

Chapter 2

Technology-Enhanced Learning Environments

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1. Introduction

Today, the interaction between science, technology, society, and education provides a fundamental framework for understanding the rapid changes occurring on a global scale. The pursuit of knowledge, which has continued since the dawn of humanity, has paved the way for scientific advancements, which in turn have transformed into technology, reshaping social life. Particularly with the digital age, the ease of access to information, the widespread use of communication technologies, and the transformation of educational environments have made the relationship between these four areas even more visible. In this context, education plays a critical bridging role, both in the transfer of scientific knowledge to society and in the effective use of technological advancements by individuals. This chapter examines the effects of digitalization on education within the framework of the science-technology-society-education interaction, the historical development of educational technologies in Türkiye, and current learning models. It also discusses digitalization in education and the changing roles of children, students, and teachers in the digital age. This book chapter is based on web-based, online, and blended learning. Examples of technology-supported learning environments are presented in this chapter, linked to these topics.

2. Science, Technology, Society, and Education

Human beings are inherently curious and have sought to understand the world around them throughout their existence. This effort is driven by the need to survive and live an easier life. Throughout history, societies have tried to solve many problems that grow increasingly complex as those societies develop and to manage future risks. All of this has led humanity to pursue science and scientific endeavors. Since humanity came into existence, science, technology, society and education have been in a state of interaction, playing a key role in historical developments (Selwyn, 2016). In its broadest sense, Science is the production of knowledge in an effort to understand the universe. Today, science has developed systems that make human life easier by transforming into technology and now directly impacts all areas of society (Yalcinkaya, 2006). Society lies at the center of this process as a social construct where knowledge is produced and the effects of technological innovations are observed. Education, on the other hand, is a bridge spanning technology, society, and science. Through it, knowledge, skills, values, and even culture are passed down from generation to generation (Selwyn, 2016).

Today's technological advances have turned societies into digital information societies. The spread of digital technologies, artificial intelligence, big data, and communication networks have not only changed economic and cultural structures, but also affected education systems, teacher-student roles, and learning styles (Bozkurt et al., 2021). From another perspective, advancing technology increases human prosperity. Today, the rapidly increasing population also increases the need for education (Koseoglu, 2025). Both the increasing need for education and the technological transformation in education systems show that traditional schools can no longer meet existing educational needs either physically or socially. Schools should be open to constant change and

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innovation and aim to foster original thinking in the student (Numanoglu, 1999). Therefore, it is imperative today to support formal learning environments with informal and technology-supported learning environments. The developing world also needs technology-supported learning environments. This is why education extending beyond school walls is considered a necessity. In addition, traditional education comes at a high cost for disadvantaged groups in developing countries and increases the gap between rural and urban education quality. For this reason, the importance of open and distance learning institutions using technology-supported learning environments as a tool is increasing.

The importance of integrating technology into education and the use of technology-supported learning environments became particularly evident during the COVID-19 pandemic, which affected education systems worldwide. In 2020, the pandemic caused widespread disruption to face-to-face education, and approximately 1.2 billion students in 186 countries were affected by the transition to distance education. In this context, distance education, which had previously been considered an alternative mode of instruction, became essential for maintaining educational continuity because of the flexibility in time and space offered by technology-supported learning environments (Koseoglu & Turkmen, 2023). The COVID-19 pandemic also highlighted the importance of quality education, which is not only a global challenge but also one of the United Nations Sustainable Development Goals for 2030. In theory, technology-supported learning environments and the opportunities they provide are expected to contribute to the transformation of future education systems. One reason for this expectation is that distance education can help expand access to education by reducing geographical barriers and, under appropriate conditions, economic barriers (Koseoglu, 2025). However, the pandemic also revealed substantial disparities in digital infrastructure and access to technology across countries and regions. These disparities affected countries' capacities to sustain education through online platforms. For example, while Sweden maintained face-to-face education in compulsory schools during the spring term of 2020, the country adopted different measures across educational levels as the pandemic developed. Therefore, Sweden's experience should be considered in relation to the specific educational level, date, and measures implemented rather than being characterized as a complete transition to distance education across the entire education system. In contrast, inadequate digital infrastructure in countries such as Peru and Kenya created difficulties in sustaining online education, leading to the continued use of more established technologies such as television and radio alongside or instead of internet-based instruction (UNICEF, 2020). Sustainable Development Goal 4 (Quality Education) provides a global framework for addressing such inequalities by emphasizing inclusive and equitable quality education and lifelong learning opportunities for all. From a sustainable development perspective, technology-supported learning environments can also function as tools for increasing the resilience and continuity of education systems in the face of crises, including pandemics, climate change, and climate-related disasters. This role became particularly relevant in Türkiye following the earthquakes in the eastern and southeastern regions of the country in 2023, when emergency distance education was among the measures considered for maintaining educational continuity in affected areas.

