CURRENT STUDIES IN EDUCATIONAL DISCIPLINES 2022

EDITORS

Dr. Mustafa Tevfik Hebebci

Oğuz Yılmaz

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About Book

Current Studies in Educational Disciplines 2022 is published annually from the selected papers invited by the editors.

This edition includes 7 papers from the field of educational technologies.

All submissions are reviewed by at least two international reviewers.

The purpose of the book is to provide the readers with the opportunity of a scholarly refereed publication in the field of educational technologies.

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Foreword

The proposed book with title Current Studies in Educational Disciplines 2022 is primarily intended to serve as a scientific reading that deals with multidisciplinary and currently determined topics in the field of educational technologies.The book is published continuously, is published every year and aims to cover topics with a broader educational setting.

The texts in the attached papers appear at the right time, should be harmonized in the modern educational technologies tendencies of several scientific disciplines that all have "one common denominator", which is to improve the quality of education. There are 7 thematic chapters, seemingly diverse, each paper is an authentic, research paper of theoretical-empirical character that deals with very interesting, current and insufficiently studied issues.

The content of the book is based on clearly identifying the current challenges in the educational technologies sector, which ensures its relevance by carefully defining the priority areas that need to be addressed in the coming period.

December, 2022

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Chapter 1

New Technologies and E-Assessment

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Introduction

Technology is developing day by day and it is integrated into many production lines. So much so that we are now in a period where human-robot integrated production is becoming widespread. In 2016, the concepts of Society 5.0 and Industry 5.0 were put forward in Japan and it became clear that this era is now the era of Industry 5.0. In addition, it has been officially stated by the European Commission that Industry 5.0 has started as of January 4, 2021. There are studies such as supply chain in the field of specialized logistics, the use of artificial intelligence in many areas, integrating virtual world studies into the real world, all online shopping and crypto money studies, internet of things, virtual reality and digital mapping. These studies are the new technologies. With Industry 5.0, (a) human-machine integration and technologies in this field, (b) renewable smart sensors that can be embedded in materials with biological technologies, (c) twin identity for modeling technological systems, simulations, (d) enabling advanced systems to work with data technologies that transmit, store and analyze, (e) artificial intelligence that can take action by solving the working principles in complex systems, (f) technologies for efficient energy resources and renewable-storable resources. The most interesting and assertive concept in this period is the concept of metaverse (Tekin et al., 2022). The concept of metaverse, which was used in 1992 by author Neal Stephenson in his book Snow Crash, is used to mean "beyond the universe". Although this concept has a fictional meaning, it is considered as a dimension such as "the future of the internet" or time. Metaverse is the precious version of real world life in the virtual environment in theory. It is estimated that the concept of metaverse will exist with its technological infrastructure and the universe it has created. The concepts of software, artificial intelligence, virtual reality, cloud, network, augmented reality and blockchain are related to the metaverse.

Education-based activations in the virtual world (vitamins, morpakampüs), cryptocurrencies and shopping with them, internet-integrated games and virtual concerts or meetings in this game, digital-based interactions such as building a virtual city or buying land, online shopping sites. It can be thought that a totality can be perceived as a metaverse. In other words, it is called the new concept formed as a result of the digital integration of these platforms in the virtual world. It is said that you can participate in the metaverse individually and live in this world by making your own digital face, that is, your avatar. To give a few examples; For those who want to do sports at home, having avatars of the same or different sports coaches at the same time, increasing the number of referees in football matches with avatars, relieving the pain of virtual reality during childbirth, being exposed to global warming in the digital environment and being sensitive to the environment and atmosphere in the real environment are some examples (Gülen et al., 2022). Apart from these examples, the use of technologies in the field of education and technology integration in education takes a new form. This form can be called metaeducation, like the metaverse.

There are many technologies that can be used in the field of education, and with the appropriate integration of these technologies, metaeducation can also be established in the field of education. There are also quite ambitious theories on this subject (Tekin et al., 2022). It is known that technology can be used widely, especially in the dimension of student evaluations of education. Evaluations of students can be made with the help of technology. For this, teachers need to train themselves first. In this article, teachers' ability to make e-assessment with new technologies and examples of technologies used in this field are given.

E-Assessment in the Process of Distance Education

Today's teacher candidates enter higher education with the hope of getting an education according to the necessity of being a teacher in accordance with the requirements of the age. From the first day, these pre-service teachers should have experiences that activate and support students in the process, use technology effectively in their classrooms and integrate technology into the teaching process (Edwards, 2021). Academicians should provide pre-service teachers with experiences of technology integration in the classroom, so that pre-service teachers should increase their technological competence and help them to repeat these skills in their future classes (Slykhuis et al., 2020). In addition, for the purpose of 21st century education, the focus of teacher preparation programs should shift from a teacher-centered teaching to a cooperative learning-centered situation rather than competition among teacher candidates who integrate technology into the teaching process and use technology effectively (Edwards, 2021).

Teacher preparation programs should ensure technology integration throughout the breadth and depth of the program (Stokes-Beverley & Simoy, 2016). In recent years, technology has become a key component in the learning process (Rich et al., 2018). Teachers are now aware that technology is an important part of students' daily lives. For this reason, many researchers have recently explored how technology integration is experienced by teachers (Browne, 2019; Buenger, 2019). Batane and Ngwako (2017) stated that the 21st century teaching process requires teachers who have the skills to use technology. In addition, technology integration affects information, communication and cooperation variables in the classroom (Alenezi, 2017).

Information and communication technology (ICT) is technology, usually a computer system, used to store, retrieve, transmit and display data and information electronically. ICT can be a management system operated by a certain number of users that enables individuals and organizations to connect (Buabeng-Andoh, 2012). Examples of ICT include computers, technological devices, mobile devices, wireless networks, computer games, robotic devices, e-reading and smartphones. Increases in the use of ICT require computer-based literacy competencies for the workforce in the 21st century to acquire, process, evaluate, create and communicate information (Alenezi, 2017). Using technology for learning can help teachers in their formal evaluation and decision-making processes when creating instructions (Herzberg et al., 2017). ICT can be effective in five main areas for teachers: Analyzing student thoughts, understanding best practices for creating classroom models, planning instruction, analyzing instructional practices. Ellaway and Masters (2008) state that student success is greatly affected by technology, as it is related to understanding instructions (Brownell et al., 2017).

Learning using technological tools allows teachers to make the material they teach more visible, which helps them remember information and provide effective feedback to their students (Khatatneh & Teh, 2018). This is crucial to learning because the way students learn has changed drastically over the past century. In this century, teaching should benefit from technology integration that helps students acquire new knowledge and achieve better learning outcomes (Alenezi, 2017). Technologically Integrated learning systems allow students and teachers to participate in new learning experiences while continuing to meet the same level of quality in education (Johnson, 2022). Researchers have determined that computer learning also helps students develop their creative skills, participate in teamwork, and draw conclusions on their own (Khatatneh & Teh, 2018). Students who use technology in the classroom have the potential to gain a deeper understanding of the content they encounter.

Rich et al. (2018), 21st century learning has required technology and computer learning to be a part of the educational process. Technology has been used to assist users in improving their ability to identify, absorb, and respond to important information in a variety of ways (Jension & Hebert, 2017). Increasingly, technology is now being applied to help develop learning standards that meet the needs of 21st century students. Batane and Ngwako (2017) argued that 21st century learning requires teachers to access technological resources that can be easily applied to their lessons. Technological developments and their simultaneous penetration into the educational process in the 21st century have made it a new way of assessing and providing feedback on student learning (Kundu et al., 2020).

Assessment is a fundamental activity at all levels of the teaching process. Identifying students' skills, knowledge, understanding and abilities is used to promote learning as well as to compare students' intended learning outcomes. Assessment strongly influences students' perceptions of the learning environment as well as their approach to learning and study (Thomson & Falchikov, 1998). Assessment is seen as a very important part of curricula aiming to both increase the quality of teaching and facilitate interaction among students (Stödberg, 2012). Assessment is at the heart of the learning experience: how students are assessed determines their progress and achievement of curricular goals. Recent developments in higher education, ICT has become even more important lately.

Technology can play an important role in this process because, if used appropriately, it can add value to any of the assessment-related activities. E-assessment is a natural partner of e-learning (Mackenzie, 2003), offering the harmonization of teaching and assessment methods (Ashton & Thomas 2006; Gipps 2005). In this way, it offers the opportunity to do a different variety and more authentic homework and provides assessment of skills that cannot be easily evaluated in other ways, through eportfolios, simulations and interactive games. The advancement of technology and e-learning systems has put e-assessment in high demand (Brink & Lautenbach, 2011). Crisp (2011) used the term e-assessment to refer to all assessment tasks conducted via a computer, a digital tool and/or the web.

Educational activities such as e-learning and technology assisted learning have become important elements providing new opportunities and approaches to teaching, learning and assessment in higher education. Evaluation using ICT is known as e-assessment, which includes the entire evaluation process from designing assignments to storing results with the help of ICT. E-assessment, alternatively known as electronic assessment, computer-based assessment, digital assessment or online assessment, is the use of ICT in assessment. E-Assessment is the process of generating feedback and evaluation for formative, summative, diagnostic or self-assessment using digital technologies (Koçdar et al. (2018). Sitthisak et al. (2008) stated that e-assessment includes supporting it using a computer, for example with web-based assessment tools. they have stated. In other words, e-assessment involves the use of any web-based method that allows systematic inferences and judgments to be made about a student's skills, knowledge, and abilities. This can offer a wide range of assessments that address a wider range of skills and qualifications that are not directly assessed through traditional methods (De Villiers et al., 2016). E-assessment has improved the measurement of student outcomes and made it possible for them to receive immediate and direct feedback (Gilbert et al., 2011).

E-assessment can take different forms, such as automated administrative procedures, digitization of paper-based systems, and multiple-choice tests and online tests that include assessment of problem-solving skills (Ridgway et al., 2004). Osuji (2012) said that e-assessment can be assumed as the use of ICT to facilitate the entire assessment process, from designing and submitting assignments to their assessment. According to Love and Cooper (2004), evaluation systems should consider interface, accessibility, security, usability, information to be collected, hardware and software technology, and information storage and processing.

Most studies agree that E-assessment is an electronic assessment, where all assessment procedures from the beginning to the end of the assessment should be carried out electronically. This means that the design, testing, recording the response, and providing feedback are all completed using ICT (Alruwais et al., 2018). Whitelock (2009) said that e-assessment is a new assessment paradigm and methodology playing an increasingly important role in the transformation of higher education. E-assessment has attracted increasing attention in the research community as a result of both the changing nature of higher education and the expectations for e-assessment practice

(Nicol, 2007). Whitelock (2009) points to other important factors in the interest in e-assessment research in relation to its potential and the challenges facing higher education today. Tools and techniques for e-assessment can be used in a variety of ways. They can be used with a stand-alone computer in classrooms or over a complex network that includes various software and hardware solutions in distance education (Stödberg, 2012).

Online Measurement and Assessment Tools

Wordwall

It is an application that provides students with fun and course content in different game formats. Wordwall is a gamification-based online assessment tool for creating different types of interactive tests such as Matching, Wheel of Fortune, Open the Box, True False, Grouping, Anagram, Word Completion, Maze Game, Word Search, Random Cards, multiple choice and drag and drop. Wordwall is a Web 2.0 tool that is both easy to use and useful for creating your own teaching resources. With Wordwall, activities specific to your class and interactive processes that students will enjoy can be done. Wordwall events can be created both printable and interactive. There are 21 printable materials and 33 interactive course materials in the Wordwall application. However, some of them are paid and some are free (Url 1).

Google Form

It is a tool where you can prepare online forms such as surveys, exams and evaluations offered to users who are members of Gmail, free of charge. Google forms tool helps you easily evaluate surveys, quizzes and other forms results. It is one of the most preferred evaluation tools because it has both a useful and easy interface. Let's write down what the types of questions the Forms application offers us, Short answer answer, Paragraph type answer, Multiple choice questions, Checkboxes, Dropdown options, File sending feature, Linear scale, Multiple choice table and Table shaped checkboxes. It also provides services in all languages. But it does not allow to create very complex forms (Url 2).

Quizizz

It is a web 2 tool where teachers can create course content and quizzes. In this tool, students are given points for both correct answers and quick answers. The application can be easily installed on computers, tablets and phones. It is also compatible with Google Classroom. This application can be used to provide motivation before the lesson and to make a fun introduction, and to follow the evaluation and deficiencies at the end of the lesson.

Socrative

It is a web 2 tool that offers test preparation, the opportunity to use the test both online and by printing. In general, it can be preferred at the end of the lesson with its fun and fast use. Students can participate in the test prepared by their teachers through the program, using their own names, a pseudonym, and an icon. Compatible with phone, tablet and computer.

Nearpod

It is a web 2 tool that offers the opportunity to present online and test students themselves. The teacher uploads the presentation about the lesson to the program (you can add multiple choice, fill-in-the-blank, or true-false questions to the intermediate parts of the presentation), students enter the system using the codes given to them, watch the presentation and give feedback.

Kahoot

It is a game-based learning platform used as educational technology in schools and other educational institutions. Learning games "kahoots" are user-created multiple choice quizzes that can be accessed via a web browser or the Kahoot app.

Classmarker

It is a preferred tool for preparing exams or tests in any language for multiple users. Many world-famous companies or educational institutions can use this program for satisfaction or training activities. This program can be installed on technological devices and is easy to use and functional. Short or long structured questions can be created, most importantly, a question bank can be created and it can select random questions from this bank, prepare a test, and offer analysis.

EclipseCrossword

Crossword puzzles can be easily prepared with the Eclipse Crossword program, which has a free and easy interface. It is a kind of hook puzzle that science teachers can use in lessons and quickly prepare for science subjects or concepts in virtual or non-virtual ways. With this puzzle, science lessons can be evaluated.

Gloster

It is a cloud-based developed platform. On this platform, concept cartoons and digital posters can be prepared by using multimedia elements such as text, graphics, sound and video together. In addition, Glogs developed and shared by different users can be accessed and ideas can be obtained to create original works.

Advantages of E-Assessment

With the development of technology, evaluation has become both easier and faster (Kundu, 2020). E-assessment has made assessment improved, accurate and faster than traditional paper-based measures (De Villiers et al., 2016). Students prefer E-assessment as they have more control, user-friendly interfaces and tests as games and simulations similar to learning environment and entertainment activities (Ridgway et al., 2004). It is also fast and easy to use (Eljinini & Alsamarai, 2012). E-assessment provides immediate feedback compared to paper testing, which helps to improve learning level (Gilbert et al., 2011). According to Bennett (2002), technology is at the center of learning and will continue to exist at this center. He also stated that the technology would not only facilitate testing but would also support real assessment. According to Hamilton and Shoen (2005), web-based tests have significant advantages in cost reduction, ease of use, reliability, reproducibility, scoring, consolidation of results and data management.

In many studies, it has been seen that e-assessment increases student performance (Gilbert et al., 2011). Students' performance also increases their learning motivation (Marriott, 2009). It also helps students in remote areas to learn and evaluate, and provides students with the flexibility to take the exam (Way, 2012). The traditional paper test takes time for the teacher, but the e-assessment offers the teacher the opportunity to make the assessment more accurately and faster (Gilbert et al., 2011; Crews and Curtis, 2010). In addition, e-assessment provides the teacher with faster feedback to students (Ridgway et al., 2004; Way, 2012). E-assessment enables the teacher to monitor students' performance and to analyze many assessments (Ellaway & Masters, 2008). Using e-assessment can reduce the burden of teachers to evaluate large numbers of students (Nicol, 2007).

E-assessment supports higher-order thinking skills such as critical thinking, reflective thinking on cognitive processes, and supports educational goals by facilitating group work projects. E-assessment has the ability to rank questions that cannot be generated using paper testing, for example software simulation, helps to represent knowledge simply and quickly (Ridgway et al., 2004)

The use of e-assessment reduces the cost of evaluating the student because it saves time (Gilbert et al., 2011). In addition, E-Assessment has its own security set that provides the questions and the student cannot copy the questions, it also includes authentication and password verification to verify the student's identity (Crews & Curtis, 2010). It helps to reduce cheating by presenting the questions in different order.

Disadvantages of E-Assessment

Although e-evaluation has many advantages, e-assessment is not completely free of disadvantages that prevent its widespread implementation and acceptance (Bacigalupo et al., 2010). Many studies have pointed out the disadvantages of e-assessment. Isaias and Issa (2013) state that most institutions lack technological infrastructure. Whitelock and Brasher (2006) drew attention to the lack of trust between students and teachers, mainly to technological inadequacies. According to Bacigalupo et al. (2010) stated that it affects students' motivation negatively. Redecker et al. (2012) stated that he had doubts about the effectiveness and impartiality of teachers. While saying that computer distraction is a disadvantage for e-assessment, Mason (2014) mentioned a very important point that affects the success of students as a whole. Whitelock (2009) states that e-evaluation gives incomplete feedback. Kocdar et al. (2018) emphasized that students participating in e-assessment had certain difficulties with authentication, and Xu and Mahenthiran (2016) emphasized that there is a possibility of cheating as a serious concern associated with e-assessment compared to traditional paper-based assessment. Some studies have also argued that cheating and plagiarism are easier and more common in e-evaluation (Koçdar et al., 2018). Apampa et al. (2011) and Mellar et al. (2018) categorizes cheating and plagiarism in easy assessments such as imitation, taking materials for exams, looking at the answers of others. Kocdar et al. (2018) and Dermo (2009) clearly stated that such forms of malpractice undoubtedly affect the validity and reliability of e-assessments.

There are some difficulties in applying e-assessment in higher education. Different studies have been explored about these challenges and suggested solutions:

1. The student's technological inadequacy and inexperience negatively affect the evaluation process (Donovan et al., 2007). In order to eliminate this, students can be given an initial training so that they can experience e-assessment (Way, 2012).
2. Lack of computer and internet access (Crews and Curtis, 2010). To solve this problem, it should provide students with a fully equipped laboratory with internet access.
3. Lack or weak technological infrastructure (Way,2012). For this, the technological infrastructure must be fully provided to establish and operate the e-assessment system.
4. Because teachers have technological inadequacies, they need a training to make them feel confident in using the E-assessment system (Ridgway et al., 2004).

Conclusion

It is obvious that technology is spreading rapidly around the world. It is seen that these technologies have an effect on all of the future plans of people from their use in their daily lives. The concept of metaverse, which has been put forward with the integration of these technologies recently and which is a technological life style, is a proof of this. Like the concept of metaverse, the concept of metaeducation has of course taken on a usable structure.

Technologies used in the field of education are likely to provide a more successful and less costly education. When all technologies related to education are considered (such as student and teacher avatars, online education, interactive teaching programs, communication technologies, internet, etc.), metaeducation can be established. Considering the teacher and evaluation dimension of this education, it is understood that this is not impossible. With this, it will be possible for teachers to be able to evaluate students and do them in meta-education. As a matter of fact, it is in a position where e-assessment can be made.

E-Assessment is one of the online evaluation forms of students. There are many computer programs available for this. Considering the advantages and disadvantages of these evaluations, it can be said that they become usable for students and the future of education. Although it is said that during the e-assessment process, problems of trust between the teacher and the student may occur or that socialization will decrease with these evaluations, it should not be forgotten that there are technologies that can be overcome. As a result, it is known and used that online chat, video calls and instant and effective communication can be made.

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Developing Digital Literacy Skills in Our Digital World

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Introduction

With the latest technological developments, the digital world concept has emerged. Digitalization is inevitable in a world where we are intertwined with technology; we feel and use technology every day. It is one of today's needs. Thanks to digitalization, we meet our needs in many domains, including the public, health, education, and shopping. The concept of digital literacy has emerged in the digitalizing world, adding new literacy to the existing ones. Digital literacy is a dynamic process that changes depending on the situation's needs (Martin, 2006). "Digital literacy" became critical for active participation in training-education, work, and other parts of social life.

The ability to use the internet and ICT (Information and Communication Technologies) transformed into digital literacy, a new form of literacy. Digital literacy becomes a prerequisite for innovation, entrepreneurship, and creativity. Without digital literacy, citizens will fail to fully participate in society and acquire the necessary knowledge and skills to live in the 21st century (European Commission, 2003). Every country is trying to raise awareness of the importance of digitally empowering their youth.

Literacy

Digital literacy is an essential skill student should have today, such as reading and writing. The main difference between literacy and reading-writing is that "reading-writing is based on decoding in the alphabet system, while the concept of literacy involves meaning" (Kurudayıoglu & Tuzel, 2010). Literacy teaches the individual the methods of acquiring and using information. In this direction, it plays a mediating role in transferring knowledge between generations (Goody, 1987).

The concept of literacy has been enriched by being used in different fields over time. Therefore, we are faced with many literacy types. Digital literacy is extensively mentioned in the literature as well. As an alternative to traditional literacy, digital literacy is essential to work and learn in the contemporary world (Churchill et al., 2008). This technology allows individuals to access, produce and share accurate and necessary information.

With the rapid development of recent e-government applications, digital literacy has gained a different dimension and created digital citizenship (Ribble, 2011). Digital citizenship is defined as individuals taking responsibility for using updated technologies (Mossberger et al., 2007). Ribble and Bailey (2007) examined digital citizenship under nine headings: Digital communication, digital safety, digital access, digital health & wellness, digital law, digital rights & responsibilities, digital commerce, digital etiquette, and digital literacy. Digital citizenship has eliminated country borders in communication and information acquisition; it has also contributed to the development of digital literacy.

What is Digital Literacy?

Digital literacy was developed with the emergence of computer use in the public sphere in the early 1980s; it was introduced into our daily lives in the 1990s and showed a significant increase after the online networked information exchange in the 2000s (Dobson & Willinsky, 2009).

The term "digital literacy" appeared in the mid-1990s to describe the changing nature of literacy via the Internet (Bawden, 2001). Lanham (1995) describes literacy in the "digital age" as "the ability to understand information no matter how it is presented." More simply, Gilster (1997), who popularized digital literacy in his book published in 1997 with the same title, describes digital literacy as "the ability to access and use networked computer resources." Here, Gilster underlined digital literacy's components of accessing tools and digital skills (Feerrar, 2019). The American Library Association (ALA, 2022) defines digital literacy as "the ability to use ICT requiring cognitive and technical skills, to find, evaluate, create and communicate information."

Digital literacy is the whole of the skills that those who use the digital environment should have (Burnett & McKinley, 1998). Digital literacy is using IT to access information, share and evaluate data from different backgrounds, and create new knowledge (Tornero, 2004). Digital literacy is the ability to be successful in encounters with the electronic infrastructures and tools that make the world of the 21st century possible (Martin, 2006). Digital literacy emerges as a concept related to 21st-century skills such as information, media, and technology skills (information literacy, ICT literacy, and media literacy). Digital literacy is the skills, attitudes, and values individuals should possess to use digital tools in the 21st century.

The digital literacy acquisition process is discussed in three stages: acquisition of digital competencies, use of the competencies, and innovative digital transformation (Martin & Grudziecki, 2006). The stage of acquiring digital competencies covers the field's skills, concepts, approaches, and attitudes. The digital use phase includes using and applying digital competence in a specific area. The innovative digital transformation stage involves possessing digital competencies and practices that allow for changes; creating a new product is related to this stage.

Despite different definitions, digital literacy, in the most general sense, is the whole of the skills that the users of the digital environment should possess (Burnett & McKinley, 1998). Like other fashionable terms, "digital literacy" has different descriptions. However, the ambiguous use of this concept will lead to misconceptions and a weakening of communication (Norton & Wiburg, 1998). According to Bawden (2008), digital literacy is a subject with confusing terminology.

Types of Digital Literacy

Educators, students, and citizens face multiple literacies in the digital age. Digital literacy is a broad concept encompassing many digital-related activity types (Martin, 2006). Moreover, digital literacy is apparently a multidisciplinary concept. Digital literacy emerges as a concept related to information technology (IT), information, technological, media, and visual literacy. Regarding content, digital literacy is broader than ICT literacy. It includes additional elements, such as media, information, and visual literacy (Martin, 2006). ICT, visual, information, and media literacy must all be balanced to create an entirely digitally literate individual (Martin, 2006). Information Literacy, Computer Literacy, Media Literacy, Communication Literacy, Visual Literacy, and Technology Literacy are the sub-disciplines of Digital Literacy (Covello, 2010, p. 4).

Components of Digital Literacy

Digital literacy components appear in the literature under concept names such as dimension, factor, component, and area. In the literature, researchers examine digital literacy by dividing it into different dimensions. According to Ng (2012), digital literacy has attitudinal, technical, cognitive, and social dimensions. According to Pérez-Escoda et al. (2019), digital literacy consists of four dimensions: learning, being able, making/creating, and being/practicing. Pala and Basibuyuk (2020) examined digital literacy in four dimensions: information technologies, communication, safety (reliability), and problem-solving. Digital literacy is defined by ALA (2013) as using ICT to find, understand, evaluate, create and communicate digital information and emphasizes multiple components. On the other hand, Hague and Payton (2010) examined digital literacy in eight dimensions: creativity, critical thinking & evaluation, cultural & social understanding, collaboration, finding & selecting information, effective communication, e-safety, and functional skills (Figure 1).

