: An online collaboration tool for assessing foreign language proficiency"

(Van Maele, Baten, Beaven, & Rajagopal, 2013; Baten, Osborne, & D'Silva Hymers, 2009; Osborne, Mateusen, Neuhoff, & Valentine, 2009)

Background:

WebCEF is an online assessment platform created as part of the Socrates-Minerva program which was funded by the European Commission (2006-2009). The main purpose of this platform is to facilitate virtual communities of practice, connecting learners and assessors across local and international contexts using "the Common European Framework of Reference (CEFR)". WebCEF is available for free which can be utilized in formal, non-formal, and informal learning settings. WebCEF received the "European Language Label" award in 2011. It also provides assessment for learning that is focused on identifying learners' strengths and weaknesses instead of only measuring their abilities.

Within WebCEF, oral production and interaction are assessed using both overall rating scales and specific qualitative scales for five key aspects: range, accuracy, fluency,

coherence, and interaction. The platform helps language teachers, teacher trainees, and students understand and apply the CEFR's levels and scales. Teachers divide learners into sub-groups, forming communities of practice that work collaboratively to assess oral proficiency. These groups assess uploaded audio or video samples and select the most appropriate descriptors from each scale. Assessors utilize an annotation feature to explain their ratings and provide comments on specific segments of the speech samples. All members of the group can view and learn from each speech sample.

Project Coordinators: “KU Leuven, Leuven Language Institute, Belgium; Università di Bologna CILTA, Italy; Université de Savoie, LLS France; Leuven Engineering College, Belgium”.

User Groups: “KU Leuven in Belgium and The University of Savoiein France”

Experience:

Students are divided into different sub-groups and each perform different tasks for assessing the output. They utilized the Google community not only as a platform for learning, organization, and discussion but also as a medium for publishing their reflective papers on the assignment. In the first stage, students talk about a predefined speaking task in WebCEF and record their own speeches. To become familiar with the CEFR framework and the WebCEF environment, they watched and evaluated other learners on the website. In the next stage, some groups become mentors and they design instruction tasks, administer oral tests, record the speeches, upload samples and assess the outputs. Other subgroups joined the discussions in the Google community and shared their perspectives with their teacher-mentor in a Belgian school or asked expert evaluation of their speech samples from foreign experts.

The WebCEF community members take the opportunity of collectively constructing their understanding of a topic as they react to and expand on each other ideas. This platform fosters improved Professional practice for teachers as well as promotes learner autonomy for students.

Case 2 - "Using MOOC Technology and Formative Assessment in a Conceptual Modelling Course"

Conducted in: "Research Center for Management Informatics, KU Leuven, Belgium"

Course flow

***The course**:* "Architecture and Modelling of Management Information Systems (AMMIS)"
Program: "Master programs of Information Management, Business Engineering and Business and Information Systems Engineering"

This course-previously taught on campus- is redesigned to employ blended learning . The following parts present the course flows:

- ***Live lectures**.* 13 live lectures were conducted, covering on the theoretical aspects of modelling exclusively online. These lecturers were recorded the and published online for the benefit of absent students or those who wished to revisit the material.
- ***8 exercise sessions at a computer lab.*** The students engage in practical modelling exercises related to the theoretical topics covered in the previous courses and receive feedback from teaching assistants.
- ***A full case**:* Students are expected to solve a case in groups. In this group work, students will work collaboratively to develop a large model. This model will encompass the behavioural aspects of the system and undergo simulated testing against various scenarios. In addition, students will engage in peer assessment throughout the project. The final model must be submitted at the end of the semester and its grade will be part of the overall course grade.
- ***A supporting online course (SPOC):*** comprises a range of resources, including recorded lectures, presentations, slides, and formative exercises designed to support the learning experience.

As a prerequisite to this course, it is expected that students who enroll in this course have followed the “MOOC UML Class Diagrams for Software Engineering” on the edX platform. Thus, students should be familiar with edX at the start of the course.

Assessment and feedback

The formative assessment: at the beginning of the course.

The summative assessment: at the end of the semester in a form of a group work evaluation and the final written exam.

Formative assessment: Three types of formative assessment are employed in the course: homework, online exercise with automated feedback, peer assessment.