To show how the relationship between science, technology, society and education affects Turkish National Education, the developments in education since 1923 are listed below. These developments in the use of technology in Turkish National Education are actually examples of how technological developments affect education systems (Kirik, 2014; Keskinilic, 2020):

- **1920s and 1930s:** With the proclamation of the Republic, the current developments in education in the Turkish Republic, which had emerged from a great war, lost its young population in the war, and where the surviving part of the people were largely illiterate, were not ignored and were among the priority targets. It was very difficult to increase the literacy rate in the Republic of Türkiye, which was financially and morally exhausted at that time. The report prepared by John Dewey in 1924 presented open and distance learning as a solution in teacher training processes. In 1933-1934 there was a plan in place to use one of the basic technological products of that period in order to increase the literacy rate among the people. This product was the letter. No matter how much planning went into the teaching of literacy by letter, the project failed to gain traction.

- **1950s and 1960s:** Advances in technology saw the letter replaced by radio and television in the 1950s. In 1951, the Directorate of Film, Radio, and Television Education was established within the Ministry of National Education. This institution prepared many films in the field of education and delivered these educational technologies right down to the villages. To reach large numbers of farmers quickly and at a lower cost, the first educational radio program -- “Village Hour” -- started broadcasting in 1954. TRT [Turkish Radio and Television] started to make educational radio broadcasts in 1964.

- **1970s and 1980s:** In 1974, the Teaching by Letter Center became a higher education center, and all this work culminated in the establishment of the Common Higher Education Institution. A two-year associate degree program was made possible thanks to this institution offering teaching opportunities to individuals who could not be placed in any institution in the exam held during the switch to university. When the capacity to receive higher education increased greatly in the following years, Anadolu University AOF [Open Learning Faculty] was established (1982). With the law published in 1981, Turkish universities were granted the right to continuous and open education. In the late 1980s, there were courses at secondary education levels in which experiments were followed on television screens using videotapes, especially in the fields of physics, chemistry, and biology.

- **1990s and 2000s:** Teaching with mass media such as radio and television was replaced by new technologies such as e-mail. Following Anadolu University, Fırat University started to implement distance education via e-mail in 1991 and also started to give computer lessons on television. After 1993, open and distance learning in Türkiye began switching to information-based systems. In 1996, Bilkent University became the first university to try education in a new medium. It launched a video conferencing system known as “New York on Air” for its students to attend lectures taught by instructors from around the world. In 1998, METU [Middle East Technical University] launched the Online Asynchronous Learning project, offering some courses in computer engineering to students. Following on from these, some institutions, especially Sakarya University and Ahmet Yesevi University, started the interactive distance education in the 2000s.

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In short, technology profoundly affects societies and education systems. The interplay between science, technology, society, and education has become even more pronounced in the digital age. Learning processes, teacher and student roles, and educational environments have all undergone a radical transformation. The increasing population, the need for access to information, and social changes all show that the traditional understanding of education alone is not enough. Today's world definitely needs learning environments that are flexible, accessible, and supported by technology. By accelerating this transformation, the COVID-19 pandemic showed us that distance education had become a necessity, not an alternative. Historical development explained in the context of the Republic of Türkiye reveals that the use of technology in education is constantly developing in line with social needs and technological advances. While technology-supported learning environments and open and distance learning systems have the potential to provide equal opportunities in education; they are considered an indispensable component of future education systems in line with sustainable development goals.

3. Digitalization in Education

Since information and communication technologies are everywhere in daily life, this age we live in is defined as the digital age. Information sharing continues rapidly wherever technology is available. Knowledge has already extended beyond school walls (Siemens, 2005). Approaches such as open and distance learning and blended learning have become a serious part of education systems, even more so since the pandemic (Graham, 2013). This transformation has significantly changed the roles of all stakeholders of education processes, especially teachers. This knowledge will be explained under the headings “Digital Literacy” and “Children and the Teaching Profession in the Digital Age.”