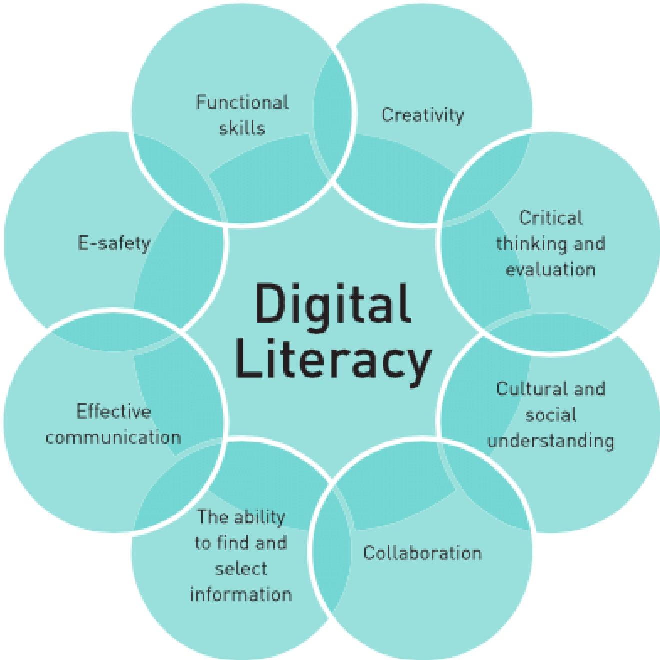

Figure 1. The components of digital literacy (Hague & Payton, 2010)

Digital Literacy Skills

Digital literacy should refer to an individual's awareness, attitude, and ability to use digital tools for communication, expression, and social action in certain life events (Goodfellow, 2011). Being digitally literate is a fundamental skill required to work and participate effectively in today's digital society. Digital literacy is the ability to navigate inside our digital world using reading, writing, technical skills, and critical thinking. It uses technological tools such as smartphones, computers, e-readers, and more to find, evaluate and transfer information (Microsoft, 2022).

Digital technology's rapid and continuous development forces individuals to use various skills (technical, cognitive, and sociological) for the performance of tasks and problem-solving in digital environments (Eshet, 2004). According to ALA, a digitally literate individual has the following skills and uses them to establish active participation in civil society and contribute to a vibrant, informed, and engaged community (ALA, 2013).

- possesses a variety of cognitive and technical skills needed to find, understand, evaluate, create and communicate digital information in a wide variety of formats,
- uses various technologies appropriately and effectively to search and retrieve information, interpret search results, and evaluate the quality of the information obtained,
- understands the relationships between technology, lifelong learning, personal privacy, and appropriate knowledge management,
- uses these skills and appropriate technologies to communicate and collaborate with peers, colleagues, family, and sometimes the general public.

Like information literacy, digital literacy requires critical thinking and finding & using information. Moreover, it involves familiarity with digital tools and using them in collaborative, communicative ways through social engagement.

Digital literacy, which consists of many dimensions and sub-literacies, requires acquiring particular digital skills and being digitally competent. Individuals who significantly developed their digital literacy skills comprehend internet security fundamentals, such as creating strong passwords and understanding and enforcing privacy settings. Surfing through a browser, using PowerPoint, making videos, designing slides, blogging, and familiarity with applications such as Photoshop are among the digital literacy indicators (EnglishBix, 2022).

Digital Competence

The literature shows that digital literacy and digital competence concepts are used interchangeably. However, there are differences between these two concepts. A wide range of competencies is needed to face today's complex challenges. Digital skills, sometimes called digital competencies, include the knowledge and skills to use ICT that an individual needs to achieve goals in their personal and professional life (Commission on Science and Technology for Development, 2018).

According to the OECD report (2005), competency is more than just knowledge and skills. It includes the ability to meet complex demands by leveraging and mobilizing psychosocial resources (including skills and attitudes) in a given context. Calvani et al. (2008) discussed digital competencies under three headings: technological, cognitive, and ethical. The technological dimension emphasizes the ability to solve technology-related problems; the cognitive dimension emphasizes discovering the correct and reliable sources, reading and evaluating the information, and the ethical dimension underlines having a grasp of ICT.

Digital literacy is defined as "the ability to survive in the digital age" by Eshet-Alkalai (2004). It is described by Martin and Grudziecki (2006) as individuals' "awareness, attitude and ability" to use digital tools for communication, expression, and social action in certain life situations.

These definitions show that digital literacy and digital competence have a dynamic and multidimensional structure. In addition, digital literacy has a broader meaning than digital competence. It is widely used in international academic fields (Bayrakcı, 2020).

What does today's society demands of its citizens? This demand-driven approach questions individuals' needs to function well in society in their position, the competencies needed to find and retain a job, and the adaptive qualities required to cope with changing technology. Competencies are essential in how individuals manage the world and help them shape it. Therefore, they are related to modern life's essential features and demands; our goals’ nature, as individuals and as societies, also determines them.

Competence is essential in how individuals cope with the world and helps them shape it. Therefore, the nature of our goals, both as individuals and as societies, determine competencies, as they are related to the essential features and demands of modern life (OECD, 2005).

Digital Literacy Frameworks

The dynamic and multidimensional nature of digital literacy has made it difficult to define the concept. For this reason, researchers have developed new definitions, models, and frameworks to explain digital literacy. There are two conceptual frameworks (TPACK and SAMR) in the literature for designing digital competence programs for teacher education; they are frequently used and well supported by empirical research (Falloon, 2020).

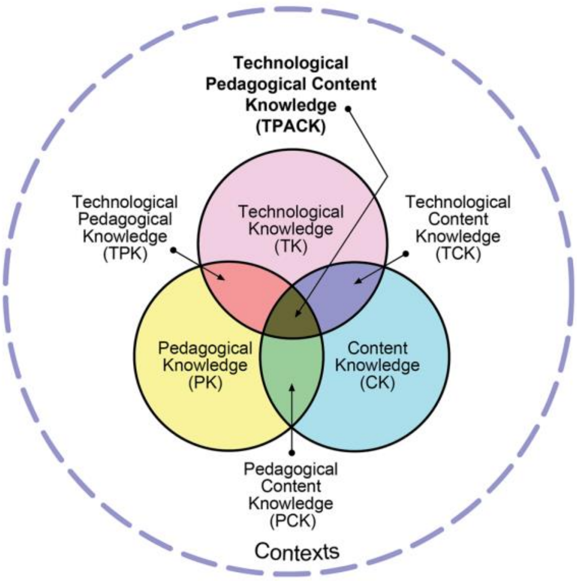

Figure 2. The TPACK framework (from Mishra and Koehler 2006) (Falloon, 2020)

The TPACK framework, developed by Mishra and Köhler (2006), is the integration and intersection of technical "know-how" (technological knowledge-TK), teaching abilities, strategies, and methods (pedagogical knowledge-PK), and "what to know" (content knowledge-CK). It is essential to create effective use of digital technology in education. The TPACK framework suggests that in developing good content, all these critical sources of knowledge (technology, pedagogy, and content) should be carefully interweaved (Figure 2).

The SAMR model includes a four-level approach for selecting, using, and evaluating technology in K-12 education (Figure 3). According to Puentedura (2006), the SAMR model is intended to be a tool through which K-12 teachers can identify and categorize their classroom technology use (Hamilton et al., 2016).

SAMR is a four-stage model representing a "spectrum" of digital technology use, ranging from substitution (old to new) to redefining learning (transformation). SAMR levels are displayed hierarchically and best interpreted as "descriptors" of the best technology used for the purpose (Puentedura, 2006).

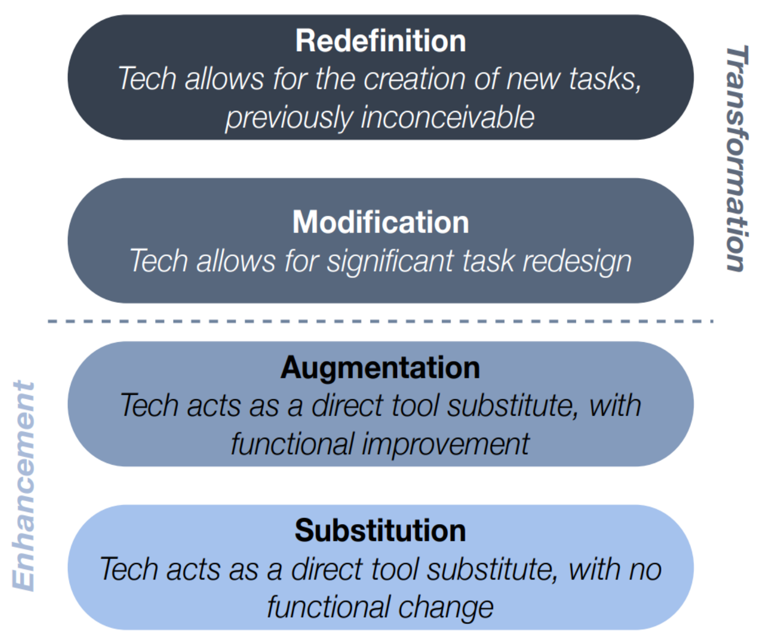

Figure 3. The SAMR model (from Puentedura 2006)

Digital Literacy Models

Various digital literacy models have been suggested to explain digital literacy. According to Pérez-Escoda et al. (2019), the proper understanding of digital literacy requires a chronologic examination of the most important models of the 21st century developing and conceptualizing this literacy. Therefore, this section will discuss five models deemed significant by Pérez-Escoda et al. (2019).

P21Model, Partnership on 21st-Century Skills (2002)

In the P21 Model (Figure 3), there are different areas such as basic subjects, learning and innovation skills, information, media and technology skills, life and career skills (Partnership for 21st-Century Skills, 2009). Digital literacy, on the other hand, emerges as a concept related to 21st century skills such as information, media and technology skills (information literacy, information and communication technologies literacy and media literacy).

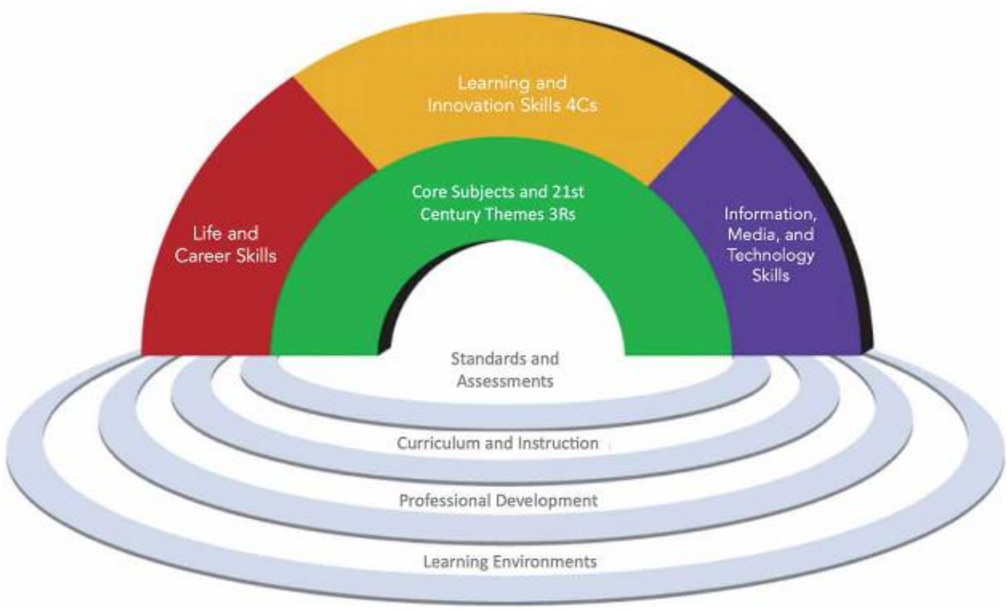

Figure 3. P21 model of digital literacy (Partnership for 21st Century Skills, 2009)

Krumsvik's Model (2008)

The researcher Krumsvik (2008) developed this digital literacy model in the context of Norwegian education policy. Digital literacy has been introduced at all educational levels and subjects of compulsory education to promote the development of this literacy in Norway. The model highlights four essential skills in achieving digital literacy: basic digital skills, didactic-ICT competence, learning strategies, and digital literacy (Krumsvik, 2011). (Figure 4).

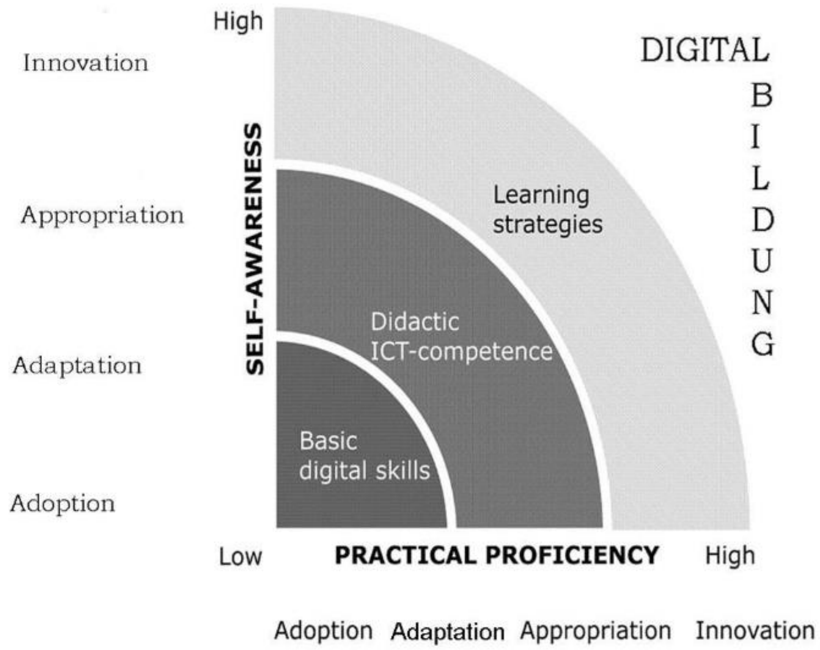

Figure 4. Krumsvik’s (2008) digital literacy model

DIGCOMP Model (2011) and Digcompedu Model (2017)

DIGCOMP project had a single purpose, creating a European frame of reference for understanding and developing digital competence. It included three goals for this purpose. These are identifying digital competence (knowledge, skills, and attitudes) required to be digitally competents, identifying digital competency areas and other existing frameworks, suggesting a strategy for using and developing digital competence at different levels.The model called DigCompEdu consists of Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (Figure 5).

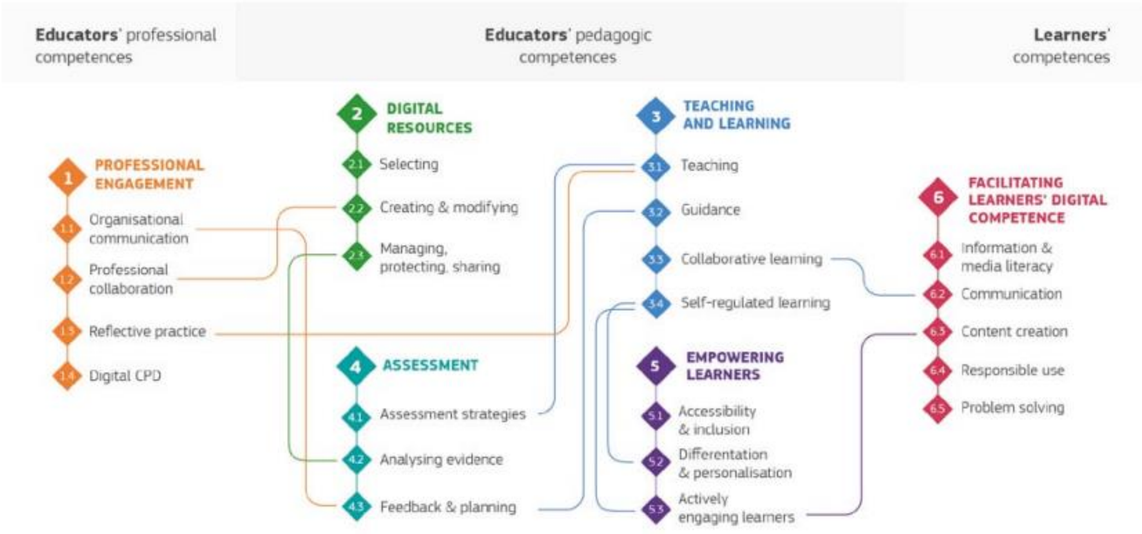

Figure 5. The DigCompEdu Framework (Redecker, 2017)

ISTE Standards (2009)

ISTE (International Society for Technology in Education) is the largest public, non-profit organization whose mission is to educate teachers and students worldwide in learning and education standards appropriate for the digital age. These standards (Figure 6) have five competence areas (International Society for Technology in Education (NETS-A, 2009).

- Facilitating and encouraging creativity and learning in students
- Designing & developing assessments and learning experiences suitable for the digital age
- Adapting the characteristic work and education of the digital age
- Promoting and exemplifying responsibility and digital citizenship
- Being committed to professional growth and leadership

Figure 6. ISTE standards (International Society for Technology in Education (NETS-A), 2009).

ISTE standards for educators includes a framework that determines teacher skills, abilities, and behaviors in seven areas (continuous personal learning, digital leadership, digital citizenship, digital collaboration, digital learning environment designer, effective digital learning facilitator, and digital data analyst) considered as the key to teacher digital literacy (ISTE, 2017).

JISC Model (2009)

The model that JISC suggested in the UK is a theoretical study that aims to apply the existing literature to teaching practices by analyzing all required literacies (information, media, technology) and students' characteristics and capacities in a changing environment.

This study formed the basis of the Professionalism in the Digital Environment (PRIDE) Project. The PRIDE Project was applied in academia to university students who develop competence areas that each profession needs. These areas were presented as a pyramid with a constructivist philosophy (Pérez-Escoda et al., 2019). The pyramid model (Figure 7) comprises access and awareness, skills, practices, and identity steps (Sharpe & Beetham, 2010).

Figure 7. "Pyramid model" of the digital literacy development model (Sharpe & Beetham, 2010)

After examining these five development models of digital literacy, a new model was developed by integrating the dimensions, areas and competencies of the other five models (Pérez-Escoda et al., 2019). (Figure 8).

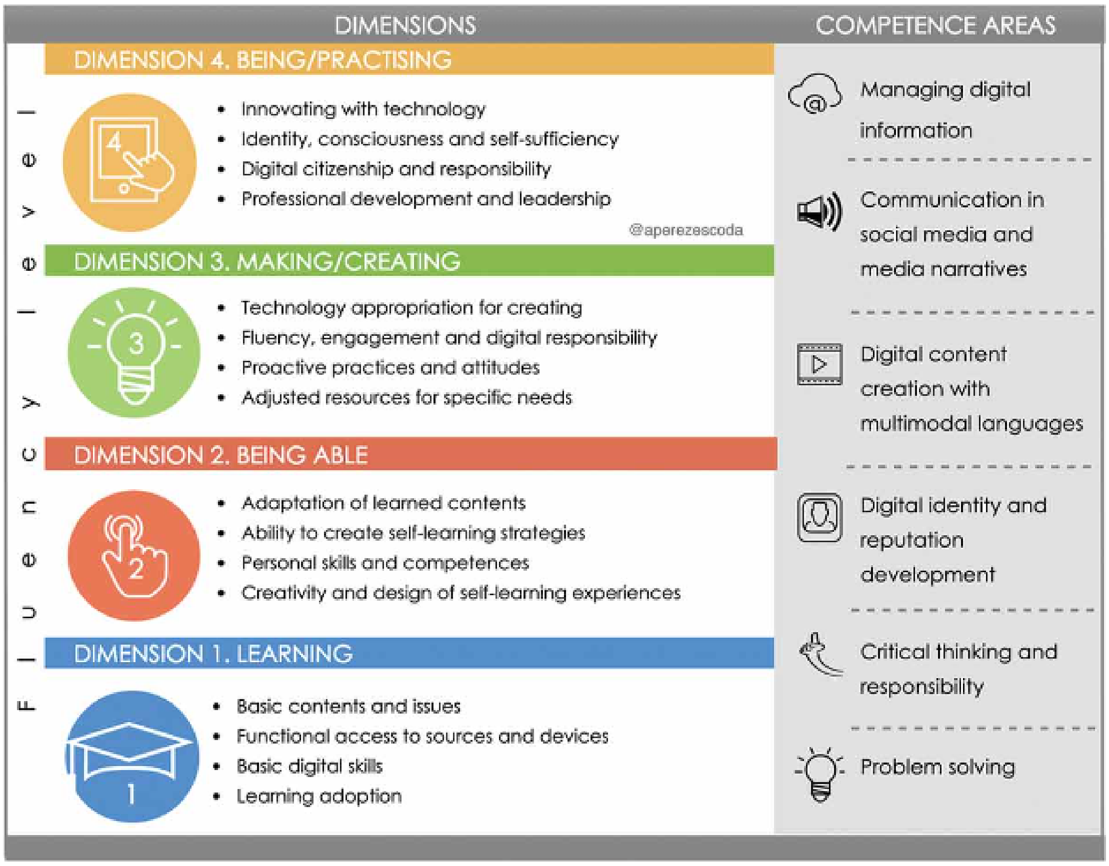

Figure 8. Dimensions of digital literacy, based on the five models (Pérez-Escoda et al., 2019)

These four dimensions (learning, being able, making/creating, being/practicing) will allow the development of six competence areas at different levels. Their levels depend on the citizen's or student's dimension.

Apart from these models, there are different models called digital literacy or digital competence models developed by different researchers to explain digital literacy with all its dimensions. These are:

- The digital competency model developed by Calvani et al. (2009) handled digital competency in three dimensions: cognitive, ethical, and technological.
- In the digital literacy model developed by Chetty et al. (2017), five disciplines (information literacy, computer literacy, media literacy, communication

literacy, and technology literacy) and three perspectives (technical, cognitive, and ethical) broadly outline a framework that can be adopted to evaluate and measure digital literacy's conceptual components.

- The digital and media literacy model developed by Hobbs (2010) determines the basic competencies of digital and media literacy: access, analysis & evaluation, creation, reflection, and behavior.
- In the digital literacy model developed by Ng (2012), digital literacy arises from three intersecting dimensions: (i) technical, (ii) cognitive, and (iii) social-emotional.
- In Hague and Payton's (2010) digital literacy model, digital literacy is the skill, knowledge, and understanding that enables critical, creative, distinctive, and safe practices while dealing with digital technologies in all areas of life. It may be helpful to think of digital literacy as a structure having several interrelated components or dimensions. On the other hand, Hague and Payton (2010) examined digital literacy in eight dimensions: creativity, critical thinking & evaluation, cultural & social understanding, collaboration, finding & selecting information, effective communication, e-safety, and functional skills.
- The DigEuLit project, which aims to establish a definition and framework for digital literacy, developed by Martin (2009), suggested a participation model consisting of digital competencies (I), digital uses (II), and digital transformation (III) stages (Martin, 2006). Digital literacy can be talked about only in stages II or III.
- The Digital Competence Building Blocks model developed by Janssen et al. (2012) gathered 95 experts from various fields to establish a common ground on the knowledge, skills, and attitudes that constitute digital competence. The research results show that experts see digital competence as a collection of knowledge, skills, and attitudes related to various objectives domains and levels.

Digital Literacy in Education

In the past, libraries used to mediate access to information, but today television, computers, and mobile devices serve this function. At this point, it is vital for individuals to filter the information they encounter and to distinguish between true and false information.

Education, which includes the learning and teaching process, is an area where digital settings are used. Digital technologies are used in this field. For this reason, digital literacy is needed more than before in education. It is impossible to separate digital literacy from the realities of daily life, including school and other aspects of education. Students, teachers, and parents rely on the internet to get their needed information. As digital literacy permeates every aspect of daily life, it is recommended that teachers of all grade levels (from pre-school to university) promote digital literacy in the classroom.

While digital technologies keep their impact on research, teaching & learning, digital literacy programs are developed and expanded in colleges and universities, enabling students to critically use and consume digital tools and create various content (Feerrar, 2019). Developing a vision of a digitally literate university will form a basis for institutional strategies, policies, and processes, flourishing digital literacy (Jisc, 2015).

In short, many researchers suggested different descriptions, frameworks, and models to explain digital literacy. Digital literacy is a broad, complex, dynamic and multidimensional issue. Like classical literacy, it is a tool for all citizens to establish interaction between the individual and society. It creates and shares meaning through which actions are directed, social patterns evolve and change, and social order advances. Whatever the name, the society we live in now is infused with digital, and it is necessary to relate to digital to establish a relationship with this society (Martin, 2009). In the digital world, digital literacy skills and competencies are essential for academic success. 21st-century students can indeed be digital natives. However, this does not mean that they will always use their digital literacy skills for learning. Individuals should be given opportunities to maintain their digital literacy for a lifetime. In this context, individuals should be provided with environments to develop their digital literacy skills, strategies, policies, and practices should be set, and support services should be offered.