- *Homework:* Students are offered the option to complete two homework, one focused on structural and the other on the behavioural perspectives of modelling. Although these assignments are not compulsory and do not contribute to the final grade, they provide an excellent opportunity to receive feedback from the professor.
- *Online exercises with automated feedback:* There are several online exercises in the online modules of edX edge platform. Those exercises consist of a variety of questions formats including multiple-choice questions, drag-and-drop exercises and true-false questions. Depending on their responses, students will receive either positive feedback with further explanation or negative feedback which may be helpful in identifying and understanding their mistakes.

- *Peer-assessment:* After five weeks, students will work in groups and develop an initial structure of their model. They will then exchange their work with other groups and provide feedback on the model proposed by their peers.

Summative assessment: The final mark will be determined by two components: 80% of the final exam and 20% of the group work. The exam questions are similar to the homework questions.

References

Al-Smadi, M, & Guetl, C (2008). *Past, Present and Future of e- Assessment-Towards a Flexible e-Assessment System*.

Alruwais, N, Wills, G, & Wald, M (2018). Advantages and Challenges of Using E-assessment. *International Journal of Information and Education Technology*, 8(1), 34-37.

Angus, S. D., & Watson, J. (2009). Does regular online testing enhance student learning in the numerical sciences? Robust evidence from a large data set. *British Journal of Educational Technology*, 40(2), 255–272.

Barnett, R. (2017). The ecological university: A feasible utopia. London: Routledge.

Baten, L. J. Osborne, Y. D'Silva, H. (2009). *WebCEF: On-line Collaboration and Oral assessment within the Common European Framework of Reference*. CerCleS (European Confederation of Language Centres in Higher Education), Nr 25.

Bearman, M., & Ajjawi, R. (2018). From "seeing through" to "seeing with": Assessment criteria and the myths of transparency. *Frontiers in Education*, 3(96). https://doi.org/10.3389/ feduc.2018.00096.

Benson, R., & Brack, C. (2010). Online learning and assessment in higher education: A planning guide. (First ed.) Woodhead Publishing Limited.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5-31.

Blair, K. L., & Monske, E. A. (2009). Developing digital literacies and professional identities: the benefits of ePortfolios in graduate education. *Journal of Literacy & Technology*, 10(1), 40–68.

Boudadi, N.A. & Gutiérrez-Colón, M. (2020). Effect of Gamification on students' motivation and learning achievement in Second Language Acquisition within higher education: a literature review 2011-2019, *The EUROCALL Review*, 28, 1.

Bogdanova, D. & Snoeck, M. (2018). Using MOOC Technology and Formative Assessment in a Conceptual Modelling Course: An Experience Report. In *ACM/IEEE 21st International Conference on Model Driven Engineering Languages and Systems (MODELS '18 Companion), October 14–19, 2018, Copenhagen, Denmark,* 7 pages. https://doi.org/10.1145/3270112.3270120.

Boud, D. & Molloy, E. (Eds) (2013). *Feedback in higher and professional education. Understanding it and doing it well*. Abingdon: Routledge.

Boyd, D. (2011) White flight in networked publics? How race and class shaped American teen engagement with MySpace and Facebook, in: L. Nakamura & P. Chow (Eds) *White race after the Internet* (pp. 203–222). Abingdon: Routledge.

Brown, J. L. M. (2012). Online learning: A comparison of web-based and land-based courses. *Quarterly Review of Distance Education, 13*(1), 39–42.

Bull, J. & McKenna, C. (2004). *Blueprint for computer-aided assessment*. Routlegde: London.

Cazan, AM, & Indreica, S (2014). Traditional assessment of learning versus online assessment.

Chung, G. K. W. K., Shel, T., & Kaiser, W. J. (2006). An exploratory study of a novel online formative assessment and instructional tool to promote students' circuit problem solving. *Journal of Technology, Learning, and Assessment*, 5(6), 1–27.

Crisp, V., & Ward, C. (2008). The development of a formative scenario-based computer assisted assessment tool in psychology for teachers: the PePCAA project. *Computers & Education*, 50(4), 1509–1526.

Correia, A. P., & Davis, N. E. (2008). The dynamics of two communities of practice: the program Team and the online course community. *Distance Education*, 29(3), 289–306.