3.1. Digital Literacy

Before defining the concept of digital literacy, we need to talk about technology literacy. Technology literacy does not only include the use of effective technology; rather, it is a set of important skills that enable students to develop in the cognitive, affective, and psychomotor domains (Crowe, 2006). It is a roadmap for students to find solutions to their real-world problems using technology. In other words, it includes utilizing knowledge about technology as a solution tool (International Technology Education Association [ITEA], 2000). Digital literacy is a concept that goes hand-in-hand with technology literacy. Digital literacy includes accessing information using various digital tools, checking the reliability of this information, and staying within the confines of ethical conduct when accessing and using information. Producing content and communicating in technological environments such as blogs and wikis is also related to digital literacy. Digital literacy is crucial for avoiding misinformation and for a safe internet environment (Silik & Aydin, 2021).

3.2. Children and the Teaching Profession in the Digital Age

It is clear that the whole world is undergoing digital transformation in the 21st century. Technology pervades all aspects of life. This digital transformation has affected all areas of society, starting with education, and has integrated digital technologies. This transformation undoubtedly affects children the most (Kiryakova & Kozhuharova, 2024). In his book *The Last Child in the Woods* (2019), Richard Louv says that children are increasingly moving away from nature, which is seen as the first source of knowledge. According to Louv, the digital age is one of the most important reasons why children are disconnected from nature. Modern childhood is now advancing with indirect experiences in front of the screen. This means that the digitalization process has also indirectly changed the concept of childhood. Modern children live a life where the internet, phone, and tablet are part and parcel of every moment of their lives. The latest technological tools accompany them at every moment of their lives. For this generation, which has grown up in digital environments, technology is not only a means of entertainment, but also the central element on which information access, communication, and learning all depend. The fact that students turn to online sources before printed sources while carrying out their academic tasks shows that the way they acquire knowledge has changed significantly (Kiryakova & Kozhuharova, 2024; Redecker, 2017). This being the case, conducting educational processes independently of technology does not seem realistic, nor does it align with students' learning habits. Therefore, the conscious, purposeful, and pedagogical use of technology in educational environments is considered a necessity, not a choice.

The concept of changing children has also changed the teaching profession and the role of the teacher. Teachers have to add many new competencies to their professional development to keep up with a rapidly changing world. Teachers must also develop their own digital competencies if their students are to use digital tools correctly and effectively, and to raise a digitally literate generation in a broader sense. Teachers should recognize technology-supported learning environments and know how to incorporate them in their teaching processes (Redecker, 2017). The teacher in the digital age is not someone who will be defined as an authoritarian figure who imparts information directly. Teachers need to teach students how to learn and develop well-rounded students. In summary, the "guide" role of the teacher, which is one of the main emphases of the constructivist approach, is also very important for digitalization in education (Mishra & Koehler, 2006). Teachers are always learning because technology is constantly advancing. Teachers need to be lifelong learners for their own professional development (UNESCO, 2018). Technological developments have also transformed the concept of lifelong learning into the concept of learning everywhere. Based on the concept of learning anytime and anywhere, technological devices have become increasingly smaller and portable, so technology is now everywhere. Wherever technology is available one will also find up-to-date information. In other words, learning can take place anywhere (Bagriacik-Yilmaz, 2023). Students can access information anytime and anywhere. One of the main tasks of teachers is to be a guide to evaluate the veracity of the information they access (Anderson, 2008). This means that teachers play a critical role in developing students' digital literacy skills (Redecker, 2017).

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Teachers need to have technological competencies in addition to field and professional knowledge, and social skills such as communication and cooperation (Mishra & Koehler, 2006). Teachers are the designers of the learning-teaching process. When planning the lesson, the subject of the course should decide how to incorporate technology in the process by considering the outcomes and the skills the student will gain from it. The technology to be used in this process can be a digital tool, a technology-supported learning environment, or a form of measurement and assessment. Teaching can be a completely blended process combined with online or in-person education. In addition to all this, technology can also be used for pedagogical purposes such as making teaching personalized, flexible and free, and increasing communication between students (Koehler & Mishra, 2009). All this also varies depending on the teacher's competency in this subject and their level of professional development. The digital age has brought about many challenges in addition to the benefits it provides. Not every student or even every institution has equal access to technology. Access to information is very easy, particularly due to internet and web resources, but these resources do not always provide accurate information. Information pollution is a key problem today. This age of rapid change is a full-blown age of consumption, and the same is true of information. This makes it difficult to motivate students to learn. Similarly, cyberbullying, especially peer bullying in social networks, and ethical problems are other challenges facing teachers in this era (Selwyn, 2016).