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Using Web 3.0 in Education: A Systematic Review

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Introduction

The internet, which has become an indispensable part of our lives, is rapidly developing and changing with each passing day. In parallel with the development of the Internet, the expected development in the Web is also observed. The first web technologies that entered our lives along with the emergence of the Internet consist of simple, plain, read-only content and are called Web 1.0 (Parsa, 2009; Dominic, Francis & Pilomenraj, 2014). In Web 1.0 technologies, there are websites where the flow of information is unidirectional, the content is limited and created by a content provider, and users can only access the provided subject (Park, 2013; Thomas & Li, 2008). Due to the limited use of Web 1.0, Odabaşı et al. (2012) named Web 1.0 users as content-dependent passive readers.

After the simple-read form of Web 1.0, web 2.0 Technologies integrated readers into the system and provided them with the opportunity to write like a writer. With Web 2.0 technologies, users can be content producers as well as information consumers (Cormode & Krishnamurthy, 2008). In this process, the web 1.0 layer forms the basis and is included in all technologies described. Unlike Web 1.0, Web 2.0 includes social communication and interaction between users, and the social use of the web and cooperation among participants comes to the forefront (Park, 2013). Furthermore, with this technology, even users without programming knowledge can produce, edit and share content (Yükseltürk & Top, 2020).

Along with the advantages provided to users by Web 2.0, information redundancy occurs and it is needed to interpret and make sense of the large amount of data obtained through computers and software (Jersen, 2019). Web 3.0 technologies emerging for this purpose are also called "semantic web". The biggest reason why Web 3.0 is called as "semantic web" is that new meaningful information can be created from the available data (Fırat & Fırat, 2021). Through Web 3.0 technology, searches that produce content-based personalized results can be made on websites (Gyamfi, 2014). The function of presenting the meaning of data with the semantic web or Web 3.0 is also added to the machines that involve understanding and processing the data (Presti & Nicolosi, 2012). As the improved-extended new version of the web we use today, Web 3.0 is a system in which computers better understand what information and what its meaning is (Yağcı, 2009; Kapan & Üncel, 2020).

With the evolution of the web and the widespread use of web technologies, new opportunities have started to emerge in the field of education, as in many other fields. With the rise of the web, traditional educational venues were replaced with digital environments, and the idea of e-learning was born (Miranda et al, 2014). E-learning is a web-based education system and is used on the internet, intranet or a computer network (Aytaç, 2003). According to Lee, Tsai and Wang (2008), e-learning has become popular and realistic with the web pages becoming interactive. The concept of e-learning continues to evolve with the development of the internet or the World Wide Web. Dominik et al. (2014) and Rajiv and Lal (2011) summarized the e-learning 3.0 applications that offer individual settings and various options for the use of Web 3.0 in education in Figure 1.

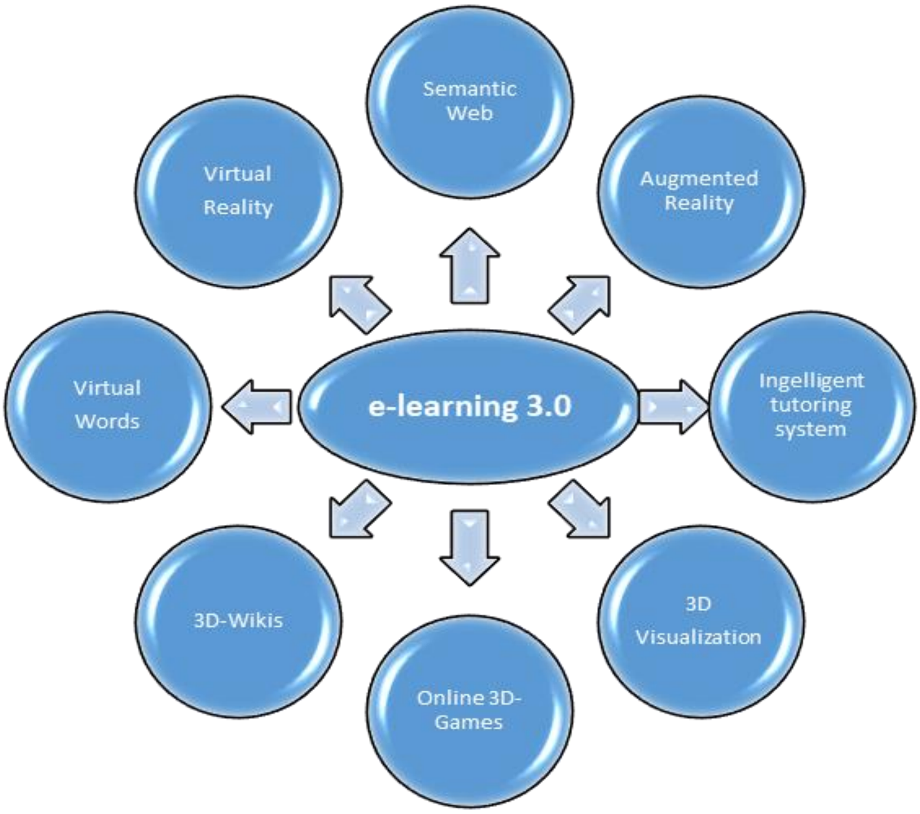

Figure 1. Web 3.0 tools in e-learning (Dominic et al. 2014; Rajiv & Lal, 2011).

While Web 2.0 provides opportunities such as social networking and cooperation between designer and user, according to Figure 1, Web 3.0, also called the semantic web, includes technologies such as big data, connected data, 3D visualization, virtual reality, 3D wikis and games, and augmented reality. These techniques, including augmented reality and mobile learning, are thought to be the future of information access and hold promise for the Web 3.0 teaching approach (Dominik et al., 2014).

Literature

Web 3.0 and Education

Along with the fact that Web 3.0 offers tools and features such as personal assistants, smart agents, 3D games, virtual worlds, and open educational resources, far beyond the opportunities offered by Web 2.0, it is envisaged that the interaction of individuals with the machine will be at the forefront rather than the interaction of individuals with each other, and accordingly, the expectations and interactions of individuals regarding the Internet will differ (Chısega-Negrıla, 2016). Collaborative, three-dimensional virtual learning environments are supported with Web 3.0 technologies, and students can be provided with learning environments at anytime, anywhere and as they wish with the enrichment of e-learning environments (Hussia, 2012). Furthermore, with the semantic web technologies in web 3.0 environments, the focus is on enabling students to manage their learning and make their own decisions about their learning (Chisega-Negrilă, 2013; Wadhwa, 2015).

The widespread use of web 3.0 in e-learning also brings along some questions. One of these questions is which theories should be used for the realization of digital learning. Learning theories provide a point of view that helps us to understand how and why learning occurs (Smith, 1999). The learning theories are divided into four as behaviorism, cognitivism, constructivism and connectivism. According to Hussian (2012), while knowledge is transmitted directly from teacher to student in behaviorism (may be related to e-Learning 1.0), cognitivism considers the student as a data processor, and constructivism suggests that students acquire knowledge after the process of structuring knowledge. According to Siemens (2004), one of the pioneers of connectivism theory, connectivism is regarded as the learning theory of the digital age and is described as the successor of other learning theories. In his study, Hussain (2012) summarizes the relationship of technological changes with the principles of connectivist learning theory in e-learning 3.0 as follows:

- Learning and knowledge are based on diversity of ideas. Social semantic networks support this diversity by providing openness and interoperability.

- Learning is the process of connecting specialized nodes or sources of knowledge. Accordingly, big data or global data storage, connected data, cloud computing, extended smart mobile technologies are used.
- Learning can be found in non-human devices. Machine learning, artificial intelligence, personal avatars, 3D visualization and interaction are used in relation to that.
- According to the connectivist learning theory, the capacity to know more is more important than what is currently known, in this context, the function of providing information control of the semantic web is used.
- The ability to see the connections between fields, ideas and concepts requires a basic skill. Nurturing and maintaining connections is needed to facilitate continual learning. Semantic web and collaborative intelligent filtering technologies are used to develop such skills.

As it can be seen above, many technologies used in e-learning supported by the learning theories of the digital age have been developed. Furthermore, in the studies on the use of Web 3.0 in education, the positive aspects of the use of these technologies in education were emphasized by showing that the use of Web 3.0 tools in education provides suitable conditions for institutions, teachers and students to reveal their potential and social and strategic skills (Atabekova et al., 2015). The number of studies on the use of Web 3.0 in education is increasing day by day (Bahadir, 2019; Greener, 2015; Halimi & Seridi-Bouchelaghem; 2021; Wu et al., 2020). However, it is observed that studies that include systematic reviews in this field are not sufficient (Fırat & Fırat, 2021; Jensen, 2019).

The compilation of studies that have been systematically reviewed is considered important in terms of determining the gaps in the literature about Web 3.0 and providing a conceptual framework for researchers who will conduct studies on the use of Web 3.0 in education. When the systematic review studies on the use of Web 3.0 in education in the literature were examined, two systematic studies were found. Among them, Jensen (2019) aimed more specifically to investigate the relationship between technology and pedagogy in the field of Semantic Web in formal education from a practical educational perspective. Fırat and Fırat (2021) conducted a systematic review study of the use of Web 3.0 tools in learning environments. In that study, Fırat and Fırat analyzed 81 English articles on the use of Web 3.0 in education, registered in Scopus and Science Direct databases, which include web 3.0 and lower technologies, from 2005 to 2020. Unlike the study of Fırat and Fırat (2021), this study examines English and Turkish articles in the Web of Science, Eric and TR Index, which include the use of Web 3.0 in education, for the years 2012-2022. The study can be considered important in terms of providing an up-to-date and holistic view of the place of Web 3.0 in education in the last ten years, with the keywords used in the search criteria. In this context, the relevant studies were systematically examined in order to determine the place of Web 3.0 technologies in education, and answers to the following research questions were sought:

1. What is the distribution of the studies on the use of Web 3.0 in education by years?
2. What are the types of studies reviewed, in which direction is the trend?
3. What are the number of citations of the studies reviewed?
4. What are the keywords used in the studies reviewed?

Methodology

The objective of this study was to comprehensively review the research on the application of Web 3.0 technologies in education. "Identifying, analyzing, and interpreting all available research on a given research issue, topic area, or phenomenon of interest" is the definition of a systematic review of the literature (Kitchenham, 2004). Although there are different definitions and stages of systematic review, Newman and Gough's (2020) systematic review stages were used in terms of basing educational research in this study.

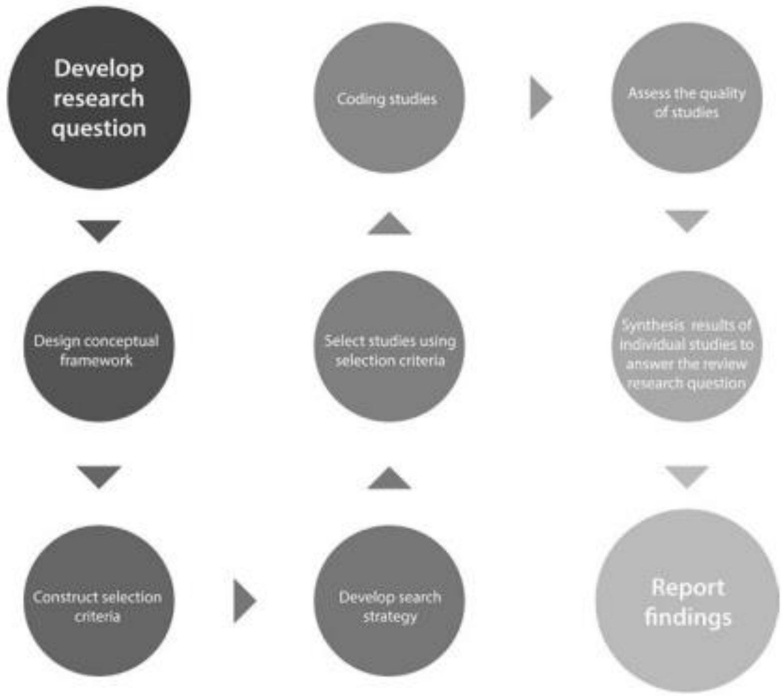

Figure 2. Systematic Review Process of Newman and Gough (2020)

According to Figure 2, Newman and Gough (2020) indicated the review stages as follows. 1) Developing the research question, 2) Designing the conceptual framework, 3) Constructing the selection criteria, 4) Developing the search strategy, 5) Selecting the studies using the selection criteria, 6) Coding studies, 7) Assessing the quality of studies, 8) Analyzing the synthesis results of individual studies to answer the review research question, and 9) reporting the findings. Accordingly, the stages of this study are presented under the following subheadings.

Constructing the Selection Criteria

According to Yılmaz (2021), this stage is one of the important stages in which the research route is determined and the road map is designed according to this route, which acts as a sort of filter for the research. The criteria to be included or excluded from the study are determined in this stage. The selection criteria in systematic reviews are shaped by the research question and conceptual framework. The most commonly used selection criteria can be listed as the characteristics of the study participants, the country where the study is conducted, the language in which the study is reported, and the research methods (Newman & Gough, 2020). Accordingly, in this study, the year of the study, research type, the number of citations and keywords were determined as the criteria for inclusion in the research.

Developing the Search Strategy

The search strategy is the plan for how to identify relevant research studies and serves to detail the resources to be sought and the manner in which resources are sought (Newman & Gough, 2020). Accordingly, The year of the studies to be included in the research, the area to be researched, the keywords to be used, the types of studies, the resources to be searched, the field to be searched and the language to be searched were determined in the stage of determining the search strategy. The criteria determined and used in the study are presented in the table below.

Table 1. Search Criteria

Year	2012-2022
Area to be researched	Title
Keywords	"web 3.0", "semantic web"
Research Type	Research Article
Databases	Eric, Web of Science, Tr Index
Search Area	Educational research
Language	English and Turkish

As it is indicated in Table 1, with this systematic research, the research articles published in ERIC, Web Of Science and TR Index databases between 2012-2022, in

English or Turkish, in the field of education, with the keywords "Web 3.0" and "semantic web" in the study title were included in the study.

Since the use of Web 3.0 technologies in education has gained popularity in the last ten years, the studies conducted between 2012 and 2022 were included in the study, and studies outside this year range were excluded. Some studies were published in books, although they were research articles. Therefore, the studies in the category of research articles and published in books were also included in the study.

Selecting Studies Using the Selection Criteria

The search was performed between 01 April and 15 April 2022 in accordance with the criteria indicated above. Two researchers searched different databases in the study. While the first researcher conducted research in the Eric database, the second researcher continued searches in the Web of Science and Tr Index. The articles were downloaded from the databases specified by the researchers and saved in the public folder created with the year of study, author and name.

Coding Studies

The studies selected within the scope of the search were processed in the table, which was prepared by the researchers and created using E-tables from Google Documents in order to allow researchers to work together, by taking into account the year of the study, author, research purpose, research type, data collection tools, participants and number of citations.

Rourke and Anderson (2004) argued that the use of a coding scheme proven by many researchers would help increase the validity of content analysis. Therefore, the classification scheme developed by Dick and Dick (1989) was used in classifying the studies according to their types. According to this scheme, the classification of studies is divided as in Table 2.

Table 2. Classification of Studies According to their Types (Dick & Dick, 1989)

Literature Review	Presentation of a summary of the literature as a critique or an expression of the latest technology.
Methodological article	Study including a new model or procedure for carrying out a technical activity
Theoretical Article	Article that primarily benefits from and contributes to the theoretical literature of the field
Empirical and Experimental Studies	All studies, except assessments, that use data to draw conclusions
Descriptive study	Presentation of information about a specific program or event using little or no data.
Evaluation study	Presentation of data and information to explain the effectiveness of a particular program or method, usually in an applied setting.
Professional article	A description of the issues related to the instructional technology profession, such as the determination of qualifications or definitions of internship programs.

Assessing the Quality of Studies

The assessment of the quality of studies is an indication of the strength of the evidence provided by the systematic review and gives information on the standards required for future research. A number of standards with a similar effect in determining how compilations are made or what a compilation should contain and report was established in order to maintain accuracy and quality in systematic reviews (Gough & Thomas, 2016). The study entitled PRISMA-Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020) is one of the important sources about systematic reviews. While the PRISMA Reporting is used to assist authors in improving the presentation of systematic review and meta-analysis research, it can also be used for critical evaluation of the presentation (Karaçam, 2013; Moher, et al., 2009). The PRISMA diagram of the research process is presented in Figure 3.

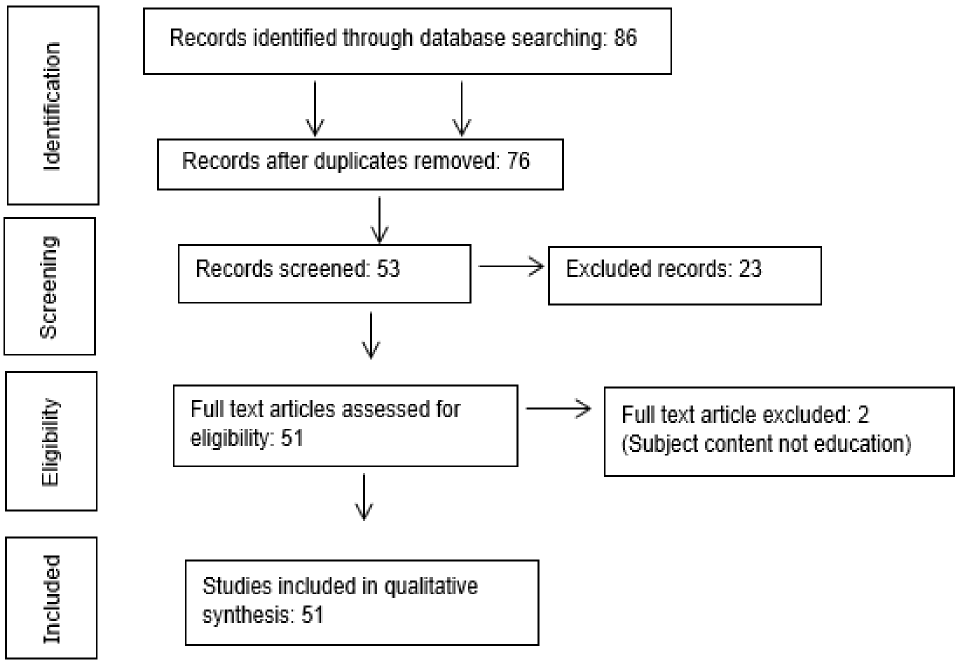

Figure 3. Systematic review PRISMA flow chart (Brunton et al., 2012, slightly changes after p.86; Moher et al., 2009, s. 8).

According to the Prisma chart above, 86 studies were found in the first search of the databases. After the reviews, it was determined that 10 studies were repeated in the databases and the repetitions were excluded from the research. With regard to the inclusion criteria, two researchers analyzed 76 articles in detail. From the titles of the articles, 23 studies that did not meet the search criteria were excluded from the research. As a result of examining the contents of 53 articles obtained after exclusion, two studies that were not related to education were excluded from the research. Finally, the study was conducted with 51 articles. Regarding consensus and disagreement among researchers, the reliability was determined by using Miles and Huberman's (1994) Reliability=consensus/ (consensus+disagreement) formula. Two researchers scanned 86 articles and reached an agreement of 92% on inclusion/exclusion. Then, the researchers discussed inconsistencies and agreed on the remaining 8%.

Limitations

Research articles were included in the study. Theses and conference proceedings were not included in the study. In future systematic analyses, the study can be expanded by differentiating the databases and adding different types of studies. Different databases can be used or all of them can be examined as a whole. Furthermore, variables such as data collection tools and the number of participants were not examined in the study since the studies in this study included a small number of experimental studies. When the scope of the study is extended, such data can be examined from the data to be obtained. Moreover, researchers are recommended to use the concept of semantic web along with the concept of Web 3.0 in their studies.

Findings and Discussions

The findings section corresponds to the “analyzing the synthesis results of individual studies to answer the review research question”, one of the systematic review steps of Newman and Gough (2020). The findings obtained in this context are presented by dividing them into sub-headings as follows.

Findings on the First Sub-Problem

The first sub-problem of the study includes determining the distribution of studies on the use of Web 3.0 in education by years. The findings obtained as a result of the reviews are presented in figure 4.

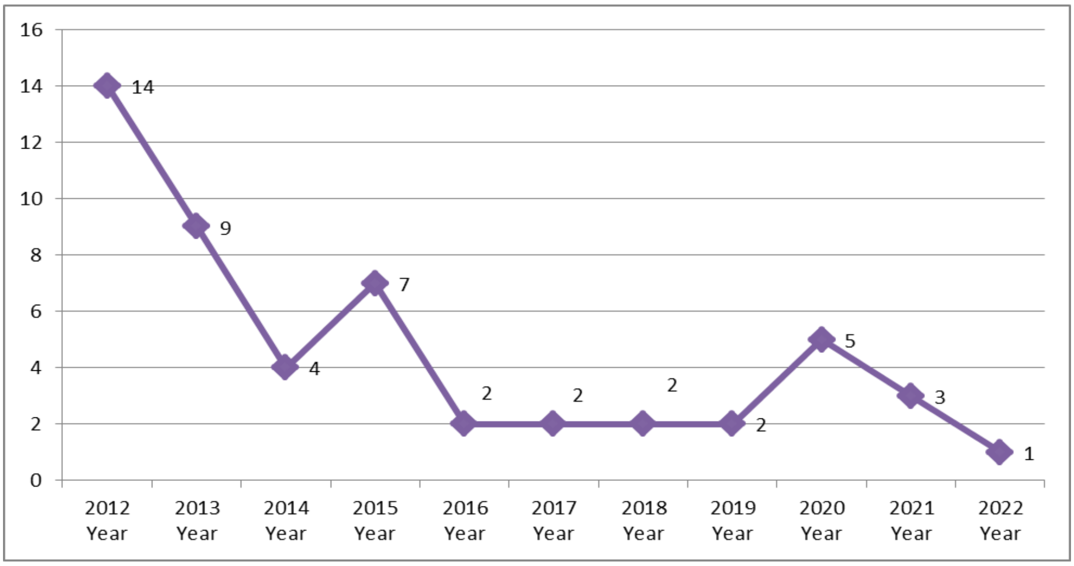

Figure 4**.** Distribution of the studies reviewed by years

The majority of studies on Web 3.0 in education were conducted in 2012, between 2012 and 2022, according to an analysis of the distribution of studies by years. It was observed that there was a decrease in the number of studies from 2012 until 2015. An increase was observed again in 2015. After this increase, there was a stagnation in the studies between 2016-2019, and it was observed that there was an increase in the number of studies in 2020.

Findings on the Second Sub-Problem

The second sub-problem of the study includes determining the types of studies on the use of Web 3.0 in education. The findings obtained as a result of the reviews are presented in Figure 5.

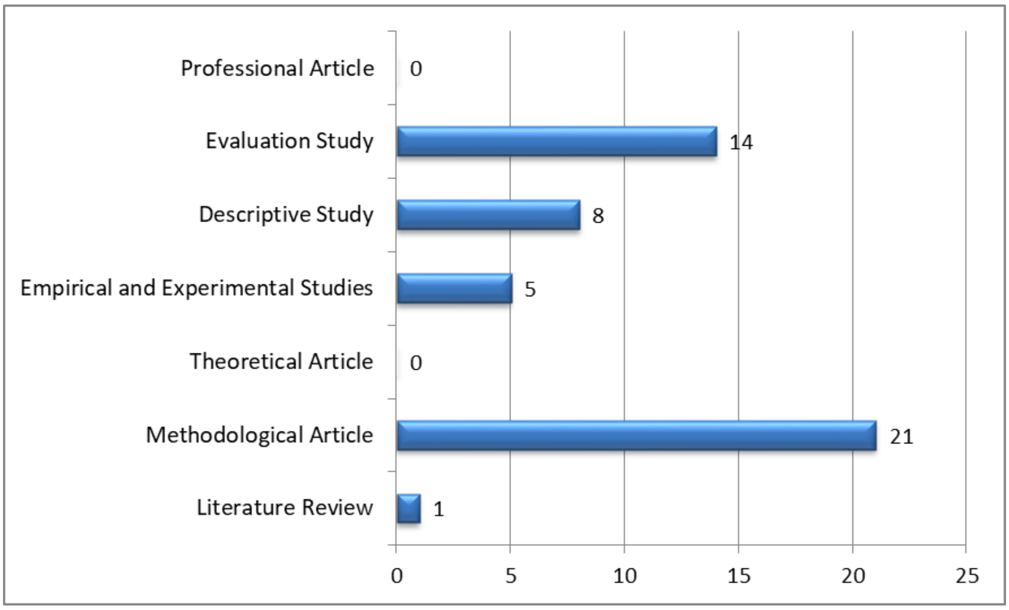

Figure 5. Distribution of the studies reviewed by types

The types of studies reviewed were classified using the classification scheme developed by Dick and Dick (1989). Accordingly, it was observed that the types of the studies reviewed concentrated on methodological (38.8%) and evaluation studies (29.6%). Nevertheless, it was observed descriptive studies (20.3%) and empirical and experimental studies (9.2%) were also conducted. Furthermore, among the studies reviewed, one study included the literature review, and two systematic studies were not included in the table because there was no category. Among the studies reviewed, no professional and theoretical articles were found.