Dawson, S. (2010). Seeing the learning community: An exploration of the development of a resource for monitoring online student networking. *British Journal of Educational Technology*, 41(5), 736–752.

De Alfaro, L. & Shavlovsky, M. (2013). *Crowd Grader: A tool for crowdsourcing the evaluation of homework assignments*, SIGCSE 2013. doi: 10.1145/2538862.2538900. University of California– Santa Cruz.

Deeley, S. (2019). Using technology to facilitate effective assessment for learning and feedback in higher education. *Assessment & Evaluation in Higher Education*, 43:3, 439-448, DOI: 10.1080/02602938.2017.1356906.

Doğan, N., Kıbrıslıoğlu Uysal, N., Kelecioğlu, H., & Hambleton, R. K. (2020). An overview of e-assessment. *Hacettepe University Journal of Education,* 35 (Special Issue), 1-5. DOI:10.16986/HUJE.2020063669

Driessen, E., Vleuten, C. V. D., Schuwirth, L., Tartwijk, J. V., & Vermunt, J. (2005). The use of qualitative research criteria for portfolio assessment as an alternative to reliability evaluation: a case study. *Medical Education*, 39, 214–220.

Dunne, E. & Owen, D. (2013). Introduction. In: Dunne E and Owen D (eds) *The Student Engagement Handbook: Practice in Higher Education* (pp. xv–xxv). Bingley: Emerald Group Publishing.

Duţă, N., & Martínez-Rivera, O. (2015). Between theory and practice: The importance of ICT in higher education as a tool for collaborative learning. *Procedia Social and Behavioral Sciences,*180, 1466–1473. https://doi.org/10.1016/j.sbspro.2015.02.294

Earl, L. M. (2013). *Assessment as learning: Using classroom assessment to maximize student learning*. Thousand Oaks, CA: Corwin Press.

Facer, K. (2012). Taking the 21st century seriously: young people, education and socio-technical futures. *Oxford Review of Education*, 38 (1), 97-113.

Ferrell, G. (2012) A view of the assessment and feedback landscape: Baseline analysis of policy and practice from the JISC Assessment & Feedback programme. A JISC report. http://www.jisc.ac.uk

Foley, B. & Goldstein, H. (2012). *Measuring success: League tables in the public sector*. London: British Academy.

Fornauf, B., Erickson, S. & Dangora, J. (2020). Toward an Inclusive Pedagogy through Universal Design for Learning in Higher Education: A Review of the Literature. *Journal of Postsecondary Education and Disability*, 33, 2, 183-199.

Garrison, D. R., & Akyol, Z. (2009). Role of instructional technology in the transformation of higher education*. Journal of Computing in Higher Education*, 21(1), 19–30.

Gee, J. P. & Shaffer, D. W. (2010). Looking where the light is bad: Video games and the future of assessment. *Edge: The Latest Information for the Education Practitioner*, 6(1), 3–19.

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & education*, *57*(4), 2333-2351.

Hargreaves, E. (2008). Assessment. In G. McCulloch, & D. Crook (Eds.) *The Routledge international encyclopaedia of education* (pp. 37–38). New York: Routledge.

Harlen, W. (2007). *Assessment of learning*. London: Sage.

Herrington, J., Reeves, T. C., & Oliver, R. (2006). Authentic tasks Online: a synergy among learner, task and technology. *Distance Education*, 27(2), 233–247.

Hickey, D. T., Ingram-Goble, A. A. & Jameson, E. M. (2009). Designing assessments and assessing designs in virtual educational environments. *Journal of Science Education and Technology*, 18(2), 187–208.

Isaias, P., Miranda, P., & Pifano, S. (2017). Framework for the analysis and comparison of e-assessment systems. In H. Partridge, K. Davis, & J. Thomas. (Eds.), Me, Us, IT! Proceedings ASCILITE2017: 34th International Conference on Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education, 276-283.

James, D. (2014). Investigating the curriculum through assessment practice in higher education: The value of a 'learning cultures' approach. *Higher Education*, 67(2), 155–169.

Jenkins, H., Clinton, K., Purushotma, R., Robison, A. J. & Weigel, M. (2006). *Confronting the challenges of participatory culture: Media education for the 21st century.* A MacArthur Foundation Report.