Findings on the Third Sub-Problem

The third sub-problem of the study includes determining the number of citations of studies on the use of Web 3.0 in education. The findings of 51 studies that were cited among the reviewed studies are presented in Figure 6.

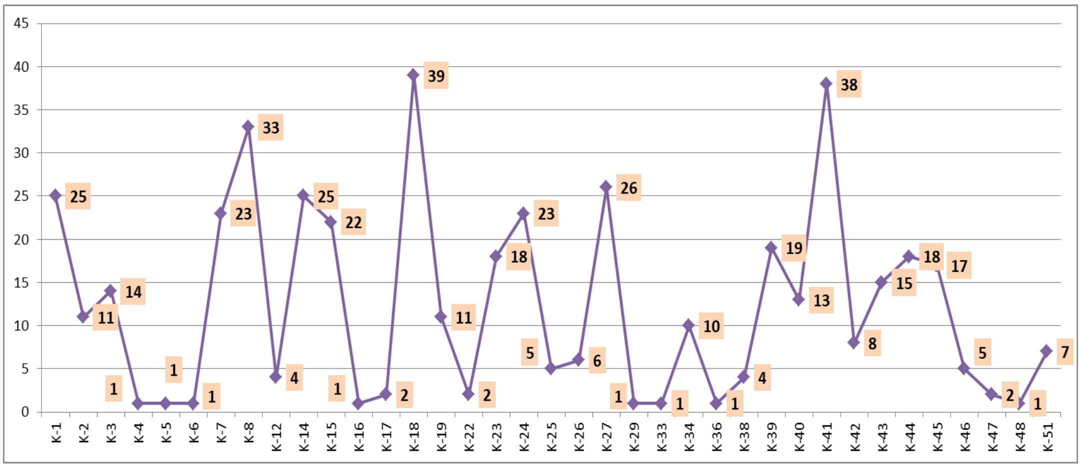

Figure 6. Distribution of the studies reviewed by the number of citations

(*K: Indicates the coding number of each study*)

When Figure 6 was examined, among the studies reviewed, the study with the highest number of citations of 39 was the study by Isotani et al. (2013) entitled “A Semantic Web-based authoring tool to facilitate the planning of collaborative learning scenarios compliant with learning theories” which was coded as K-18. The second most cited study was “A systematic literature review of the use of Semantic Web technologies in formal education” written by Jensen, coded as K-46 with 38 citations. Immediately after, the most cited study was the study of Siadaty et al. (2012) entitled “Self-regulated Workplace Learning: A Pedagogical Framework and Semantic Web-based Environment” with 33 citations, which was coded as K-8. It was followed by the study of Bhattacharya et al. (2015) entitled “Threshold concepts and the semantic web” with 26 citations. When the frequency distribution of the citation numbers of the studies was examined, it was observed that there was an intensity in the distribution of the studies with more than 20 citations. Therefore, studies with more than 20 citations are presented in tables as follows.

Table 3. Studies with more than 20 citations

Number of Citations	Authors	Name of the Study	Year
39	Isotani, S., Mizoguchi, R., Isotani, S., Capeli, O. M., Isotani, N., De Albuquerque, A. R., Ig. Bittencourt & Jaques, P.	Semantic Web-based authoring tool to facilitate the planning of collaborative learning scenarios compliant with learning theories	2013
38	Jensen, J.	A systematic literature review of the use of Semantic Web technologies in formal education	2019
33	Siadaty, M., Gašević, D., Jovanović, J., Pata, K., Milikić, N., Holocher-Ertl, T., Jeremić, Z., Ali, L., Giljanović, A. & Hatala, M.	Self-regulated Workplace Learning: A Pedagogical Framework and Semantic Web-based Environment	2012
26	Bhattacharya, S., Cohen, M. B., & Cohen, M. B.	Threshold concepts and the semantic web	2015
25	Adorni, G., Coccoli, M., & Torre, I.	Semantic Web and Internet of Things supporting enhanced learning	2012
25	Carmichael, P., & Tscholl, M.	Cases, simulacra, and Semantic Web technologies.	2013
23	Halimi, K., Seridi-Bouchelaghem, H., & Faron-Zucker, C	An enhanced personal learning environment using social semantic web technologies	2014
23	Hsu, I. C.	Intelligent discovery for learning objects using semantic web technologies	2012
22	Vera, M. S., Fernández, J. T., Sánchez, J. S., & Espinosa, M. P.	Practical experiences for the development of educational sys-tems in the semantic web.	2013

Findings on the Fourth Sub-Problem

The fourth sub-problem of the study includes determining the keywords of the studies on the use of Web 3.0 in education. As a result of the reviews, the keywords that are used more than one (1) are presented in tables as follows.

Table 4. Keywords Used in Studies and Number of their Uses

Keywords	**Frequency**
Semantic Web	20
E-Learning	10
Educational Technology	4
Web 3.0	3
Education	3
Semantic Technologies	3
Ontology	3
Workplace Learning	2
Higher Education	2
Online Systems	2
Technology Uses İn Education	2
İnternet	2
Scorm	2
Semantics	2
Cloud Computing	2
Participatory Design	2
Knowledge Creation	2
İnterdisciplinarity	2
Learning Objects	2
Semantic Web Technologies	2

When Table 4 was examined, the most repeated keywords were Semantic web (20), e-learning (10), and educational technology (4). It was observed that the keywords Web 3.0, Education, Semantic Technologies, and Ontology were mentioned in three studies.

Conclusion and Discussion

This study looked at 51 research articles on the use of web 3.0 technologies in education that were published between 2012 and 2022 in the ERIC, Web of Science, and TR Index databases in English or Turkish and had the terms "Web 3.0" and "semantic web" in the study title. In the systematic review, it was observed that studies were intensely conducted in 2012. It was observed that there was an increase again in 2015 and 2020 after 2012. It was also observed that there was a decrease in the number of studies and stagnation from time to time between these years. These findings are consistent with Fırat and Fırat (2020) study. As a result of the systematic review of Fırat and Fırat (2020) on the use of web 3.0 in education, it was observed that the studies increased in 2012 and the highest number of studies was reached in 2013. Along with the decrease after this, an increase was also observed again after 2015.

When the studies were classified according to the types of studies developed by Dick and Dick (1989), it was observed that methodological (38.8%) and evaluation studies (29.6%) were studied more frequently. Nevertheless, it was observed that descriptive studies (20.3%) and empirical and experimental studies, although their number was small (9.2%), were also conducted. Furthermore, two studies, including literature review (Fırat & Fırat, 2021; Jensen, 2019), were also included among the studies reviewed. Among the studies reviewed, there were no theoretical articles. These findings revealed that the studies on the semantic web mainly consisted of studies that included a new proposal for a new model and procedure. Since Web 3.0 technology is a new technology for education, the number of studies on the effectiveness of its use in education can be expected to be high. These findings are partially consistent with the study of Fırat and Fırat (2020). In their systematic review, Fırat and Fırat (2020) indicated that the majority of the studies consisted of experimental studies and studies on the design or presentation of learning software, which is called "methodological" in this study. It was considered that the number of experimental studies was higher in their studies, unlike this study, since they included the concepts involving the applications such as augmented reality in their systematic reviews.

It was found that the most cited studies were "A Semantic Web-based authoring tool to facilitate the planning of collaborative learning scenarios compliant with learning theories" (Isotani et al., 2013) and "A systematic literature review of the use of Semantic Web technologies in formal education" (Jersen, 2019), respectively, when the distribution of the studies according to the number of citations was examined. Based on these findings, it can be understood from the researchers' interest in the study that digital learning includes a learning process, so the tools developed should be based on learning theory. It can also be said that researchers had a great interest in this systematic study, and therefore, there is a need for such systematic studies. Furthermore, when the articles were reviewed in detail, it can be said that methodological studies involving a new model or procedure for the execution of the technical activity and descriptive studies involving the definition and use of the semantic web using little or no data received more citations. This may suggest that there are still descriptive deficiencies in the studies on web 3.0/semantic web and that experimental studies cannot be conducted because this technology is not fully understood.

When the keywords used in the studies were examined, it was observed that the word semantic web was used more than web 3.0. It is considered that future studies can be conducted on this concept, and the studies can be extended. It was observed in the findings that the keyword e-learning was highly used along with the keyword semantic web (n=10). It was considered that the concept of semantic web, which is a kind of synonym of web 3.0, was used more in the studies as a result of defining it as semantic web in its definitions and reinforcing it with examples in this context for a better understanding of Web 3.0 technologies.

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Pedagogical Assumptions Behind The Use of Animations in Chemistry Lessons

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Introduction

Students' struggle with learning concepts in chemistry has long been known by chemistry educators (Adadan, Trundle & Irving, 2010; Derman & Eilks, 2016; Derman & Ebenezer, 2020). Some explanations as to why this may be the case include:

a) Some concepts of chemistry are abstract concepts that learners do not encounter in their daily lives (Taber, 2008; Taber & Coll, 2002),
b) In order to solve problems of chemistry, students need to work with many different concepts and data simultaneously (Johnstone, 2010; Plass, Moreno & Bruenken, 2010),
c) Success in chemistry requires thinking and making conversions between macroscopic, particulate (also called microscopic, molecular or submicroscopic) and symbolic level representations (Adadan, 2013; Gabel, 1994; Johnstone, 2006; Johnstone, 2010; Derman & Ebenezer, 2020),

d) students studying chemistry tend to come to class with previous knowledge that go against scientifically accepted theories, which can hinder learning (Adadan, Trundle & Irving, 2010; Derman & Ebenezer, 2020; Taber, 2002).

Therefore, in order to provide better understanding of the chemistry concepts for students, reaching strategies must be developed and assessed accordingly. Indeed, studies have been conducted on computer aided instruction, born out of the desire felt by teachers use a chemistry module on polymer as they believed its three-dimensional, animated molecular models can explain polymerization and stretching processes more easily (Dori & Barnea, 1997). Furthermore, thanks to computer models, students are able to link their submicroscopic explanations of chemical systems with their macroscopic observations. Through visualisation of submicroscopic processes in chemistry it is possible for students to construct a meaningful understanding of chemical knowledge (White, 1988) such as “strings” (symbols and equations), “propositions” (relationships among concepts), and “logicomathematical understanding” (mathematical problem solving—e.g., working out solution concentration problems). Therefore, chemistry courses can be improved through the application of appropriate teaching strategies that incorporate computer technology (Ebenezer, 2001, p. 74). It is more common to make use of visualisations in secondary and post-secondary chemistry classrooms as here it is possible to provide students with greater access to the central concern of chemistry, namely structure and reactivity (Ebenezer, 2001).

Thanks to the modern-day improvements provided by new educational technologies, it becomes possible for educators to provide students with access to visual representations of atomic structures, molecular interactions, and large datasets, which can be used to aid chemistry learning. Nowadays, it is commonplace to see physical and chemical processes demonstrated through “molecular experiments” used by students and teachers at all levels of education using a wide range of visualizations. It is easy to see the advantage of such tools in order to advance the learning of chemistry: by using these tools that demonstrate visual representations of the phenomena of study that is invisible to the eye, students can develop a richer and deeper understanding of chemistry concepts. In chemistry education and research community, there are currently two approaches to the design and study of visualizations as part of two major theoretical frameworks. Although these frameworks have a lot of common ground, they are different in kind. First, the aforementioned studies indicate that students have difficulty connecting submicroscopic explanations of chemical systems with their macroscopic observations in addition to finding it challenging to work in both these levels simultaneously and comfortably (Ebenezer, 2001, p. 74).

Many designers considered these difficulties as the central obstacle for learning chemistry, and have come up with new visualizations that present multiple levels at the same time (Adams et al., 2008). This framework puts forward that visualizations are effective because they lift the burden on the student to determine the relationship between different levels. Secondly, researchers of chemistry education state that what makes chemistry is difficult to learn is the challenge students face in coordinating the meaning of multiple representations (Kozma & Russell, 1997; Russell et al., 1997). Students find it difficult to understand the relationship between symbolic representations, such as empirical formulas and structural diagrams, as multiple representations can be used to refer to the same submicroscopic entities.

The application of these two frameworks has provided important insights into how chemistry visualisations can be designed; however, both of these frameworks falls short in their power to explain how and why visualizations can be used more commonly to encourage chemistry learning across the curriculum. For visualizations to take full effect in the classroom, what is needed is a more comprehensive explanation of their role.

Stieff and Ryan (2013) used three theoretical frameworks founded on cognitive learning theories to explore how molecular visualizations can make a connection with how students learn to the design of dynamic visualizations with the aim of stirring the discussion on the role of visualizations and the design of research programs that look into their efficacy. This innovative look on the theory-research-practice triad explores the ways that; (i) the potential of visualizations in supporting how domain concepts are retained in memory according to the tripartite model of working memory

(Baddeley & Hitch, 1974; Baddeley, 1992). In this model proposed by Baddeley and Hitch's, a multi-component model of working memory is emphasized that includes specific mental structures that process mental representations corresponded by each of the senses (see Figure 1).

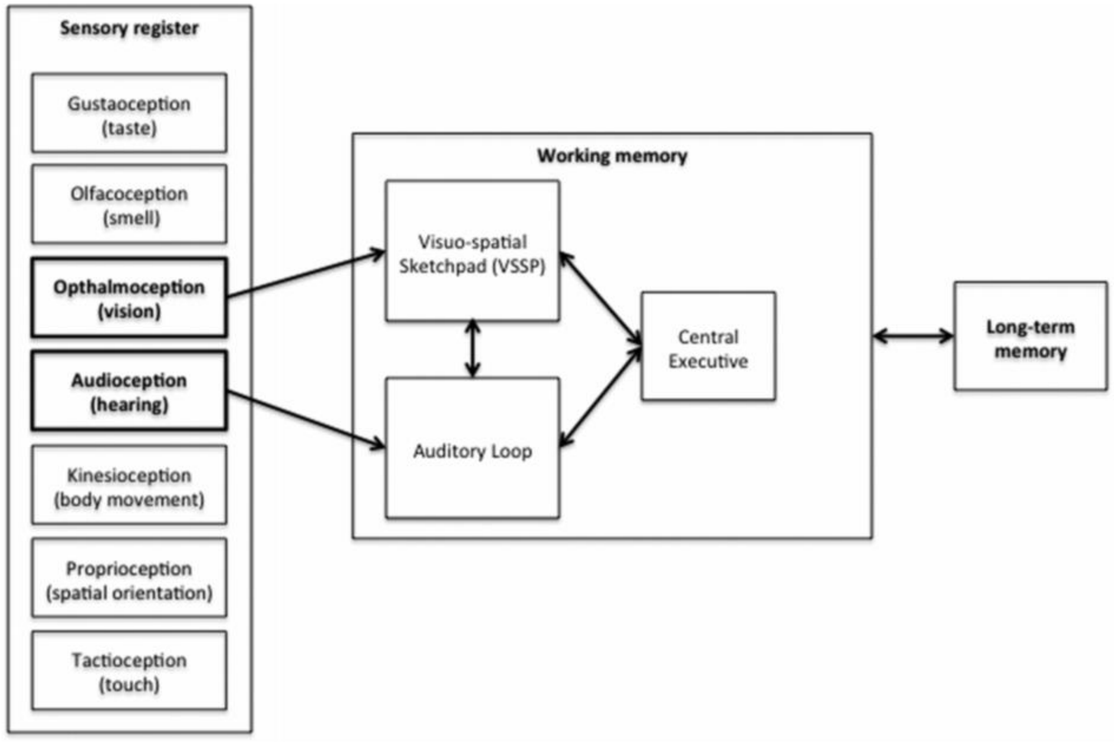

Figure 1. Conceptualization of Baddeley and Hitch's tripartite model of working memory (Stieff & Ryan, 2013, p. 25)

Chemistry education research paradigms are encouraged by the tripartite model of working memory which narrowly look into the ways in which students perceive, encode, and recall the various representations that chemistry visualizations use. In the tripartite model of working memory there are also multiple implications for the design of animations and simulations in the field. First of all, the model claims that through visualizations a primary challenge faced by students in learning chemistry can be overcome. Many of concepts and processes taught in chemistry do not have an equivalence in real life that have visual representations.

When students are expected to learn an idea as simple as an "atom," this idea is solely represented in the auditory loop as a mere word and its corresponding definition. Hence, thanks to visual representations of atoms provided by animations or simulations, students are provided with a concrete representation that can be encoded in visual working memory. In the same vein, visual representations of quantitative relationships are equally likely to improve retention and recall through visualisation. The model welcomes questions that seek an answer to which representations are most effective, which of them are (in) effectively paired, or how students encode molecular representations.

ii. The potential of visualizations embedded in lessons using the contemporary "knowledge-in-pieces" model of conceptual change to promote understanding of concepts (Smith, diSessa & Roschelle, 1993; diSessa, 1988). Despite the narrow predictions of information processing models about retention and recall, they don't offer much about the quality of conceptual understanding or complex problem solving. On the contrary, the focus of conceptual change models consists of the knowledge structures developed by the learners from their experiences be it in formal learning contexts or everyday life (Posner, Strike, Hewson, & Gertzog, 1982). From this perspective, conceptual change models are more agnostic about the structure of the mind and refrain from strong statements about the location of information in memory or the processes that are a part of retention and recall. What conceptual change models have in common is the focus on the processes through which students take in information to make sense of the world coherently (Carey, 1986). Hence, in conceptual change models, analyses provided not only supplement, but also extend those of information processing models in order to account for a student's knowledge before and after instruction.

Today, the validity of multiple competing models of conceptual change is actively debated by cognitive and learning scientists whose arguments differ to a great extent in terms of their underlying assumptions about the nature of knowledge and the processes involved in conceptual change. According to Stieff and Ryan's (2013) opinion, the three models taka centre stage in this debate are: models that focus on mental model revision (Gentner et al., 1997; Gentner & Gentner, 1983), models that focus on ontological recategorization (Chi, 2005; 2008) and the "knowledge-in-pieces" model (Smith, diSessa & Roschelle, 1994; diSessa, 1988). Despite the contrasting predictions about the efficacy of various interventions for promoting conceptual change offered by these models, all three agree that conceptual change is more complex than simple belief revision. In other words, while each model posits that conceptual change necessarily involves replacing one's false ideas with scientifically correct models, they each also assert that belief revision alone is not adequate to make sense of the failure of students to comprehend scientific concepts after years of education, or the emergence of difficulties that arise while learning.

According to Stieff and Ryan (2013), each of these models can offer useful explanations for the efficacy of visualizations in addition to clear-cut design principles; however, they argue that the "knowledge-in-pieces" model (KiP model) offers the most utility in terms of chemistry education researchers who study the development of new animations and simulations at multiple levels of instruction. Unlike information processing models, the KiP model gives no inherent value to the visualization itself; rather, the model posits that visualizations are beneficial depending on how they are used to aid students in putting their current understanding within the framework of scientifically accepted ideas. Therefore, if visualizations are designed with the sole purpose of "showing" molecular interactions, it is unlikely that they will lead to any conceptual change in the long run. However, when students are asked to systematically compare their observations from a visualization with their prior understanding, then conceptual change is achieved in learning contexts. Furthermore, it must be recognised that in such environments conceptual change is not likely to occur after a single exposure to a visualization.

Due to the nature of conceptual change as a gradual process, students require repetitive exposure opportunities to explore a visualization any useful conceptual change can be achieved. If sufficient time is not given for the understanding to be revised in due time, students' accurate understanding can be displayed only briefly after demonstration (DiSessa, 1993; Smith, DiSessa & Roschelle, 1993). According to the knowledge-in-pieces model, students' prior knowledge is accepted to be a productive resource rather than an obstacle to be eliminated or ignored (DiSessa, 1993; DiSessa & Sherin, 1998; Smith, DiSessa & Roschelle, 1993). Hence, it is imperative that new research agendas with visualizations characterize the quality of students' conceptual understanding not only before and after instruction, but during instruction as well. **(iii.)** the potential of visualizations for supporting social interactions in chemistry through the use of one model of social cognitive learning (Bandura, 1976; Bandura, 1986). Visualizations can promote student interaction with one another. Vygotsky's Theory of Social Development (Vygotsky, 1978; 1986), Lave's Situated Learning Theory (Lave & Wenger, 2003), and Bandura's Social Cognitive Learning Theory (Bandura, 1976; Bandura, 1986) are among the most common theories employed in the cognitive and learning sciences community today.

Each theory focuses on different aspects of the social environment and offers convergent perspectives on human learning and development. Collectively, in social learning theories, learning is studied as a process occuring between teachers and students as well as among individuals. Thus, in each theory, the focus is on the active role of social agents and learning is framed as a process rather than an outcome. According to Stieff and Ryan (2013), Bandura's (1976) Social Cognitive Learning Theory offers a more precise model of to explain the role social agents in human learning and offers a clearer bridge to conceptual change and information processing models of learning. Building on previous cognitivist perspectives, social Cognitive Learning Theory offers a model of learning that examines how learning takes place within a social context. Thus, social cognitive learning theory does not downplay the analysis of mental representations: the theory attempts to explain the active role played by social factors to help an individual learner to build mental representations during the process of learning. For that purpose, social cognitive learning theory differs from other social earning theories in how it directly addresses the role of motivation and human agency in learning.

Consequently, the theory provides a basis for research on visualizations and offers design principles for curricular structure and pedagogical methods. According to social cognitive learning theory, when research agendas focus on how students learn with visualizations together and how they learn from teachers who model their thinking using visualizations. It is emphasized in social cognitive learning theory that social interactions in the classroom and broader societal and cultural factors play an important role. These studies involve examining changes in individual learning which occur as a result of social factors or the quality of social processes in classrooms where visualizations are employed. Thus, the way visualisations encourage meaningful social interactions and the way teachers can make use of them to model their thinking effectively as well as the way visualisations can be used to promote self-efficacy and agency can be studied through these research paradigms

As a result of the application of social cognitive learning theory to chemistry visualizations, two clear design principles emerge. First, the theory suggests that visualizations should be used in ways that encourage interaction among students and teachers, which can enable teachers and peers to use the visualization as a resource to model their thinking and help students learn through observation of others (as opposed to working with a visualization in isolation). As such, the visualization considered a resource that the teachers can use to improve their thinking. Second, a high degree of control should be offered to students in visualizations. In this way, students can perceive the control they have of their learning, which as a result will promote self-efficacy and agency. It is possible that students regard visualizations as environments that offer little control in which they have no impact on the progress of their own learning. Thus, it is advised that molecular visualizations should be designed that focus on the 'heart of chemistry', which is the relationship between chemical structures and reactivity at the molecular level. Through the exploration of this relationship, students are able to 'see' representations of unseen phenomena.

Some of the issues that have a negative impact on students' abilities to learn chemistry concepts include chemical theories and chemical education theories. Nevertheless, some of these other issues are actually related to psychology or cognitive learning theories as well as theories on the optimal design and usage of multimedia programs (Schönborn, Höst & Lundin Palmerius, 2010). Therefore, these and other chemical,

chemical education, psychology/cognitive, and multimedia theories should be considered (Suits & Sanger, 2013, p.2).

Molecular-Level Animations

Wikipedia (“animation”, 2022) defines animation as “the rapid display of a sequence of static images and/or objects to create an illusion of movement.” The visualizations that display a scripted sequence of events for passive viewing constitute animations (Oakes &Rengarajan, 2002). Using these visualizations, students are usually able to set an initial set of conditions and restrict the displayed information, thereby highlighting only those features most relevant to the represented concept (Stieff & Ryan, 2013, p.18).

Animations have the potential to promote a deep understanding of chemistry (Rieber, 2005), by allowing retention of not only facts and concepts, but also an appreciation of the processes and practices of science-making. Dynamic representations can change the texture as well as the outcome of classroom interactions by making it possible for students to see what they cannot normally see, manipulating variables and observing the results of their activity, and collaborating with others to negotiate meaning and reach conclusions. However, there are involves a number of critical design decisions involved in developing or choosing these resources—as well as integrating them into the chemistry curriculum—(Schwartz, Milne, Homer & Plass, 2013, p.70).

Animations of system behavior may be used to aid learners to interpret simultaneous changes in variables by showing an underlying computational model (van der Meij & de Jong, 2006), and embedded signalling or guidance can scaffold the learner’s successful use of a multimedia resource by directing attention to relevant points (de Jong, 2005; Plass, Homer & Hayward, 2009). Using animations can prove to be an effective tool in directing students’ focus on a specific aspect of a phenomenon at the submicroscopic level, such as the process of dissolution (Tasker, Bucat, Sleet, & Chia, 1996). Animations are representations that involve change over time (Tversky, Morrison, & Betrancourt, 2002), created through the generation of a series of images or frames (Betrancourt & Tversky, 2000).

In the context of science education, an animation can be used to paint a picture of a process or phenomenon in real time, slow motion, or visualized from different points of view; while it may also show abstract information such as a change in pressure or the relationship between two variables (Hegarty, 2004). Using scaffolding, such as visual cues, to draw the viewer's attention to specific features, and incorporating interactivity, allowing the user to stop, start, or repeat portions of the presentation can constitute examples of animations. (Schwartz, Milne, Homer & Plass, 2013, p. 47).

Computer animations that are used to demonstrate chemical processes at the molecular level have been subjects of study for almost two decades (Williamson & Abraham, 1995; Sanger & Greenbowe, 2000; Tasker & Dalton, 2006), and it has been shown that they have a potential to improve students' conceptual particulate-level understanding of chemistry (Sanger, 2009).

Computer animations are generally divided into two categories (Rieber, 2005): Presentation animations (which are used to present new information or to elaborate on information presented earlier) or conceptualization animations. In most visualizations (Williamson, 2011) that are designed for chemistry instruction, depictions are used of atoms, molecules, and/or ions and their interactions (the particulate representation), either as static images or as dynamic visuals with both animations (Sanger, 2009) and simulations (Tasker, 2005). The benefit of particulate visualizations (static or dynamic) in the chemistry education is the possibility to provide students with a view of the behaviours and interactions between the chemical particles, which are often abstract and challenging for students to generate by themselves. Therefore, thanks to these visuals, the abstract interaction of atoms, molecules, and ions become more concrete (Sanger, 2009), and the cognitive load on the student is reduced (Johnstone, 2006, Tasker, 2005, Tasker & Dalton, 2006; Kelly & Jones, 2007). Furthermore, these visuals, combined with effective instruction, can help students make connections between the macroscopic, particulate, and symbolic representations (Kelly & Jones, 2007; Kelly, Phelps & Sanger, 2004; Sanger, 2009; Williamson, 2011), as a result of which they can grasp more scientific conceptions (Tasker, 2005; Sanger, 2009; Williamson, 2011).

Depiction of dynamic visuals can be especially helpful for chemistry students as for most chemistry concepts students need to understand how the chemical systems change over time (e.g., reactants vs. products, before-and-after gas law experiments, equilibrium reactions, etc.). Rieber (2005) indicated that while dynamic computer animations were generally useful to students studying science, they can actually be distracting if the lesson does not involve visualization, motion, or trajectory. Animations can be considered student-centered forms of instruction (Sanger, 2009; Williamson, 2011), which can support student learning as they develop a conceptual understanding of chemistry topics. While molecular-level animations have been shown to provide a deeper learning for students in chemistry, these animations can also misfire, causing new student alternative conceptions that were not present before viewing these animations (Kelly & Jones, 2007; Sanger, 2009; Tasker & Dalton, 2006) and can prove distracting to students if the concepts that they focus on are not visual in nature (Sanger & Greenbowe, 2000).

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Online Exams: An Opportunity or A Threat?

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Introduction

Educational institutions benefit from distance education programs to reach more students and provide equality of opportunity among learners. There are important initiatives in this context on a global and national scale (Coursera, Khan Academy, edX, & Udacity, etc.). The number of these initiatives and contents is increasing day by day (Galante, 2002). At first, distance education was considered an alternative or supporting factor to traditional education (face-to-face education) (Wang, 2008). However, today, especially with the development of software and network technologies, distance education has become much more than a supporter and alternative to traditional education (Allen & Seaman, 2008).

At present, universities, schools, certificate programs, and courses conduct education and training programs only through distance education. Berkeley University, Udemy, Coursera, Khan Academy, Harvard University, and Udacity are some of these institutions and platforms worldwide. For example, thanks to Coursera, learners could attend the courses given by faculty members working in the world's leading universities worldwide without paying a higher education fee. Participation documents and certificates can be obtained if the necessary conditions are met. edX, another similar initiative, offers the opportunity to take courses from the world's leading universities, such as Harvard University, Georgetown University, and the University of Chicago. Udacity, on the other hand, offers a nanodegree program for individuals who want to specialize in talent or pursue a full-time career. Another similar initiative is Udemy, which is also widely used. Udemy is a massive open online course founded in 2010, featuring adult and student-oriented courses by expert instructors. As of July 2022, there are 75 different languages, 54 million learners, over 70 thousand instructors, more than 200 thousand courses, and 740 million course enrollments (Udemy, 2022).

Discussions on education continue intensely with regard to distance education. Moreover, the most discussed topics are how exams will be conducted, how to provide feedback to students, how to ensure exam security, and how to ensure a fair and transparent evaluation. As a matter of fact, the contribution of unattended online exams to overall success is low, cases of cheating are higher, and they are not effective enough (Anderson et al., 2005; Bozkurt & Uçar, 2018).

This study evaluates online exams from a general perspective. The traditional literature review was adopted as the research method in this direction. The information, which is disorganized in traditional literature reviews, is handled as a whole, and a link is established between the topics discussed to create a synthesis in the end (Baumeister & Leary, 1997).

Distance Education

Distance education is continuously increasing its impact on education and training environments. This has caused traditional education applications to be replaced by technology-based online applications (Galante, 2002). Distance education is a form of learning that is structured independently of the time and place of students, instructors, and curriculum and is structured with a systematic approach (Gunawardena & McIsaac, 2013). In another definition, it is the whole of formal education in which the learner and instructor are in different physical environments, bringing together the learner and instructor with information and communication technologies on a common platform (Simonson et al., 2003). In other words, it can be defined as a learning process in which students benefit and stay away from the learning source regardless of the time and place and where the interaction is carried out with remote and online systems (Özkul & Aydın, 2016).

Distance education is structured learning where students and instructors are separated by place and sometimes by time. It can also be defined as the fastest-growing form of education today. The concept, which was once considered a special form of education using non-traditional education systems, is now becoming an important concept at the center of education. Concepts such as networked learning, connective learning areas, flexible learning, and hybrid learning systems have expanded the scope and changed previous distance education models. Courses developed in the web environment are now regarded as traditional programs that have become a competition for those who want to attend any training with the perspective of “anytime, anywhere” (Gunawardena & McIsaac, 2013).

In the literature, the concept of distance education also appears as distance learning, e-learning, and virtual learning. Simonson et al. (2003) emphasize four basic elements in distance education, which are as follows:

1. Distance education is a formal education conducted by an institution.
2. Instructors and learners are separated from each other in terms of space or time, or both time and place.
3. Education is carried out synchronously and asynchronously using information and communication technologies.
4. Learning Management Systems (LMS) are used.

History of Distance Education

The distance education process, which started with stenography courses by sending letters in the USA, continues to be carried out and developed with virtual classes on the internet and web today (NEA, 2000). In Figure 1, the periods and stages of distance education are shown. In the literature, there are other researchers who evaluate these phases and periods differently (Casey, 2008, Moore & Kearsley, 2011).

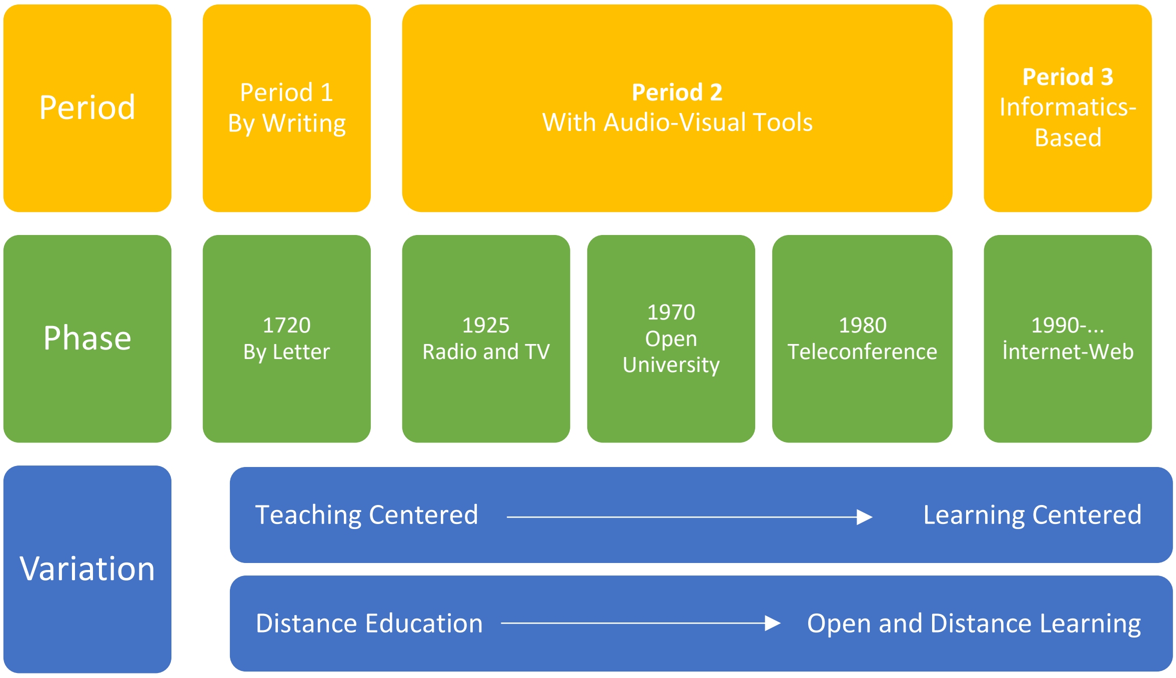

Figure 1. Periods, phases, and variations in distance education (Bozkurt, 2016)

Currently, distance education, which is carried out based on information and communication technologies, has taken a completely different form from its earlier form in the 1990s. One of the most important developments in this regard is synchronous virtual classrooms. Virtual classrooms are environments where instructors and students, who are physically separated, teach their lessons synchronously. Applications such as Adobe Connect, Microsoft Teams, Big Blue Button, and Zoom are the most preferred software with virtual classroom support today. Through such software, courses are taught synchronously, and when necessary, permissions and arrangements are made, asynchronous use of the course is provided. Many operations (right to speak to students, file sharing, etc.) done in traditional classrooms can also be done in virtual classrooms (McBrien et al., 2009; Schullo et al., 2007).

The worldwide interest and spread of distance education, which is greatly affected by the rapid development of technology, is theoretically attributed to five reasons (Cavanaugh, 2001; Oblinger, 2000), which are listed as follows:

1. Extending access
2. Providing students with flexibility
3. Reducing costs
4. Reaching different markets
5. Appearing in the form of adapting new technologies and methods

Synchronous and Asynchronous Learning

Distance education consists of two learning models: synchronous and asynchronous (Midkiff & DaSilva, 2000). Synchronous distance education is the participation of instructors and students in educational activities from different places simultaneously. In this model, there is a mutual interaction. Training occurs live. In asynchronous distance education, instructors and students participate in educational activities both in different places and in different time periods. In this model, students can benefit from teaching materials whenever they want. A basic comparison of the synchronous and asynchronous models was made in Figure 2 (Margaret, 2022).

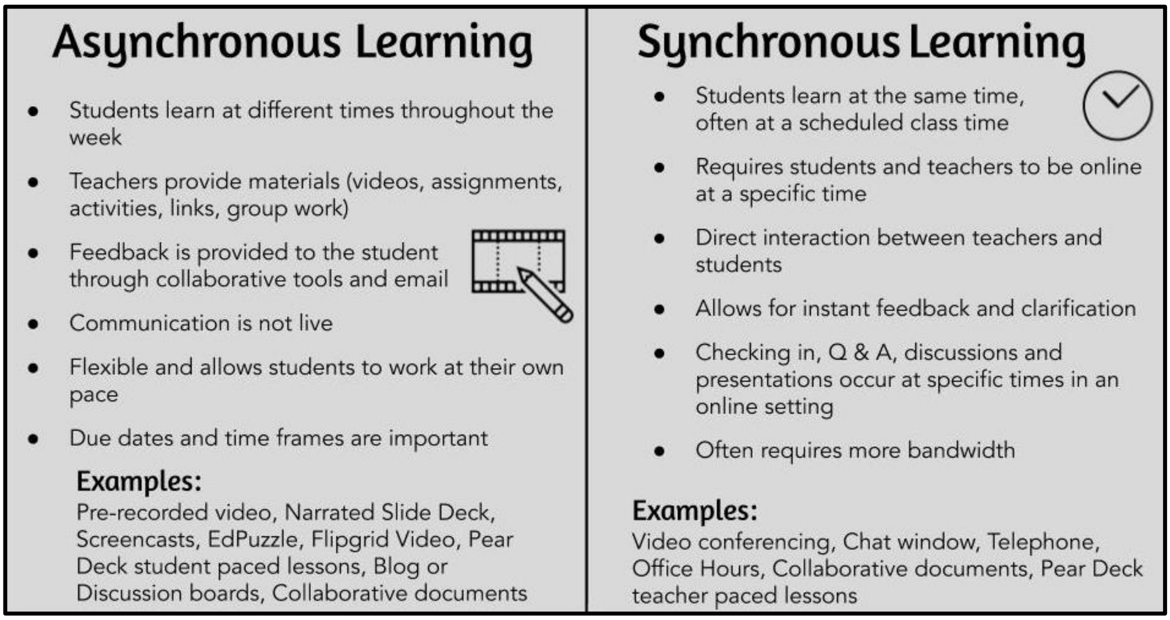

Figure 2. Asynchronous vs. Synchronous Learning

Effective implementation of synchronous and asynchronous training is directly related to when, why, and how to use it. Planning complementary face-to-face meetings together with synchronous methods (video conference, message, etc.) in discussing complex issues could contribute to the effective execution of educational activities. However, the asynchronous model is more effective for discussing complex issues that require time. Virtual environments such as email, discussion boards, and blogs can be used in such cases. Table 1 presents summary information on when, why, and how to use the synchronous and asynchronous learning model.

Table 1. When, why, and how to Use Asynchronous vs. Synchronous E-Learning (Hrastinski, 2008)

	Asynchronous E-Learning	**Synchronous E-Learning**
When?	• Reflecting on complex issues • When synchronous meetings cannot be scheduled because of work, family, and other commitments	• Discussing less complex issues • Getting acquainted • Planning tasks
Why?	• Students have more time to reflect because the sender does not expect an immediate answer.	• Students become more committed and motivated because a quick response is expected.
How?	• Use asynchronous means such as email, discussion boards, and blogs	• Use synchronous methods such as video conferencing, instant messaging, and chat, and complement face-to-face meetings.
Examples	• The students expected to reflect individually on course topics may be asked to maintain a blog. • The students expected to share reflections regarding course topics and critically assess their peers' ideas may be asked to participate in online discussions on a discussion board.	• The students expected to work in groups may be advised to use instant messaging as support for getting to know each other, exchanging ideas, and planning tasks. • A teacher who wants to present concepts from the literature in a simplified way might give an online lecture via video conferencing.

Blended Learning

Recently, the blended learning model has been widely used besides the synchronous and asynchronous learning models. Blended learning is an approach used to combine the strengths of face-to-face and online learning to develop the knowledge and communication skills necessary for success (Lindquist, 2006). This type of learning aims to increase the quality of education by combining traditional education with technology (Harriman, 2004). A schematic version of blended learning is presented in Figure 3.

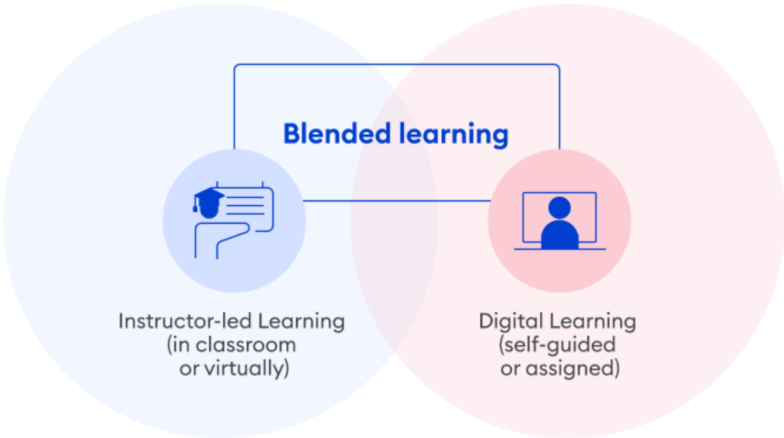

Figure 3. Blended Learning (Kolinski, 2022)

One of the important advantages of distance education is that it offers an adaptable learning environment. In this respect, it is important to consider individual differences regarding learning in distance education and offer learning options that can address individuals' learning styles. Distance education, in which adaptations are made to meet the individual learning needs of each user in line with information such as the individuals' preferences, prior knowledge, attitudes, and skills, is also crucial in terms of assessment and evaluation (İnan et al., 2016).

Component of Distance Education

It is seen that distance education is investigated from different perspectives in terms of components. One of the previous studies was conducted by Demir (2014). According to the researcher, distance education consists of four components. Figure 4 shows the basic components.

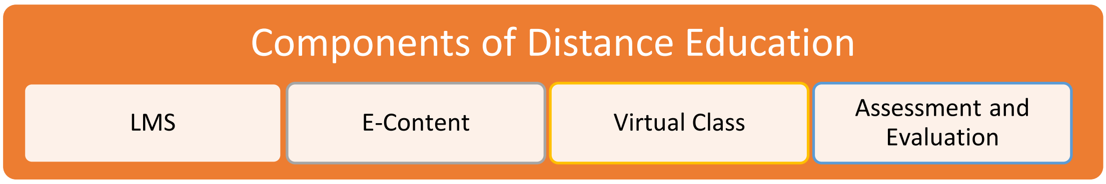

Figure 4. Components of distance education (Demir, 2014)

Assessment and evaluation are also important in distance education, as in traditional face-to-face education, in planning, directing, and measuring the success of education (Demir, 2014). In the context of distance education, assessment and evaluation tools offer more alternatives than traditional assessment tools (Demir, 2014; Simonson et al., 2003). Besides, the fact that instructors and students are in different environments in online exams has brought about reliability and validity discussions (Gül & Doğan, 2011; Karahocagil et al., 2021).

Assessment and Evaluation in Distance Education

Technology, which affects every component of education, has also, directly and indirectly, impacted the assessment and evaluation process. One of the most notable outputs of this effect is that traditional pen-and-paper assessment and evaluation activities are easier and less error-prone through online applications (Bayrak & Yurdugül, 2015). Online assessment and evaluation applications tend to be used increasingly with the rapid development of computer and mobile technologies and the increase in internet connection speed (Başol et al., 2017). Many educational institutions have taken initiatives in this direction on behalf of the sustainability of education for possible force majeure reasons.

Assessment is at the center of the learning process (Baki & Birgin, 2002). Hence, the evaluation of education given is as important as the presentation of education and training in distance education. Here, we come across the concept of assessment and evaluation in distance education. Assessment and evaluation in distance education are defined as the online evaluation method of educational activities conducted with distance education (Bozkurt & Tekedere, 2013). Online assessment and evaluation are not different from traditional assessment. Assessment techniques used in traditional teaching environments can be easily applied to online assessment environments (Cabı, 2016; Donovan et al., 2007). However, there are some important points to highlight here. One of the biggest mistakes is transferring the pen-and-paper exams to the online environment as they are. Online exams should not be evaluated as in traditional assessment and evaluation tools. Instead, it is important to use assessment tools and techniques appropriate to their nature.

Assessment and evaluation in distance education are categorized into two groups: formative and summative, as in face-to-face education. While formative assessment includes assessment tools such as homework, peer assessment, self-assessment tests, and exam preparation tests, summative assessment consists of final exams, homework, or activities that affect the achievement grade (Karadağ, 2014). All these assessment and evaluation activities are carried out in online environments. These activities offer quite different alternatives for summative evaluation. Another grouping includes formal (quizzes, homework, etc.) and informal (Emails that provide feedback, etc.) evaluation processes (Gunawardena & Lapointe, 2003).

As in all teaching activities, the main function of assessment and evaluation is to bring learning to better levels and increase the effectiveness of teaching (Şimşek, 2011). For this reason, it is critical to conduct an assessment and evaluation with techniques and methods suitable for its purpose. Assessment and evaluation techniques in distance education are discussed under two headings.

1. Traditional assessment and evaluation techniques
2. Alternative (Complementary) assessment and evaluation techniques

The comparison between traditional and alternative assessment and evaluation techniques is given in Table 2.

Table 2. Traditional vs. alternative assessment (Bailey, 1998)

Traditional Assessments	Alternative Assessments
One-shot tests	Continuous, longitudinal assessment
Indirect tests	Direct tests
Inauthentic tests	Authentic tests
Individual projects	Group projects
No feedback provided to learners	Feedback provided to the learners
Speeded exams	Untimed exams
Decontextualized test tasks	Contextualized test tasks
Norm-referenced score interpretation	Criterion-referenced score interpretation
Standardized tests	Classroom-based tests

Detailed information on some of the traditional and alternative assessment and evaluation techniques is given below (Atılgan et al., 2019; Bahar et al., 2015; Kutlu et al., 2017; MoE, 2007).

Traditional Assessment and Evaluation Techniques

- **Multiple choice questions:** They consist of a question sentence and a correct answer with more than one distractor for the question.
- **True or false questions:** These are questions in which a statement is true or false according to the available information.
- **Matching questions:** These are the questions that include a list of instructions, a list of statements, and a list of answers to be connected to the statements for matching, and the statements and answers are asked to be matched with each other in accordance with the instructions.
- **Fill-in-the-blank questions:** These are the questions that are asked to write the short sentences or words that are expected to exist in the given expression and that are not written in the blank spaces in the expression.
- **Short answer questions:** These are questions answered with a word, a sentence, or a symbol.

- **Long-answer questions:** These are the questions in which long written answers are collected regarding the statement given in the form of one or more sentences.

Alternative (Complementary) Assessment and Evaluation Techniques

- **Concept maps:** It is a technique based on students' associating their existing knowledge with newly learned information, making connections between information, and expressing them visually.
- **Diagnostic branched tree:** It is a technique in which another true-false question form linked to the chosen answer is presented depending on a question statement given as true-false, and new questions are presented depending on the answers.
- **Word association:** It is a technique in which the words evoked by a keyword presented on a topic within a specified short time are taken as a response.
- **Project:** A detailed study covering achievements on a presented research topic, individually or as a group, with broad research content and long-term and progressive evaluation processes.
- **Drama:** It is the process of displaying a concept or sentence through improvisation or play and restructuring the concept in line with the available information.
- **Demonstration:** This is a technique based on the students' practical presentation and explanation of an event or situation.
- **Structured grid:** It is a technique based on placing the answers to more than one question in a table by the instructor, the answers of which are related to each other, and testing skills such as ordering, linking, associating, and selecting the answers to the questions from the table.
- **Product selection file (portfolio):** This is a technique in which different works carried out by the student on one or more subjects are combined and evaluated in a purposeful, meaningful, and specific order.

In countries such as Turkiye, assessment and evaluation, which is seen as a determining part of education rather than being an integral part of it (Özkan & Turan, 2021) and always a controversial subject, has become even more controversial with its inclusion in distance education (Güvendir & Özkan, 2021). Assessment and evaluation as an important part of the education process cannot be carried out effectively enough in distance education (Ocak & Karakuş, 2022). A reason for this situation is the insufficient level of knowledge about how to perform the online assessment and how to monitor student performance (James, 2016). To overcome this deficiency, the determination of learning goals and the determination of criteria to measure them are the first elements (Robles & Braathen, 2002). Another is distrust of online exams.

Online Exams

Online exams, which are frequently used in distance education activities, are system components in which learners answer various questions prepared by an instructor on a platform (generally LMS). They can be taken anywhere and anytime via any smartphone, tablet, or computer with internet access.

Student achievement in exams is accepted as one of the important indicators of education quality, which is affected by many factors. One of the most important of these factors is the exam environment. This is a critical factor for student performance. (Duart, 2000). The other factor is the assessment method. Brown et al. (1999) state that the assessment method significantly affects student learning. DeSouza and Fleming (2003) suggest that students who took an online exam were more successful than students who took the same exam in print in the classroom, thanks to immediate assessment and feedback. However, there are different arguments on this topic. Some studies have indicated that the exam environment has no effect on academic achievement (Solak et al., 2020; Yağcı et al., 2015).

Online exams have brought some negative effects as well as many positive effects. One of the most fundamental issues about online exams is exam security (Karahocagil et al., 2021; Solak et al., 2020). Many researchers suggest that online exams have validity and reliability problems, which is a major obstacle to fair evaluation (Güvendir & Özkan, 2021; Rossiter, 2020). There are also studies in the literature claiming the opposite (Shraim, 2019). Tümer et al. (2008) consider online exams to be at least as successful as pen-and-paper face-to-face exams and argues that they not only facilitate the teaching process but also increase the quality. Shraim (2019) claims that online exams are more useful on the conditions that necessary precautions should be taken.

The biggest criticism of online exams is that they are suitable for academic irregularities such as cheating and plagiarism, as the exams are not under any supervision. There appear to be some studies confirming this concern. As a matter of fact, Rossiter (2020) revealed that academic irregularities in online exams due to the COVID-19 epidemic were approximately 40% more than the previous year. Another study suggested that the probability of cheating in online exams is four times higher than that in face-to-face exams (Watson & Sottile, 2010). Another criticism is of authentication. Online exams are found to be insufficient for verifying students' identifications (Flior & Kowalski, 2010).