Jian-Hua, S., & Hong, L. (2012). Explore the effective Use of Multimedia technology in College Physics teaching. *Energy Procedia*, 17, 1897–1900.

Jordan, S (2013). E-assessment: Past, present and future. New Directions in the Teaching of Physical Sciences (9), 87-106.

Leitão, G., Colonna, J., Monteiro, E., Oliveira, E.H., & Barreto, R.D. (2020). New Metrics for Learning Evaluation in Digital Education Platforms. *ArXiv, abs/2006.14711*.

Lin, Q. (2008). Preservice teachers' learning experiences of constructing e-portfolios online. *Internet and Higher Education*, 11(3), 194–200.

Lopes, A.P. & Soares, F. (2022, 4th-6th July). Online Assessment Using Different Tools And Techniques In Higher Education (Conference Proceedings). EDULEARN22 Conference, Palma, Mallorca, Spain.

Mackey, J. (2009). Virtual learning and real communities: online professional development for teachers. In E. Stacey, & P. Gerbic (Eds.) *Effective blended learning practices: evidence-based perspectives in ICT-facilitated education* (pp. 163–181). Hershey: Information Science Reference.

Mackey, J., & Evans, T. (2011). Interconnecting networks of practice for professional learning. *The International Review of Research in Open and Distance Learning*, 12(3), 1–18.

Mansell, W. (2009). *Why hasn't e-assessment arrived more quickly?* The Guardian. https://www.theguardian.com/education/2009/jul/21/online-exams-schools

McCallum, S., & Milner, M. M. (2020). The effectiveness of formative assessment: Student views and staff reflections. *Assessment and Evaluation in Higher Education*, *0*(0), 1–16. https://doi.org/10.1080/02602938.2020.1754761.

Molina-Carmona, R., Pertegal-Felices, M. L., Jimeno-Morenilla, A., & Mora-Mora, H. (2018). Assessing the impact of virtual reality on engineering students' spatial ability. In Visvizi, A., Lytras, M.D. and Daniela, L. (Ed.)*The future of innovation and technology in education: policies and practices for teaching and learning excellence* (pp. 171-185). *Emerald Studies in Higher Education, Innovation and Technology,* Emerald Publishing Limited, Bingley.

Nganji, J.T. (2018). Towards learner-constructed e-learning environments for effective personal learning experiences. *Behav. Inf. Technol*. 37, 7, 647–657. DOI: https://doi. org/10.1080/0144929x.2018.1470673.

Oldfield, A., Broadfoot, P., Sutherland, R. & Timmis, S. (2012). *Assessment in a digital age: A Research Review*. Bristol: Graduate School of Education, University of Bristol.

Oosterhof, A., Conrad, R. M., & Ely, D. P. (2008). *Assessing learners online.* New Jersey: Pearson.

Osborne, J., Mateusen, L., Neuhoff, A., & Valentine, C. (2009). Practical guidelines on the use of the WebCEF online assessment environment. In H. Bijnens (Ed.),

WebCEF. Collaborative evaluation of oral language skills through the web. Heverlee, Belgium: AVNet, K.U.Leuven.

Pachler, N., Daly, C., Mor, Y., & Mellar, H. (2010). Formative e-assessment: Practitioner cases. *Computers & Education*, 54, 715–721.

Pellegrino, J. W. & Quellmalz, E. S. (2010). Perspectives on the integration of technology and assessment, *Journal of Research on Technology in Education*, 43(2), 119–134.

Perry, W. G. (1968). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart & Winston.

Rosenbusch, K. (2020). Technology Intervention: Rethinking the Role of Education and Faculty in the Transformative Digital Environment. Advances in Developing Human Resources, 22(1), 87–101. https://doi.org/10.1177/1523422319886297.

Rusman, E., Mart.nez-Mon.s, A., Boon J., Rodr.guez-Triana, M.J. & Villagr.-Sobrino, S. (2014). Gauging teachers' needs with regard to technology-enhanced formative assessment (TEFA) of 21st century skills in the classroom. In Kalz, M. & Ras, E. (Eds), *Computer Assisted Assessment. Research into E-Assessment*. CAA 2014. Communications in Computer and Information Science, 439. Springer, Cham. https://doi.org/10.1007/978-3-319-08657-6_1

Sarker, M. N. I., Wu, M., Cao, Q., Alam, G. M., & Li, D. (2019). Leveraging digital technology for better learning and education: A systematic literature review. *International Journal of Information and Education Technology*, *9*(7), 453-461.