Positive Effects of Online Exams

Knowing the positive effects of online exams on students and instructors is among the important factors in the effective execution of assessment and evaluation. Many studies have reported the positive effects of online exams (Anderson et al., 2005; Dommeyer et al., 2004). Zakrzewski and Bull (1998) state that online exams have three important advantages: time independence, place independence, and instant feedback. Some of the positive effects of online exams used in the distance education process for both students and instructors are given below:

1. Cost and time savings (Callı et al., 2003)
2. Archiving and reuse of question banks (Callı et al., 2003)
3. Minimization of assessment errors (Solak et al., 2020)
4. Obtaining objective results (Anderson et al., 2005)
5. Instant announcement of results by administering exams easily (Kuhtman, 2004; Yağcı, 2012)

6. A rich display of information with the integration of multimedia elements into exams (Liu et al., 2001; Luecht, 2001)
7. Facilitating the work of the instructors (Dommeyer et al., 2004)
8. The opportunity to always access and apply the exams (Başol et al., 2017)
9. Writing of comprehensive question banks (Natal 1998)
10. Suiting to new teaching approaches (Gül & Doğan 2011)
11. Providing variety and originality for assessment (JISC, 2010)
12. Follow-up of the learning process and correcting the misconceptions thanks to the instant feedback (Başol et al., 2017)
13. Being supportive of learners with latency and difficulty or incompleteness (Başol et al., 2017)

Negative Effects of Online Exams

In addition to the positive effects of online exams, the negative effects and disadvantages should be well studied. Considering the existing disadvantages when instructors prefer online exams will also prevent potential problems. Some negative effects and disadvantages of online exams are listed below:

14. It is necessary to have sufficient information technology equipment and internet infrastructure (Başol et al., 2017; Marriott & Teoh, 2019)
15. For some exams, it takes time to prepare the questions and the question bank online (Çiğdem & Tan, 2014)
16. Setting up, operating, and managing the online system requires significant budgets and time (Debuse & Lawley, 2014; Dommeyer et al., 2004; Wirth & Klieme, 2003)
17. Introducing the online system to users may require additional effort and time (Debuse & Lawley, 2014)
18. Although various technologies are used to monitor exam takers and prevent cheating in the online environment, the process of surveillance and exam

security is very challenging (Duart, 2000; Kumar & Rathi, 2019; Solak et al., 2020)

19. Momentary malfunctions may occur in the system, the exam process may be interrupted, and exams may remain incomplete (Marriott & Teoh, 2019)
20. Students had to control non-exam skills such as screen reading, using time, and preparing an exam environment at home rather than using a pen and paper. They must deal with the negativities related to the conduct of the exam rather than the content of the exam (Ocak & Karakuş, 2022).

Figure 5 summarizes the advantages and disadvantages of online exams.

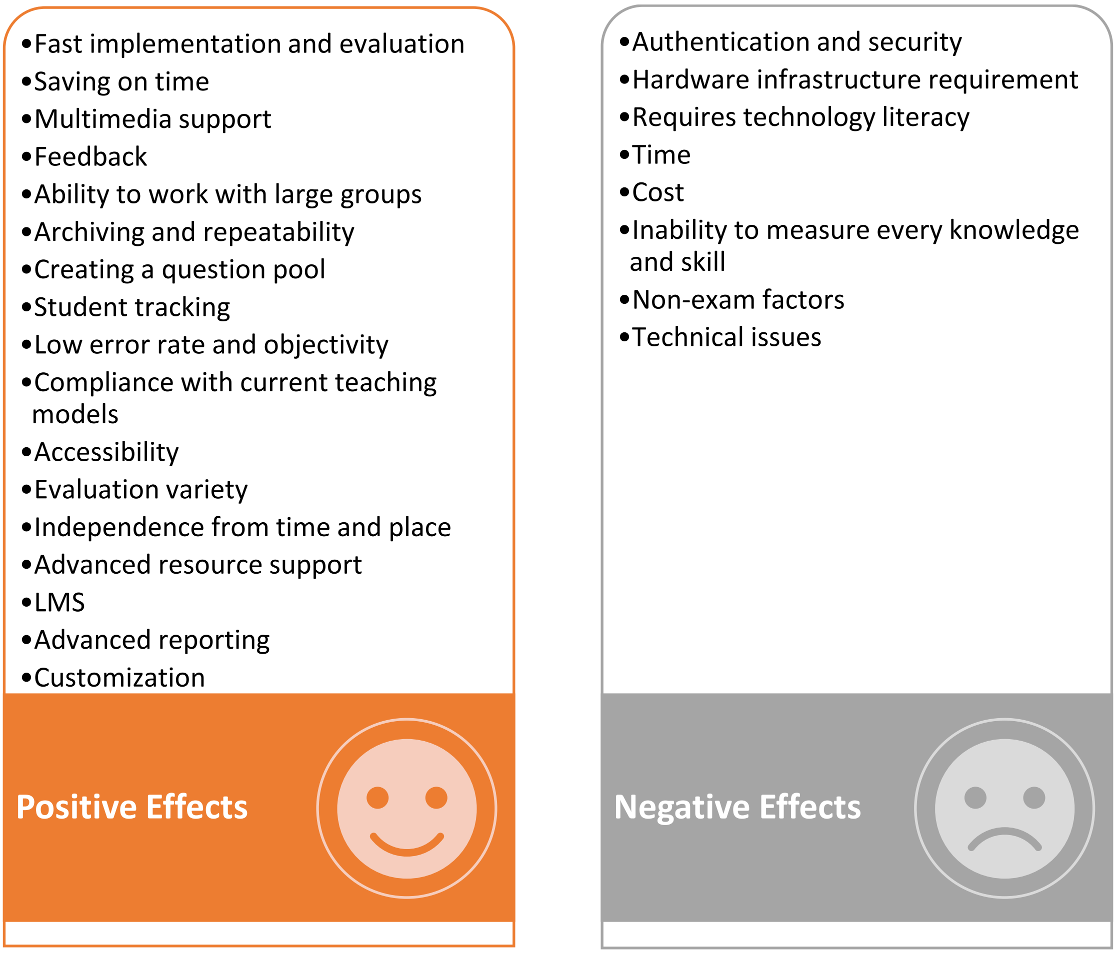

Figure 5. Positive and Negative Effects of Online Exams

Academic Misconduct (Copying and Cheating)

An issue that educators complain about the most in online exams is academic misconduct. In the literature, numerous studies have dealt with this concern (Alwi & Fan, 2010; Özen, 2016) and found the justification for these concerns (Ebaid, 2021; Hillier, 2014; Lanier, 2006; Rossiter, 2020; Watson & Sottile 2010). To this end, King and Case (2014) showed that 74% of students believe that cheating in an online exam is very easy or somewhat easy. Another study showed that students' ability to access electronic resources quickly with technology positively affects their attitudes toward cheating in online environments (Khan & Balasubramanian, 2012). In that study, 37.5% of the students admitted that they cheated in the exams made with paper and pencil, and in online environments, this rate rose to 78%. Student behaviors that threaten security in online exams can be listed as follows (Flior & Kowalski, 2010; Yılmaz et al., 2022):

1. Switching to another browser during the exam
2. Opening another browser simultaneously
3. Using printed sources at the time of the exam
4. Benefitting from other devices along with their devices
5. Other people taking the exams instead of themselves
6. Using fake camera image software

The above-mentioned academic misconduct attracts more attention since instructors and students are in different environments (Ramu & Arivoli, 2013). As a matter of fact, cheating and plagiarism, which are described as academic irregularities, are not new concepts brought about by distance education and online exams. When such academic irregularities are evaluated more generally, they are undesirable situations that have existed and will continue to exist in education (Lin & Wen, 2007).

Some measures to be taken could help prevent possible academic misconduct. These measures can be categorized into two:

1. Measures to be taken with an online exam design
2. Technology-assisted measures

The online exam design is more important than technology-assisted measures. Such negativities are less experienced in online exams prepared by instructors effectively and carefully. In addition to this, screen sharing can be prevented, questions come sequentially, one entry right, and time restriction can be suggested as other measures (Guvendir & Özkan, 2021). In addition to multiple-choice test-type evaluations, alternative evaluations, such as product files, can be included in the process (Robles & Braathen, 2002). Hence, various performance evaluations, including exams, should be used to ensure quality in distance education (Pekcan & Toraman, 2022). Such measures can contribute to the solution of problems that may occur in the process.

Balta and Türel (2013) propose using performance-oriented assessments to prevent academic misconduct. In this direction, they recommend that the assignments be designed in stages, not all at once. The gradual requesting of homework and projects prevents unethical behaviors and ensures that the instructor has a great command of the assignment. Additionally, this application offers an opportunity for the instructors to get to know the students. Another similar suggestion is that online exams are not conducted as a single end-of-term exam (summative assessment) but as a formative assessment to measure learning throughout the process (Shraim, 2019).

Improving the hardware, software, and technology infrastructure to ensure exam security in online exams is among the solution suggestions (Al-Shalout et al., 2021). One of the biggest problems with online exams is that students involve other people in exams instead of themselves. Kınalıoğlu and Güven (2011) claim that this problem can be prevented with systems with video, camera, or face recognition. However, technological measures such as these cannot be used by all institutions due to their high costs. At this point, open-source software can be used (Proctoring software, etc.). According to Gunasekaran et al. (2002), online exams should be supervised and face-to-face to avoid high costs. However, it will not be a practical application in force majeure situations such as COVID-19 or when it requires learners to be in different environments. In addition, this approach is not suitable for distance education. Although studies are conducted in the context of authentication in the literature (Hylton et al., 2016; Kumar & Rathi, 2019), it does not seem to have widespread use.

A disadvantage of supervised online exams used for authentication is that students must have the hardware, internet infrastructure, and technology usage skills. However, rural regions have weaker technological infrastructure than central regions, which might create victimization for the student and cause inequality of opportunity. Another problem is that students from lower socioeconomic levels may not have the computer, smartphone, or even the internet required by the examination system. Additionally, it is another problem that the possible system or user-related technical problems cannot be solved instantly. It is of great importance for a smooth assessment and evaluation that the institutions that decide on video verification in this regard produce alternative solutions at these points.

Conclusion

Distance education has started to be used widely, especially after the COVID-19 pandemic, which emerged in the world in 2019 and caused a break in face-to-face education almost worldwide. In this process, assessment and evaluation activities, which are indispensable components of education, were also affected, and face-to-face exams began to be held online. During this period, online exams were used extensively. Although online assessment and evaluation methods, which offer more alternatives than the assessment and evaluation methods used in face-to-face education, provide many conveniences and opportunities, such as multidimensional evaluation and time and space independence in group work, they have also brought some negativities. Some of the primary disadvantages of online exams include issues such as hardware, software, and internet infrastructure requirements, the time-consuming nature of preparing questions, budget and time requirements for managing and operating online systems, challenges in the prevention of cheating in online exams exam, the difficulty of ensuring the security of the system, momentary malfunctions that may occur in the system and interruption of the exam process, are a requirement of more preparation than face-to-face education.

The main advantages of online exams, which is one of the online assessment and evaluation methods, can be summarized as cost and time savings, archiving and question banks, minimum measurement errors, objective results, easy application, fast results, use of multimedia elements, and tracking of student achievement. As a result, efforts to minimize the disadvantages of online exams, which continue to become widespread, should be continued, and it should be used as an assessment and evaluation method with a design suitable for the content of education, considering the advantages it provides.

The increase in the number of scientific research and projects to be carried out in the context of online assessment and evaluation is of great importance in revealing the current situation. Finally, it is clearly seen that online exams could be widely used in the future. For this reason, it is vital that all stakeholders in education prepare themselves in this direction and adapt to such technologies.

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Student Respond Systems (SRSs)

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Introduction

Student Response Systems: Instructional Technologies

Clickers, also known as Personal Response Systems (PRS), Student Response Systems (SRS), and Automated Response Systems (ARS), are one of the powerful interactive technologies in the classroom that can be used to encourage active learning (Bojinova & Oigara, 2011; Martyn, 2007; Chien, Chang & Chang, 2016). They are small transmitters that look like a television remote controland they allow students to quickly answer questions presented in class. This technology, which has been in development since the 1960s (Judson & Sawada 2002), allows the instructor to pose questions to a class using electronic presentation software such as PowerPoint. Questions are usually prepared in multiple choice or true/false formats (Aljaloud, Gromik, Kwan & Billingsley, 2019). When students answer the questions, the clickers' codes appear on the screen and students know their answers are recorded. A computer summarizes the responses and the results are automatically displayed in graphic form, usually a histogram. Depending on the teacher's preference, the answers can be shown anonymously or the teacher can view which students the answers belong to. Student Response Systems devices may differ in terms of use. Students can use a special device such as a remote control, their computer or cell phone, to answer questions. These response systems consist of three parts;

1. Clickers (small remote control-like devices used by students)
2. Receivers (which receive Clickers' signals),
3. A software program installed on the teacher’s computer

Clickers emit infrared signals that are received by a receiver and sent to the teacher’s computer. (Meedzan & Fisher, 2009). After the questions are answered by the students using one of these various devices, the student answers are immediately displayed on the screen for everyone to see, thus allowing students to receive corrective feedback on their answers and compare their answers with the answers of their peers (Blood & Gulchak, 2012).

Clickers increase classroom interaction and can be used with adults or young learners. When they are used, the rate of answering difficult multiple-choice questions is higher than traditional in-class methods. In addition, it was seen that students who answered using clickers were more honest in their answers (Stowell & Nelson, 2007). More interestingly, students who use clickers during class perform better on exams and tests than students who don't use these technological devices (Kennedy & Cutts, 2005; Morling et al., 2008; Shaffer & Collura, 2009).

Clickers have received great attention in the educational technology literature, and their use in college classrooms has increased significantly (MacGeorge et al., 2007). Some research studies have shown that Clickers are useful tools for engaging students in active learning during lessons, improving students' overall communication, and helping instructors create a more student-centered classroom environment (Beatty, 2004; Caldwell, 2007; Draper & Brown, 2004; MacGeorge et al., 2007). It is known that they yield many positive results in terms of curriculum and student outcomes. Some studies show that personal response systems, when used as a teaching strategy, are effective in motivating students to participate in clasrrom activities and learn the subject matter (Debourgh, 2008; Hatch, Jensen & Moore, 2005; Moredich & Moore, 2007; Skiba, 2006; Stein, Challman & Brueckner, 2007).

Over the past 20 years, the technology used on university campuses has expanded from overhead projectors and videotapes to comprehensive multimedia presentations that include laptops, LCD projectors, online tests, and personal response systems such as Clickers (MacGeorge, et al., 2008; Stowell & Nelson, 2007). The results of a research revealed that the new technological possibilities of Clickers can be used to improve the questioning and feedback skills of instructors (Trees & Jackson, 2007), to motivate and monitor student participation (Stowell & Nelson, 2007), to encourage discussion of important concepts (Brickman, 2006) , and to activate students' thoughts (Collins, Moore & Shaw-Kokot, 2007). It is clear that student response systems technology is one of the most promising ways to make classrooms more learner, knowledge, assessment and community centered (Bransford, Brophy, & Williams, 2000). Using clickers can be especially useful in long lessons or at the end of the day when students and lecturers are tired.

Research in educational technology shows that the use of Clickers also improves the interactive atmosphere in the classroom (Laurillard, 1993). When used correctly, this technology can improve the quality of learning outcomes in lessons by increasing students' interaction and engagement with their instructors and peers, resulting in a remarkable transformation in the classroom (Bojinova & Oigara, 2011).

Clickers can improve reflection and understanding for students when used with small group discussions (Brewer, 2004; Brickman, 2006). Similarly, Draper and Brown (2004), in a multidisciplinary study on clickers usage, draw attention to several advantages of Clickers; lessons are more fun, anonymity allows students to answer without the risk of embarrassment, students can check that they understand the material. The use of clickers makes learning more exciting and encourages students to think about their own learning process and to understand the subject of the lesson. Thanks to these devices, students immediately respond to questions asked during the lesson. Considering the answers given by the students, a discussion activity is started by the teacher about the lesson topic. Thus, it is ensured that students learn the information and integrate their own knowledge with other ideas (Debourgh, 2008).

Active Learning and Student Response Systems

Faculty members at universities have shifted their pedagogical focus from traditional teaching methods to active learning strategies. Strategies to encourage students' participation in higher-order thinking such as analysis, synthesis, and assessment are essential elements of active learning, unlike traditional lessons (Bonwell & Eison, 1991). Active participation requires students not only to express their ideas orally or in writing, but to turn their thoughts into action (Bonwell & Eison, 1991). At this point, Clickers is an important active learning tool that allows students to work actively in collaboration. In this way, students interact and work together to achieve a goal (Barkley, Cross & Major, 2014; Handelsman et al., 2004; Kirschner, Paas & Kirschner, 2009; Yoder & Hochevar, 2005).

The use of Clickers effectively transforms didactic teacher-centered learning environments into interactive student-centered learning environments. Thus, it encourages student-faculty interaction, ensures cooperation between students, increases the retention of knowledge, provides rapid feedback, and ultimately improves active learning (Meedzan & Fisher, 2009). Clickers can provide more efficient learning compared to some active learning methods such as class discussions. In a normal classroom discussion, only one or two students have the opportunity to answer a question. Even if the answer is correct, the teacher has no way of measuring whether the other students know the correct answer. In class discussions, a student who is unsure of his own answer may avoid answering because he does not run the risk of being wrong (Martyn, 2007). However, since all students have the opportunity to respond in activities using Clickers, all given answers can be seen by the teacher.

Trees and Jackson (2007) conducted a study of the use of Clickers in large classrooms and concluded that students benefited most from Clickers exercises that encouraged student engagement. The results of the researches support the use of Clickers as they increase the active participation of the students, strengthen the measurement and testing practices and develop active learning environments. With the use of Clickers, instructors can effectively use active learning techniques in much larger classes, such as those done in small classes. In addition, active learning environments can be developed and student participation can be increased by methods such as collaborative work, group discussions, case studies or directed small group activities (Stowell & Nelson, 2007; Tivener & Hetzler, 2015).

Clickers can increase students' focus, engagement, and interaction by allowing their active participation even in large classrooms. Students use Clickers to respond to the teacher's questions and can see an anonymous summary of the class's responses in real time. Teachers can view individual student responses at any time to individually assess a student's performance or participation (Chien, Chang & Chang, 2016; Lantz, 2010).

Teaching and Learning with Clickers

Teaching with Clickers

In a standard lesson, there is often a large amount of information, terms, or concepts that students need to learn. Students can sometimes get confused in determining what they need to learn from so many concepts and miss the main message. In such cases, Student Response Systems can be used effectively to help students become aware of the main theme and content of the lesson. Clickers questions highlight critical information for students and draw students' attention to key ideas. As a result, when teachers use student response systems to highlight main ideas, it can help clarify key concepts and prevent students from accidentally learning or memorizing incorrect information (Blood & Gulchak, 2012).

In addition to directing students' attention to the actual learning objectives of the course, Clickers can also be used effectively to review the main themes or ideas of a course and ensure that they are learned. In order to do this successfully, first of all, the main ideas of the course and the basic concepts that are expected to be learned must be clearly defined. Then, true-false or multiple-choice Clicker questions should be prepared in accordance with these concepts. These prepared questions are presented to the students at a time that seems appropriate during the lesson and they are asked to answer them. Answers can be shown to students after students have been given enough time to respond. Thus, students can get instant feedback on whether their answers are correct on the main ideas and themes of the lesson. If most of the questions are answered correctly, it is possible to move on to teaching the next concepts, as it shows that the whole class has achieved these goals. However, if more than half of the class give wrong answers, the topics can be repeated to make up for these deficiencies, as this shows that the targeted concepts are not understood (Blood & Gulchak, 2012).

Student response systems can be used to facilitate five existing principles of teaching: (1) uncovering student feedback, (2) identifying students' prejudices and assumptions about course material, (3) holding small and large group discussions, (4) promoting social cohesion in the learning community and (5) collecting anonymous data from students to support conceptual practice. (Dong et al., 2017)

About collecting student feedback to improve learning and teaching, the use of Clickers makes it less time-consuming to collect and interpret students' responses, and unlike paper-based methods, Clickers data provides quick and immediate feedback useful for formative assessment. Students can see their own and their peers' answers, and productive group discussions can be made about why students gave these answers. To identify students' assumptions or biases about course material, Clickers can be used to gather information about students' opinions, assumptions, or behavioral expectations that may affect teaching and learning processes. Compared to answering a question by raising a hand, Clickers are an anonymous and more efficient way of collecting data about what students expect and know about the subject.

Clicker histograms visually depict students' views and can be used to engage students in critical discussions. Second, when students are asked about their views on a topic or their past experience, students are expected to give more honest answers as the answers will be given using Clickers and the answers will be displayed anonymously (Dong et al., 2017). Students can give any answer they want using Clickers, and the variety in the group's responses when the answers are shown provides an excellent "starting point" for critical thinking and discussion activities (Mollborn and Hoekstra 2010). Teaching methods that use active learning, such as small group and classroom-wide discussion methods, often result in better student learning than traditional methods in which students play more passive roles (Bruff, 2009, p. 24). Moreover, Clickers can be used effectively to promote social cohesion in the classroom. First, by viewing the data of responses using Clickers over time, information sharing among group members increases. Finally, anonymous data about students' beliefs or experiences is perhaps most efficiently collected through Clickers (Dong et al., 2017).

According to Crossgrove and Curran (2008); the great thing about Clickers is that it helps instructors quickly know how well students understand a topic. As a result of determining the wrong answers received, the learning deficiencies of the students can be detected quickly. Thus, the teacher has an opportunity to compensate for misunderstandings and can correct learning deficiencies. The use of these devices not only informs the teacher about the incomplete learning of the students, but also allows the students to recognize their deficiencies by seeing their own wrong answers (Lantz, 2010).

Students can achieve more meaningful learning by using student response systems. The Peer Instruction (PI) mentioned here provides a simple and effective model for developing inquiry strategies. In this model, a question is asked by a teacher, students respond to that question by using their clickers, a histogram of student responses is displayed, students discuss with their peers for 2-3 minutes to justify their answers, students are given a second opportunity to respond by using their clickers, and a second histogram is prepared showing the students' responses after the discussion. Finally, the lecturer gives the correct answer. If the responses from the second histogram reflect limited understanding of the concept, the lecturer can then adapt the discussion to further discussion or provide further examples (Jones et al., 2012). If the results show that 75% of the answers are correct when the first answers are received, the teacher can see that this subject is understood, and can move forward in the lesson faster and focus on new subjects by passing the learned subjects (Anderson et al., 2011; White et al., 2011).

Promoting Classroom Participation with Clickers

Teachers use a wide variety of methods and techniques to ensure active participation of students in lessons. The common purpose of all of them is to enable students to participate in the lessons more actively and effectively and, as a result, to help their learning be more permanent. Clickers, also known as student response systems, are one of the systems actively used to encourage student interaction and participation in lessons (Bachman & Bachman, 2011; Cain et al., 2009; Hoyt et al., 2010; Sevian & Robinson, 2011; Dong et al., 2017).

Research shows that student achievement, attention, and behavior improve when students are given multiple opportunities to respond to teacher-created questions during instruction. Accordingly, student response systems offer a creative way to incorporate technology into teaching and increase the opportunity for all students in a classroom to answer questions. All students are more likely to answer questions when student response systems are used in classrooms. Because, in this process, all students can answer at the same time with the answering tools they have, instead of giving them a word to answer one by one. Similarly, some other research shows that the use of student response systems leads to increased student engagement, learning, and response rates. In addition, student response systems are seen positively by both teachers and students and are believed to increase participation and interest in classroom activities (Blood & Neel, 2008; Blood & Gulchak, 2012).

Students learn better when they are active in cognitive processes, that is, their success increases as their active participation increases (Shernoff & Hoogstra, 2001). The increase in the participation of the students with the Clickers questions is an indication that the success of the students will also increase. Some scientific reports on this subject show that the use of student response systems also improves student learning (Beekes, 2006). These studies show that students who use student response systems during lessons perform better in exams than students who do not (Kennedy & Cutts, 2005; Shaffer & Collura, 2009; Fallon & Forrest, 2011).

In classrooms, students are sometimes shy about expressing their thoughts because they are not sure of their own opinions and they do not know what their friends are thinking. In these cases Clickers can be used to overcome this problem. If you ask students a Clicker question at the beginning of a lesson about the activities they want to do in that lesson or the topic of discussion you will be discussing, it is likely that everyone, including the shy students, will answer that question. In this way, you can even involve your shy students in activities that require discussion and exchange of ideas. These shy students, who are hesitant to answer the questions asked orally through different methods, easily answer the questions asked through Clickers. Such students prefer questions that they can answer using Clickers rather than traditional questioning techniques (Lantz, 2010; Trees & Jackson, 2007). In addition, thanks to games and competitions that require information exchange within or between groups through Clickers, it can be ensured that students interact and all students express their ideas (Blood & Gulchak, 2013).

Student response systems also allow teachers to keep track of who or how many of their students are responding to questions during lessons, so teachers can continue to get answers until all or enough of their students have responded. In this way, each student is given enough time to answer the question. When a question is asked in classical classroom environments, some of their friends respond quickly, other students may not be able to complete their answers within this period. Only because of this timing problem, such students cannot attend the class in classical classroom environments. Such problems can be easily solved in classrooms where student response systems are used (Bruff, 2009).

As a result; student response systems encourage active participation in the lesson. Especially, students who are reluctant to verbal classical questions of teachers are more willing to answer these questions when they use student response systems. Some studies have shown that students are more likely to respond to their teachers' questions when they are asked to respond using clickers rather than a verbal response (Blood, 2010; Blood & Gulchak, 2012).

Enhancing Classroom Interaction with Clickers

Clickers can be used adaptively in various disciplines and levels of academic study to improve student engagement in the learning process. Increasing student engagement makes learning more customized, especially in large classroom settings, and can optimize learning outcomes. They are also an effective educational tool for promoting interactive and collaborative learning in the classroom. Clickers, by their nature, have a great potential in terms of providing the student with the opportunity to control the learning process and thus encouraging learning. They are generally used to increase student participation, which is the main goal of teachers (Buskist & Benassi, 2012; Hake, 1998; Laxman, 2011).

Clickers offer students the opportunity to think about a question and give their own answer before the question is answered by other students. In this way, student response systems often encourage students who wait for their friends' answers before giving their own answers, to give their own answers without being influenced by any of the answers. These students, who have the opportunity to express their own ideas directly, become more interested in the lesson and then become more willing to discuss with their peers. In this way, these students will be more willing to participate in large or small group discussions that may take place after the questions are answered (Bruff, 2009).

Eastman, Iyer, and Eastman (2011) have found that students are more attentive when they use Clickers, they feel more comfortable in class participation, and they enjoy the lessons more. The increase in this two-way interaction allows students to express their thoughts more and to increase information exchange among peers (Anderson, 2003; Marks, 2000). Moreover, it encourages both active collaborative learning and class participation. In other words, increasing the interaction between teacher and student also increases students' participation in the lesson (Gallini & Moely, 2003; Blasco-Arcas et al., 2013).

Even if the questions are simple, students think deeply to find the right answer when trying to answer a question using Clickers. Because thinking and reviewing background knowledge are steps that cause students to think deeply, questions answered using Clickers cause students to use these techniques during the lesson. When students use Clickers, they believe that they think and learn more in lessons (Hoekstra, 2008; Lantz, 2010).

Providing Instant Feedback with Clickers

One of the most useful uses of clickers in the classroom is that they allow instant feedback (Laxman, 2011). By providing instant feedback to students with the help of Clickers, students are involved in active learning processes and this positively affects students' success (DeBourgh, 2007). Clickers provide immediate feedback to the teacher on student motivation, interest, and student understanding of content. Students stated that Clickers helped them focus, confirm their understanding, and learn the material more effectively (Bojinova & Oigara, 2011). While answering the questions, the teacher allows students to discuss their answers with their peers before showing them the correct answer. This process provides an opportunity for collaboration, active learning, peer instruction, and interaction. It also allows students to understand which answers they consider wrong or correct and why. In brief, Clickers help the teacher get instant feedback on how well students are following the material presented in class, and potentially also encourage not only student engagement but performance. (Bojinova & Oigara, 2011).

Immediate feedback and correction of errors are very important parts of the teaching process and allow students to identify and correct their mistakes before it is too late. When the student responds to a question or activity, feedback is given when a message is sent to the student by any method about the correctness or incorrectness of this answer. In this process, with the help of Clickers, students receive instant feedback on the correctness of their answers and what other students' answers are, just a few seconds after they answer. Thus, students can instantly realize their wrong or incomplete learning and focus on the areas they think they are lacking (Beatty, 2004; Kulhavy, 1977; Lantz, 2010).

Moreover, as a result of Clickers questions, teachers can change their lesson plans and manage their lessons more effectively as a result of the feedback they receive before it is too late. For example, if Clickers results show that students understand a topic, the teacher can now move on to the next topic without wasting any more time on that topic. However, if students have deficiencies in their learning, the teacher can spend more time addressing the missing points and correcting this missing information. It is very difficult to implement such applications without Clickers, especially in large classrooms (Bruff, 2009).

Assessing Students' Learning with Clickers

Clickers can be used as assessment tools, as well as being used for different purposes in the teaching process. Students can see the exam questions prepared by the teachers with the help of slides and can answer the questions with the help of Clickers. The important thing here is that each student is given enough time to answer the questions. After the students have answered the questions, the teacher can easily evaluate the answers, taking into account different statistics. In this way, both time and paper are saved as the teacher does not have to evaluate the questions manually. In addition, by using Clickers, a pre-test can be applied at the beginning of a new lesson and at the end of the lesson, by applying the same exam as a post-test, students' learning in that lesson can be checked. Moreover, by preparing short questions about a given assignment, it can be checked quickly at the beginning of the lesson whether this homework has been done (Blood & Gulchak, 2012).

Student Response Systems (Clickers) can also be used in control of students' class attendance. In fact, it's probably not a good idea to use clickers for taking attendance per se, especially in large classes. Responses from students do not imply that the student is actually in the classroom, but rather assures that the clicker device is there. It is possible for a student who will miss the lesson to give his clicker to another student who will try to answer both students' questions in secret. While not useful for classroom attendance control, clickers can be used to administer in-class exams. Lincoln (2008) found that nearly three-quarters of students like clicker exams because they get instant feedback on their performance. Also, using clickers to assess students' retention and comprehension is effective because they provide feedback to teachers in these areas (Anderson et al., 2010). The anonymity provided by clickers can reduce students' anxiety. Moreover, honest answers and immediate feedback can increase students' hope of success in a subsequent test (Fallon & Forrest, 2011)

Providing Student Anonymity with Clickers

Students often do not volunteer to answer questions when their teachers ask them directly, as they are afraid of giving wrong answers. However, in student response systems, students do not see which answers their other friends have given, so this helps students answer questions anonymously more comfortably. Students, who are afraid of giving wrong answers in front of their peers, participate more actively in the lesson with the help of clickers questions. The anonymity provided by Clicker questions allows a wide variety of opinions to be heard in the classroom. As a result, clickers are very democratic tools in making classroom decisions or involving more students in activities (Lantz, 2010).

Student Response Systems (Clickers) encourage students to actively participate in activities and to express their understanding of the subject, thanks to the anonymous response opportunity provided by the system. It helps students overcome the fear of giving a wrong answer and, as a result, the fear of being ridiculed by the instructor or other students. Clickers encourage student discussion on the topic covered in class. This can be achieved in two ways: students can discuss possible answers on multiple choice questions with their peers and then choose the answer they think is correct, or alternatively, students can be asked to choose an answer based on their understanding of the topic. After showing the distribution of results and a short discussion with their peers, they are given a second chance to answer the same question. In addition, Clickers provides students and instructors with quick and valuable feedback on the class's overall understanding of the content material covered during the Q&A sessions. Therefore, this technology can be used as a formative assessment tool and can help instructors assess the difficulties students face in a particular subject (Bojinova & Oigara, 2011).

Making Learning Fun and Increasing Student Interest with Clickers

Student response systems are very useful tools for engaging students who prefer to remain passive and not answer questions in traditional lessons. Studies show that students' interest generally increases in lessons in which student response systems are used, and disinterested students feel more willing to participate in the lesson (Kay & Lesage, 2007). Such students mostly prefer to stay passive in the lessons because the lessons do not interest them or they do not feel motivated enough. However, it was observed that when they were asked to answer a question using student response systems, their interest increased and they felt more motivated (Elliot, 2003). In addition, thanks to the time provided by Clicker questions, students have the opportunity to rest and refresh their attention (Laxman, 2011). Student response systems make the classes more fun while making the class more interactive, allow all students to compare their knowledge with the knowledge of their other friends, and cause even reluctant students to feel included in the lessons (Lantz, 2010.). Some studies have stated that most of the students like the use of student response systems in their classrooms (Barnet, 2006).

One of the reasons why some students find classroom activities boring and feel reluctant is because they are afraid that their teachers will choose them for the answer. The stress and anxiety caused by this situation prevent these students from enjoying the lessons. At this stage, students find the lessons more interesting and entertaining as student response systems allow students to answer anonymously whenever they want (Chien et al., 2016; Stevens & Fontenot, 2017, Walker et al., 2018).

Some courses may be intense and take long periods due to their content. The intensity of the information they need to learn in these lessons and the length of the lessons can cause the students to get tired, lose their motivation and distract themselves as a result. Clickers questions, which are carefully placed in some parts of these long lessons, can cause students to rest for a short time, increase their motivation and their attention span (Cutts et al., 2004; Lantz, 2010).

As a result, students of this age are fond of using technology and Clickers are fun to use because Clickers follows the principles of game-based learning. Since twenty-first century students have grown up using computer games, short sessions using Clickers make the lesson time more enjoyable by eliminating the monotony of the lesson (Bojinova & Oigara, 2011).

Initiating Effective Discussions with Clickers

It is very important for students to participate in small group discussions during the lesson to improve their learning experience. Having students discuss a particular question with their peers is one of the most beneficial ways to involve them in the learning process. When students actively learn the subject matter, they tend to learn the material more deeply and faster. Small group discussions allow more students to actively participate in class-wide discussions. Student response systems can make small group discussions more beneficial in this regard. Students who would normally be reluctant to participate in small group discussions can express their ideas more freely through the use of student response systems and participate more in these discussion activities. Because classroom response systems allow instructors to monitor student responses, students' response to a question using clickers before or after a small group discussion creates an accountability that can encourage students to participate more seriously in that discussion (Bruff, 2009, p. 35).

With the help of the answers given as a result of the Clickers questions you asked the students in any part of the course, discussions with high student participation can be started in the classroom. In order to initiate an effective discussion environment in this way, after the students have answered the questions, some students may be asked to explain the reasons for their answers. While students explain the reasons for their answers, other peers can learn from their explanations. In particular, some of the students who gave the most preferred answers may be asked to explain their reasons. If no student volunteers in this regard, teachers can encourage students with small explanations. Students can be asked to think about the wrong answers and to explain why they might have been chosen (Bruff, 2009, p.32).

There are various uses of classroom response systems to generate and encourage classroom-wide discussions. As a typical practice for doing this, the 'think-pair-share' classroom participation technique, first proposed by Lyman (1981) and used by many instructors, can be termed a 'think-vote-share' practice when applied by using Clickers devices. Instructors who use clickers in this way first ask their students a multiple-choice question. Students reflect on the question and submit their answers using their clickers. The instructor then displays the system-generated bar graph showing the results of the question, showing how many students chose each answer option. These results, together with the exchange of ideas that students make before submitting their answers, shed light on and enhance the classroom-wide discussions implemented by the instructor (Bruff, 2009, p. 25).

During the discussion, students can be encouraged to express their thoughts about each other's answers and comments. The discussions that the students have among themselves voluntarily are much more productive than the discussions conducted under the leadership of teachers. In addition, if students touch on the main ideas of the lesson and talk about it, it should be avoided to comment on those topics again.Students learn such ideas more permanently when they discover it on their own. In this process, the answers to Clickers questions should not be disclosed immediately. This will prevent students from having a discussion about that topic. Without fully explaining the answers to the questions, students can be encouraged to continue the discussion as much as possible (Bruff, 2009, p20).

Conclusion

Student response systems are very useful tools for both students and teachers. For teachers, these response systems provide instant feedback on students' learning processes and allow them to measure how well the targeted concepts in the lesson have been learned by the students. Student response systems are also very effective tools for actively involving students in the course process, promoting student interaction, and providing students with feedback on their learning. Moreover, as students will feel more comfortable, the relationship between student and teacher will improve and students will be more willing to participate in the lessons as they enjoy the lessons more. In summary, student response systems are devices that are useful and effective in lesson processes for both teachers and students (Blasco-Arcas et al., 2013; Caldwell, 2007).

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A Digital Game-based Science Activity for Children: Stop Climate Change

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Introduction

In recent years, we see that technology and technological applications have been used effectively in many fields of education. Especially, during the novel coronavirus (Covid-19) process, students and teachers could not continue their education in an area close to the whole of the world for a long time. It has been determined that approximately 1.5 billion students cannot continue face-to-face education due to the Covid-19 (UNESCO, 2020). In this process, education and training activities had to be continued remotely. It has been greatly affected by our perspective on education and training activities during the pandemic process (Bozkurt and Sharma, 2020). The teaching of the lessons had to be moved from the concrete environment (face to face) to the abstract environment (online). For this reason, synchronous (Henriksen, Creely & Henderson, 2020) and asynchronous (Lowenthal, Borup, West & Archambault,

2020) content presentation has been used extensively in online environments during the pandemic process. Ministry of National Education (MoNE) has tried to carry out the lessons prepared within the framework of distance education activities for around 18 million students in our country through EBA TV, EBA live lessons and EBA academic support applications (Sözen, 2020). MoNE has been working on the use of digital technologies in education for a long time. In this context, the Movement to Increase Opportunities and Improve Technology (FATIH) Project started to be implemented in pilot schools in 2012. For this purpose, studies such as making internet access available to all schools and dissemination of information technology classes have been carried out for the use and dissemination of new technologies in education (Işık and Bahat, 2021).

Digital Games and Education

In this study, a digital game was developed to teach the subject of Climate Change using Unity, one of the digital game development platforms. Anastasiadis, Lampropoulos and Siakas (2018) new generation of students has been significantly influenced by the digital age and constantly uses Information and Communication Technologies (ICT) in their daily lives. Digital game-based learning provides further benefits for enhancing students' learning experience and improving learning and teaching procedures, while promoting active interaction and communication between students and educators. Greenfield (1996) reached four basic conclusions in his research with students aged 12-16 playing adventure games with students aged 12-16: a) Video games help develop strategies for reading three-dimensional images. b) They help improve learning through observation and hypothesis testing. c) 'They expand the understanding of scientific simulations. d) They increase parallel attention strategies. Gros (2007), video games are useful tools for learning and gaining knowledge of certain strategies. They also enhance the learning that is characteristic of the culture of the information society, and this learning is likely to have long-term consequences. Although entertainment is the first factor that attracts people to spend long hours playing games, effective principles and/or approaches in game design facilitate and engage positive learning outcomes (Gee, 2007; Li and Tsai, 2013). Digital games provide engaging experiences, interactive learning environments and collaborative learning activities; therefore, they have greatly increased in popularity in recent years (Squire, 2002; Squire, Giovanetto, Devane, and Durga, 2005). As it can be understood from the literature, in recent years, more and more technology and its elements have been allocated in education. Digital games will play an important role in the teaching processes of the course of science in order to teach students the subject and its content that are difficult to learn and to have fun while learning.

Scope of the Study

Within the scope of this study, a digital game about climate change, which has become increasingly important in recent years, has been developed by utilizing Unity, one of the digital game development platforms. Unity, like other "game engines", is a "software framework", or set of tools for developers that simplifies rendering, physics, and input, and frees them from creating sandboxes from scratch.

Many studies have been published so far on the creation of games in computer classes, literature. Most of these studies are concerned with how games can be highly motivating to teach computer science subjects, particularly in software engineering, virtual reality, and computer languages (Ward, 2008). The Unity Game Development Environment, a popular game development platform, is rarely used in computer classes. Although Unity is used in education after high school, it has been determined that it is rarely used for students aged 14-16 (Comber, Mayer, Motschnig, & Haselberger, 2019). With this research, it is aimed to teach climate change and related concepts with a digital game developed using Unity platform for primary school students. When the literature is examined, the content within the scope of this research that may be directly related to climate change at primary school level has not been found.

Game Content: Stop Climate Change

Login page

This page is the one that appears when we first open the game. As seen in Figure 1, there are three choices on this page. The main song of the game plays here, as well. On this page, we can start the game, adjust the volume of the music, and exit the game.

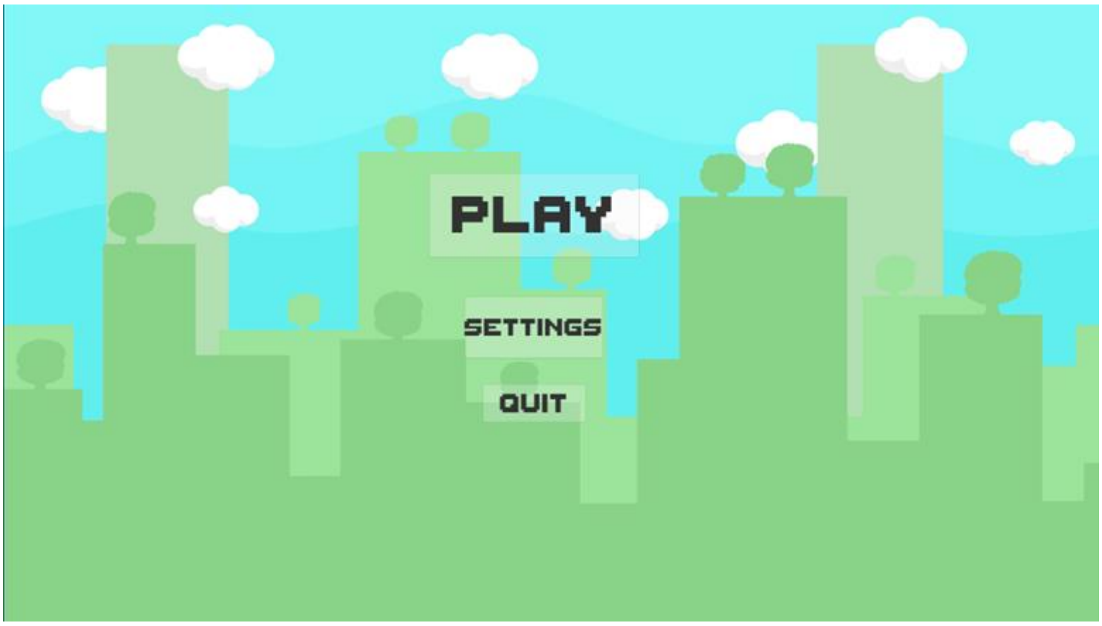

Figure 1. Main screen of the game (login page)

As seen in figure 1, selecting “Quit” allows us to close the game. When “Settings” is selected, we see the screen displayed in figure 2. We can adjust the volume of the music of the game or turn the music on and off. Pulling the bar to the right increases the volume, while pulling it to the left decreases the volume. We can return to the home screen by selecting “Main Menu.”

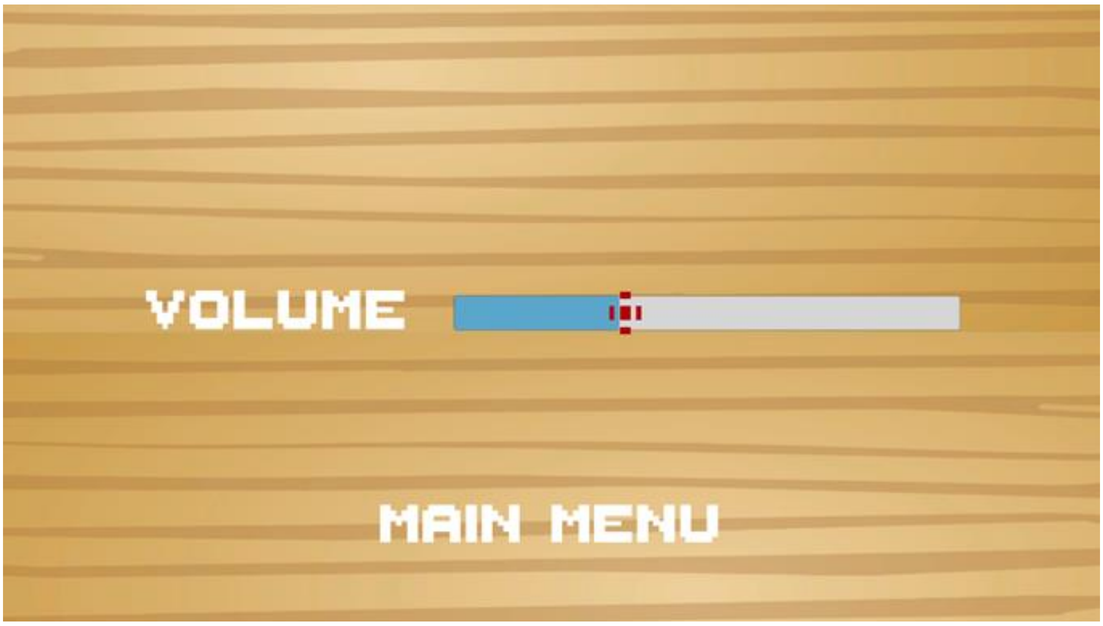

Figure 2. The settings screen

As seen in figure 3, when "Play" is selected, three different questions and an additional level are displayed. The questions lead to the relevant levels. On this screen, there are visuals that will help in understanding what global warming is, including CO2, Earth and a thermometer, the Sun, and a tree.

Figure 3. The level selection screen

The player can go to the desired level of the game by clicking on the relevant question on this screen. The order of the questions and the related levels is chronological. The first question is “Why is climate change happening?” In this level, the player is informed about the causes of climate change. The second question is “What happens in the process of climate change?” In this level, the player is informed about what happens during the process of climate change and the results through visuals and gameplay. The third question is “What can we do to prevent global warming?” In this level, there is information about how we can prevent global warming and the wasting of energy sources with visuals and platform elements. In the Green World level, a green and beautiful world, which we could obtain if we prevent global warming, is depicted for the player. The player does not need to pass a previous level to move on to the next one. As levels are finished, the player is directed back to the level selection screen. It will be more beneficial for the player to proceed in chronological order, but the level selection screen nevertheless allows players to choose levels in any preferred order.

Process of the Game

In a game, game elements form the infrastructure of the game. This infrastructure affects the playing of the game and provides communication with the player. While playing the game, the player plays according to the existing game mechanics. These mechanics are different for Windows, Android, and iOS platforms. Gameplay mechanics include features such as the character’s movements, jumping, and interactions with other elements.

Non-touch Devices

In Windows, we use the mouse cursor to press buttons in the game. After placing the mouse cursor on the button that we want to press, we select it by pressing the left mouse button. For example, when we open the game, we move the mouse cursor over the word "Play" on the screen and left-click, and then the level selection screen appears. We can move our character to the left by pressing the A key on the keyboard and to the right with the D key. With the space key, we can make our character jump.

Touch Devices

To press buttons on mobile devices, clicking is enough. For example, when we open the game and click on "Play" on the screen that appears, the level selection screen then appears.

Joystick usage will be helpful at this point, as mobile devices do not have a keyboard for making the character move. We can control the character with the joystick in the lower left corner as seen in figure 4. When the joystick is moved to the left, we move the character to the left, and the character moves to the right when the joystick is moved to the right. When we pull the joystick up, the character makes a jumping movement.

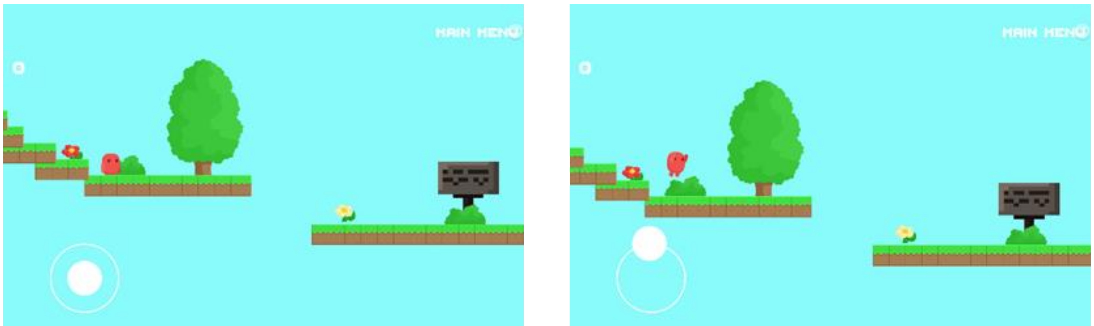

Figure 4. The joystick is visible in the bottom left of the screen. In the figure on the right, the character is jumping

Game Items and Features

There are four different levels in the game. Figure 4 presents an image from the "Green World" level. We can return to the main screen with the "Main Menu" button, which appears in the upper right in figure 5. We can exit the game from that screen or we can adjust the volume from the settings section of the game. To change the level, we can choose a new level after selecting "Play" from the main menu.