Shaw, S., & Crisp, V. (2011). *Tracing the evolution of validity in educational measurement: Past issues and contemporary challenges. research matters*. A Cambridge Assessment Publication. https://www.cambridgeassessment.org.uk/Images/471470-tracing-the-evolution-of-validity-in-educational-measurement-past-issues-and-contemporary-challenges.pdf

Shute, V. J. & Kim, Y. J. (2013). Formative and stealth assessment. In: J. M. Spector, M. D. Merrill, J. Elen & M. J. Bishop (Eds) *Handbook of research on educational communications and technology* (pp. 311-323). New York, Lawrence Erlbaum Associates.

Simin, S, & Heidari, A (2013). Computer-based assessment: pros and cons. Elixir International Journal Vol, 55, 12732-12734.

Smith, G. (2007). How does student performance on formative assessments relate to learning assessed by exams? *Journal of College Science Teaching*, 36(7), 28–34.

Sorensen, E. K. (2005). Networked eLearning and collaborative knowledge building: design and facilitation. *Contemporary Issues in Technology and Teacher Education*, 4(4), 446–455.

Sorensen, E. K., & Takle, E. S. (2005). Investigating knowledge building dialogues in networked communities of practice. A collaborative learning endeavor across cultures. *Interactive Educational Multimedia*, 10, 50–60.

Sutherland, R. (2013). *Education and social justice in a digital age*. Bristol: Policy Press.

Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). Rethinking assessment in a digital age: Opportunities, challenges and risks. *British Educational Research Journal*, *42*(3), 454-476.

Tinoca, L., Pereira, A., & Oliveira, I. (2014). A conceptual framework for e-assessment in higher education: Authenticity, consistency, transparency, and practicability. In Handbook of Research on Transnational Higher Education Management (In Siran M, pp. 652–673). IGI Global. https://doi.org/10.4018/978-1-4666-4458-8.ch033

Van Aalst, J. & Chan, C. K. K. (2007). Student-directed assessment of knowledge building using electronic portfolios. *Journal of the Learning Sciences*, 16(2), 175–220.

Van Maele, Jan, Baten, Lut, Beaven, Ana, & Rajagopal, Kamakshi. (2013). E-Assessment for Learning: Gaining Insight in Language Learning with Online Assessment Environments. In *Computer-Assisted Foreign Language Teaching And Learning: Technological Advances* (pp. 245-261). IGI GLOBAL.

Vonderwell, S., Liang, X., & Alderman, K. (2007). Asynchronous discussions and assessment in online learning. *Journal of Research on Technology in Education*, 39(3), 309–328.

Wang, T.-H., Wang, K.-H., & Huang, S.C. (2008). Designing a web-based assessment environment for improving pre-service teacher assessment literacy. *Computers & Education*, 51(1), 448–462.

Whitelock, D. M., & Brasher, A. (2006). Developing a roadmap for e-assessment: Which way now? In: Danson, Myles ed. Proceedings of the 10th CAA International Computer Assisted Assessment Conference. Loughborough, UK: Professional Development, Loughborough University, pp. 487–501.

Whitelock, D. & Watt, S. (2008) Reframing e-assessment: Adopting new media and adapting old frameworks, Learning. *Media and Technology*, 33(3), 151–154.

Whitelock, D., Reudel, C., & Mackenzie, D. (2006). E-assessment: Case studies of effective and innovative practice a JISC. *Jt. Inf. Syst. Comm*, 184.

Winkley, J. (2010). *E-assessment and innovation.* A Becta report, Coventry, UK.

Wolsey, T. (2008). Efficacy of instructor feedback on written work in an online program. *References.*

Yan, Z., & Boud, D. (2021). Conceptualising assessment-as-learning. In Z. Yan, & L. Yang (Eds.), *Assessment as learning: Maximising opportunities for student learning and achievement* (pp. 11-24). New York: Routledge.

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