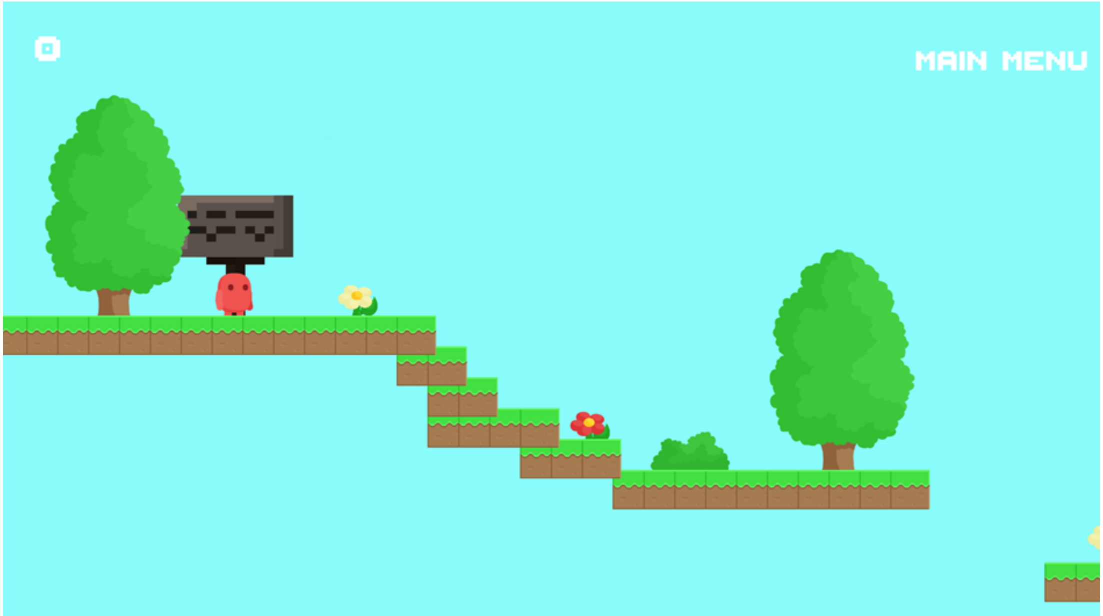

Figure 5. Game items

Character

The red object in figure 5 standing next to the tree and in front of the sign is the main character of the game. The player brings life to this character by directing him. The player passes through the selected level by moving the character left and right and making him jump. If the main character does not move, the game cannot be played. Therefore, the most important character of the game is the main character. His name is Emre and he represents the player. The target audience for the game comprises children aged 6-12 years.

Scoring System

The number "0" initially appears on the scoreboard in the upper left of the screen. In the game, there are trees for acquiring a score in each level. As trees are collected, 5 points are added to the scoreboard. The reason for using this scoring system is to offer a competitive element for players. In the game, tree numbers vary from level to level. In the first level there are 5 trees, so for the first level, the total possible maximum score is 25 points. For the second level, there are 6 trees, so the total possible maximum score is 30 points. For the third level, there are 4 trees, so the total possible maximum score is 20 points. Players can compete with each other using this scoring system.

In figure 6, there is a tree that the character will get, and in figure 7, in the upper left the scoreboard total is seen to have increased. More than one of these objects can be found in each level. Since there is more than one, players can compare scores among themselves.

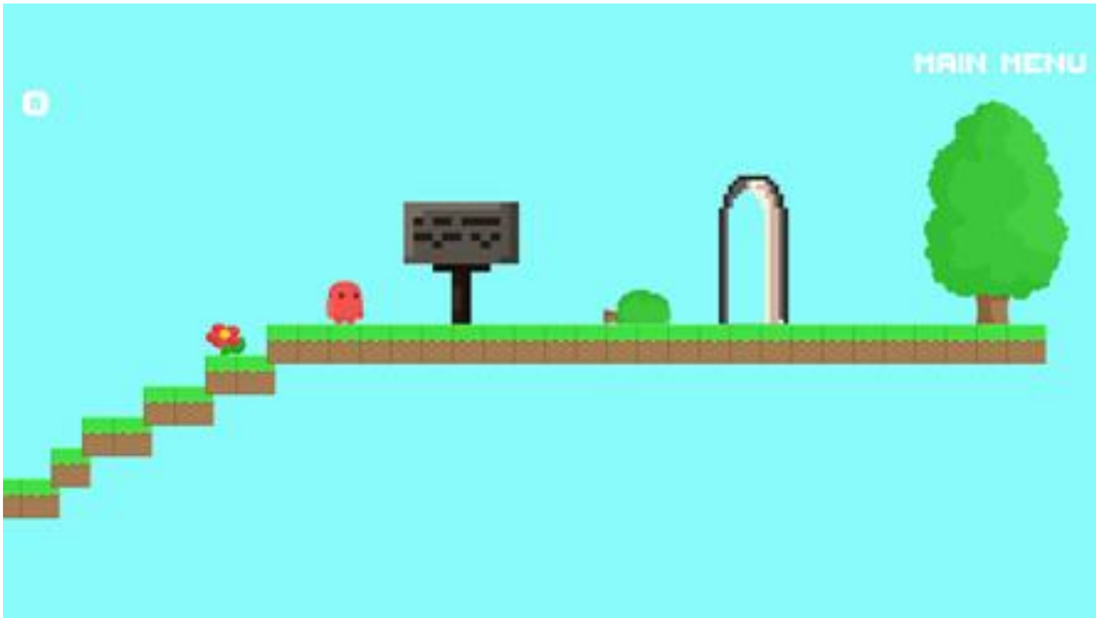

Figure 6. Before getting tree for points

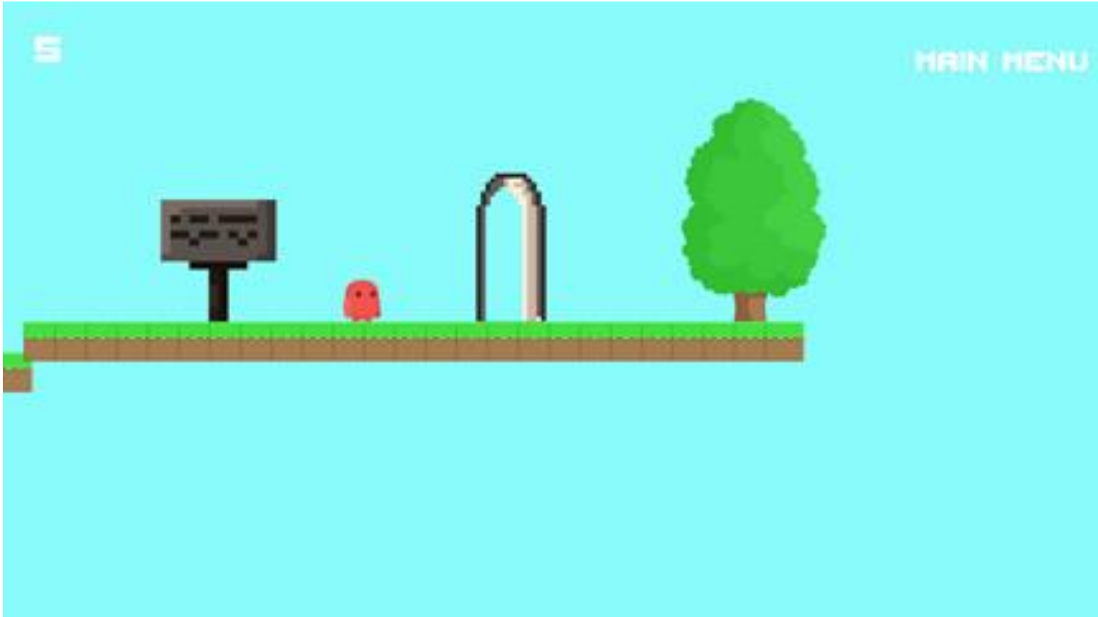

Figure 7. After getting tree for points

Portal

The portal seen in figure 6 and figure 7 is visible at the end of each level. This portal functions as a door and is located at the end of the level. The player must pass through the portal to finish the level. The level cannot be completed without going through the portal. The character returns to the level selection screen after passing through the portal and can then move on to the next desired level. The aim of the game is to reach all four portals by completing the four levels.

Elimination and Restarting

When we touch certain objects in the game, we get burned. When we are burned, we encounter the screen shown in figure 8. These objects vary from level to level. When the main character (Emre) touches these objects, he is eliminated. The game restarts when the green “Restart” button is pressed under the text that appears on the screen after the character is burned by one of these objects. Pressing “Restart” resets the scoreboard and the character returns to the first part of the game. The game is entered again from the level selection screen and the player tries again from the beginning to score points and reach the portal at the end of the level.

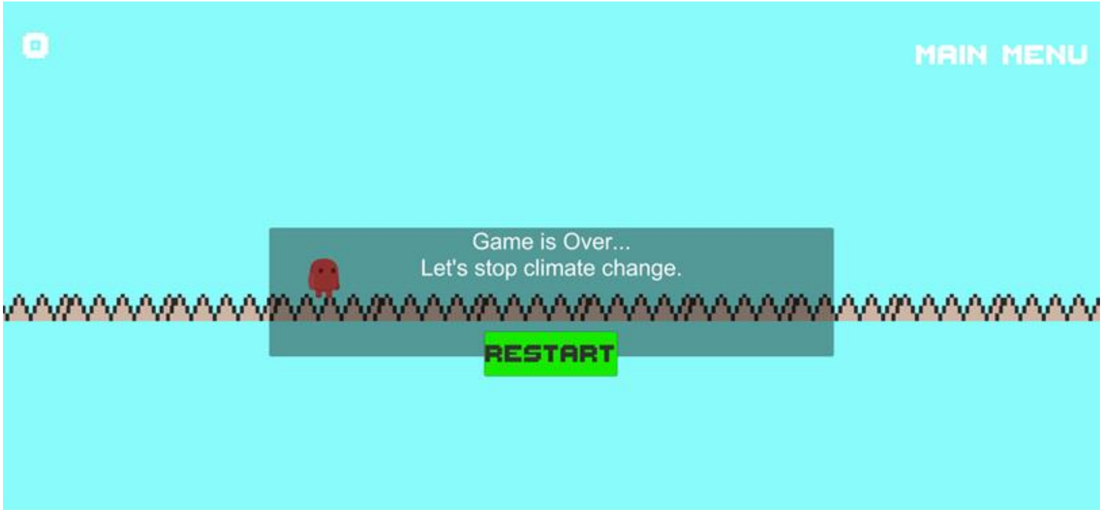

Figure 8. When the main character eliminated

Sign System

The sign system in the game is the game's most important element after the main character. The signs contain the educational aspects of the game and convey information to the students. When Emre comes in front of a sign, the text written on the sign can be seen in a bubble that appears below it on the screen. These texts vary from level to level and they provide answers to the questions asked for each level. For example, one level asks "Why is climate change happening?" In this level, information about the causes of climate change is accordingly given on the signs. As seen in the example in figure 9, when the character stands in front of a sign, the informative text opens in a bubble at the bottom of the screen. It is important for players to read the contents of these signs and be informed about the concept of climate change.

Figure 9. When the main character is in front of a sign

Game Levels

"Why is Climate Change Happening?"

The theme of this level, which is the first level of the game, is as follows: People are increasing Earth's climate change and temperature by using fossil fuels. This adds to the large amounts of greenhouse gases in the atmosphere, increasing the greenhouse effect and causing global warming. To explain these factors that cause climate change, background images and a gray theme are used in this level to emphasize air pollution and the release of toxic gases into the atmosphere. In addition, the platform elements in this level are gray. In figure 10, toxic CO2 and CO gases are seen in the cloud in the background, and the construction of factories can be seen at the rear. Later in this level, the player will encounter items more closely related to real life. In figure 11, the character is seen interacting with vehicles waiting to buy gas at a gas station and he must make his way through these vehicles. City elements are seen in the background, placed there to help build this feeling of pollution. The player earns points by finding trees in this section. The scores earned here do not change the course of the game but will allow the player to compare points in conversations with other players. The level continues until the character enters the portal. The player will gain information from the signs in this level. The name of the level on the signs is “Why is climate change happening?” This question is answered by the signs. The player gets information on this subject in the bubbles that appear at the bottom of the screen whenever the character comes in front of a sign.

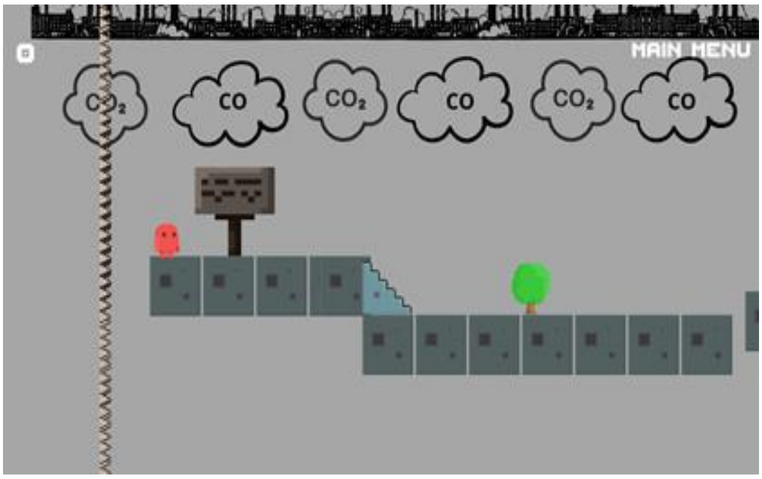

Figure 10. Starting point for this level

Figure 11. The character interacts with objects

"What Happens in the Process of Climate Change?"

When we move on to the second level, we deal with the increase in the greenhouse effect due to the presence of water vapor, carbon dioxide, methane, nitrogen oxides, and other greenhouse gases in the lower atmosphere of the Earth in the process known as global warming. Students will begin to learn about the factors that cause global warming and concepts related to climate change as a result of global warming. This level contains two parts. In the first part, the increasing temperatures in the world are mentioned together with the greenhouse effect, urban development, and resulting desertification. In the second part, the melting of glaciers due to increasing temperatures and the negative situations caused by this melting are addressed.

In the first part, a background reminiscent of desert dust, which may arise due to desertification, is used. A platform with brown tones is used to match the background. At the same time, if the character touches a white box, the character will be eliminated. The "Restart" message will then appear. These white boxes are seen in the upper part of figure 12; the character is standing on the platform there.

In the second part, the melting glaciers turn into water in the background due to the increase in temperatures, and a snowy environment and a cold blue more suitable for this theme are used in the background. If the character falls into the water, he will be eliminated. In figure 13, the water and the snowy environment are seen. The player earns points by finding trees in the first and second parts. The scores earned in this way do not change the course of the game but will allow the player to compare points with other players. The score in the first part is carried over into the second part, and this level continues until the character enters the portal. The player receives information from the signs, as in the previous level. The name of the level on the signs is "What's going on in the global warming process?" This question is answered as the player accesses information on the subject in the bubbles that appear at the bottom of the screen whenever Emre stands in front of the signs. In the first part, information about desertification and the excessive use of concrete is given on the signs together with information on the efficient use of water. In the second part, the signs address the melting of glaciers and the resultant dangers that the world will face.

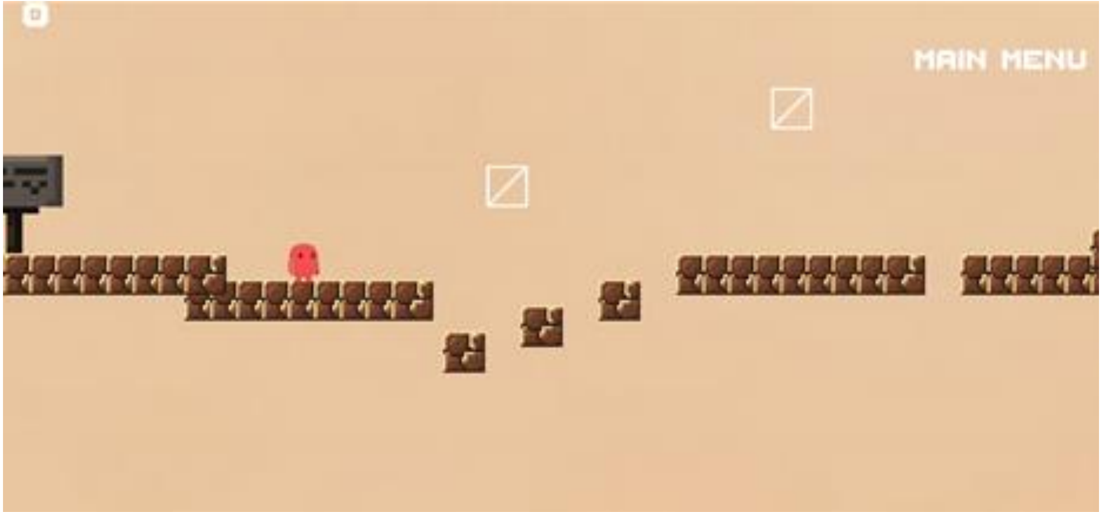

Figure 12. Image from the first part and the starting point of the level

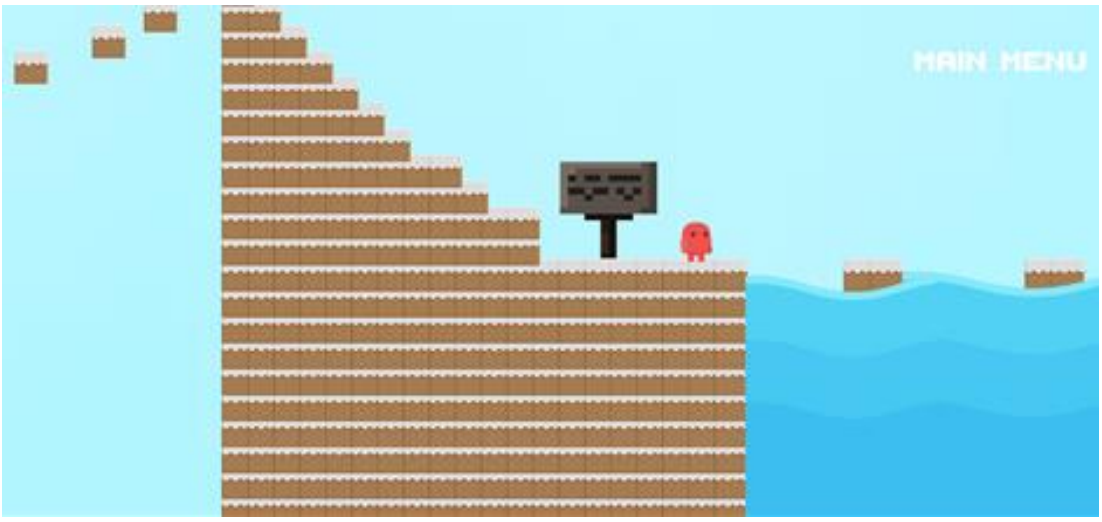

Figure 13. Image from the second part

"What Can We Do to Prevent Global Warming?"

As we move on to the third level of the game, attention is drawn to elements that are solutions to the problem of global warming caused by the emergence of greenhouse gases. In this way, students will understand that if the factors causing global warming are eliminated and/or reduced, the negative effects of climate change will also be decreased. Looking at the game's theme, we see solutions suggested to solve this problem. For example, rather than using fossil fuels that produce harmful gases, the importance of finding solutions with renewable energy sources depicted in the background of the game is shown in this level. We have many natural energy sources such as wind, water, and solar power that we can use without harming nature. Reducing the use of fossil fuels and preferring renewable energy sources will reduce harmful gas emissions into the air. This will be extremely beneficial for us in preventing global warming.

To show the importance of renewable energy sources, wind turbines, water energy, and solar panels appear in the background in this level. In this level, we can first pass over the wind turbines; if we fall, there is a possibility of passing them from below. Afterwards, we pass through the part where water energy is produced. In this part, the character is eliminated if he falls into the water. Next come the solar panels. In these parts, as players interact with these objects, they will learn more detailed information about renewable energy sources. The water energy part is shown in figure 14.

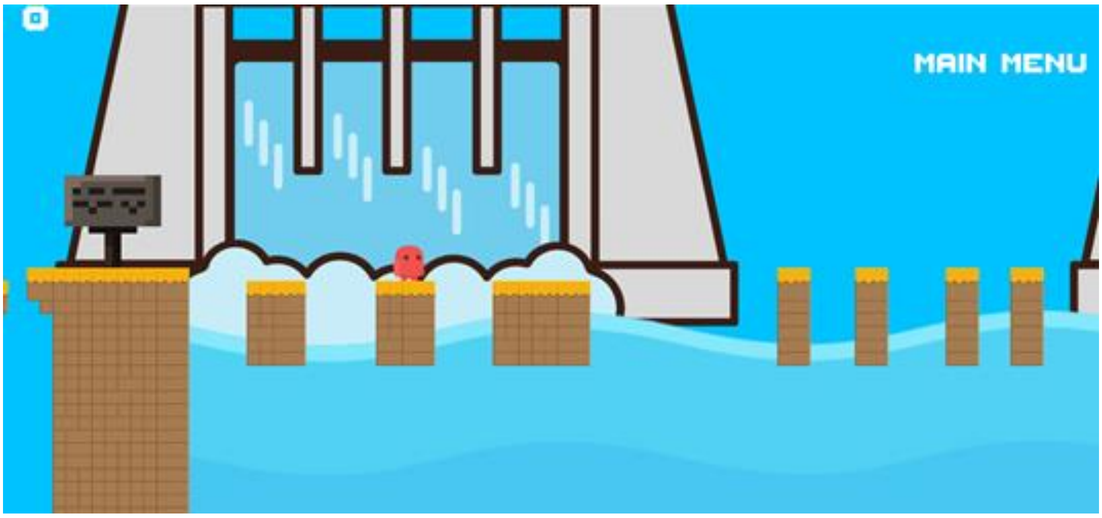

Figure 14. Main character in the part of this level addressing water energy

The player earns points by finding trees in this level. Again, the score will not change the course of the game, but players can compare their scores among themselves. The level continues until the character enters the portal.

The player gains information from the signs in this level, which are titled “How can we prevent global warming?” This question is answered when the character accesses information from bubbles that appear at the bottom of the screen upon standing in front of the signs. The signs contain information about renewable energy sources. Each time the player comes to a new renewable energy source in this level, information about that source is provided.

“A Green World”

The aim of this level, the final level of the game, is to present students with a depiction of a world where climate change has been prevented. Through this comparison, an effort is made to create environmental awareness among the players by prioritizing the beauty and naturalness of a world without global warming. In this level, the player encounters easier gameplay compared to other sections. This level is intentionally easier and shorter to make the player feel that a world without global warming will be comfortable and simpler. The trees, flowers, and greenery in the design of this level facilitate that feeling.

The player gains points by finding a tree in this section. A deal is offered to the player in the text written on a sign before the player claims the tree. A better future is offered in this deal. The level continues until the character enters the portal.

The player will obtain information from the signs in this level. While making reference to the previous levels on the signs, the concept of a green world is presented. The character can access information on this subject from the bubbles that appear at the bottom of the screen upon standing in front of the signs.

Conclusion

In recent years, when distance education activities have increased rapidly with the Covid-19 pandemic, we see that technology and technological applications have found more place in the teaching processes. In this context, applications such as Zoom, Teamlink, Google Meet, Adobe Connect and Webex have been frequently used as teaching-learning tools in distance education. In the distance education processes, various video tools such as Udemy and Khan Academy, which have educational content, were also used during the period when students were away from school. In these applications and in science teaching with the help of tools, a more synchronized distance education activity was carried out. This digital game about climate change, which aims to teach climate change to students by endearing it to students, can be considered more as an asynchronous distance education activity. Thus, it is aimed that students can both play the game and have fun in the process while they are learning climate change and related concepts, independently of each other, at any time and with the help of a smart device they want. The aspect of this digital content developed using the Unity platform, which distinguishes it from other applications, is that students are active while learning the subject and concepts related to the subject.

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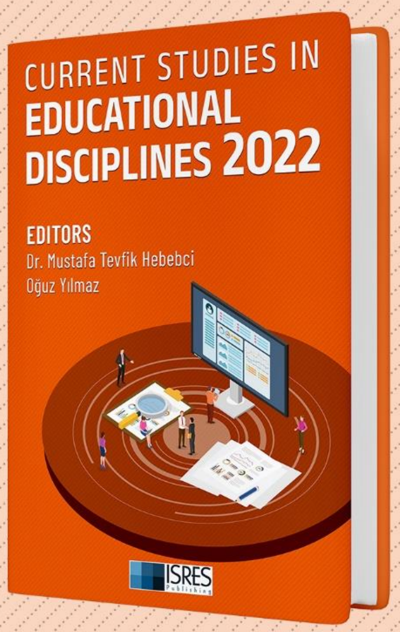
The proposed book with title **Current Studies in Educational Disciplines 2022** is primarily intended to serve as a scientific reading that deals with multidisciplinary and currently determined topics in the field of educational technologies. The book is published continuously, is published every year and aims to cover topics with a broader educational setting.

The texts in the attached papers appear at the right time, should be harmonized in the modern educational technologies tendencies of several scientific disciplines that all have “one common denominator”, which is to improve the quality of education. There are 7 thematic chapters, seemingly diverse, each paper is an authentic, research paper of theoretical-empirical character that deals with very interesting, current and insufficiently studied issues.

The content of the book is based on clearly identifying the current challenges in the educational technologies sector, which ensures its relevance by carefully defining the priority areas that need to be addressed in the coming period.



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