4. Web-Based, Online, and Blended Learning

When technology-based contemporary education approaches are examined, web-based learning, online learning, and blended learning models emerge. The most basic features of these models can be listed as personalizing learning, providing a flexible and free learning environment, providing access to education, and equal opportunities. The main differences between these three models are the structure and usage patterns of their respective learning environments. Web-based learning offers a broad framework, while online learning is a completely digitalized version of this framework. Blended learning, on the other hand, offers a more holistic learning experience by combining digital and physical learning environments. The most important disadvantage of web-based and online learning is that the communication and interaction between students and teachers is limited. This is why blended learning is seen as powerful model because it combines both face-to-face learning and distance education. Web-based, online, and blended learning models have similar goals but different characteristics. All these are explained under the relevant headings.

4.1. Web-Based and Online Learning

Teaching activities in web-based learning are presented using internet technologies. Learning Management Systems (LMS) play a major role in this process. Learning management systems are integrated systems that serve to manage teaching content while providing the means to observe and assess students and teachers (Ozan, 2008). Technology-supported learning environments such as Google Classroom, Moodle, Blackboard, and Canvas are examples of learning management systems that are actively used today. They are flexible models that offer freedom in the context of web-based

time and space, and the responsibility for learning lies directly with students. Students need to have metacognition and self-management skills (Khan, 2005).

Online learning is considered a narrower subtype of web-based learning. In this model, learning is done entirely over the Internet and all interaction between the teacher and the students takes place in the digital realm. Online learning has become more visible, especially with the proliferation of distance learning apps. This model incorporates synchronous (live lectures, video conferences) and asynchronous (recorded content, discussion forums) learning activities that can be used together and offers students a high level of flexibility (Anderson, 2008).

4.2. Blended Learning

Blended learning is a model in which traditional face-to-face education and distance education are integrated in a planned way. Although traditional education is seen as a teacher-centered process that does not support students' individual learning experiences, it offers serious advantages in the context of social interaction compared to distance education. Blended learning is a powerful and rich model that combines the freedom and accessibility of distance education with the social communication of traditional education (Unsal, 2010). Graham (2013) defines blended learning as not only the coexistence of different environments, but also as a systematic design process that combines the strengths of these environments. This model enhances students' active participation, personalizes learning, and provides a rich experience by incorporating multiple learning environments. Distance education, particularly after the pandemic, is a topic that is on the agenda of the entire world. The effects of the transition to distance education during the pandemic continued after it was over. This is why blended learning is seen as a powerful model for the future. This is because blended learning is not so much a single model as an approach that focuses on the positive aspects of both types of education (Osguthorpe & Graham, 2003).

Designing a blended learning-based course is not much different from designing a web-based, online or in-person course. An effective blended learning design is created by identifying learning outcomes, choosing the appropriate blended learning model, incorporating interactive activities, and using the right technology. The main topic that guides this process is blended learning models. Blended learning models can be listed as follows: Rotation Model, Flexible Model, Enriched Virtual Model.

4.2.1. Rotation Model

The rotation model includes four different model titles, considering the learning environment used. These models are Station Rotation, Laboratory Rotation, Individual Rotation, and Flipped Learning.

4.2.1.1. Station Rotation Model

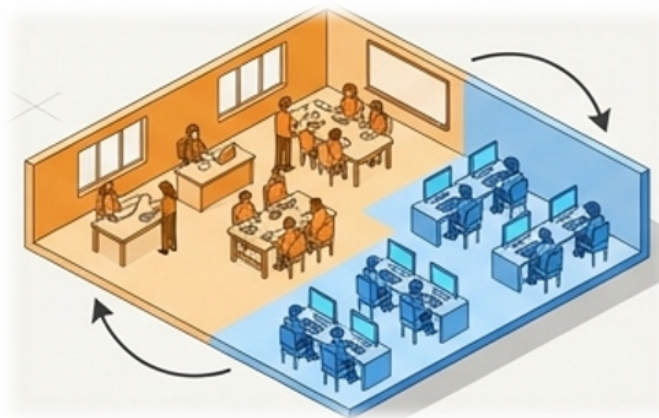
The Station Rotation model is a blended learning model in which students rotate among different stations within the same classroom setting, with each station offering a different learning activity. At

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least one station incorporates technology to support learning, which may include online learning activities. Other stations may involve a variety of instructional approaches, such as direct instruction, individual work, collaborative activities, or small-group work, depending on the instructional design. Students rotate among the stations according to a predetermined schedule or teacher guidance, engaging in different learning activities throughout the lesson (Staker & Horn, 2012).

Figure 1.

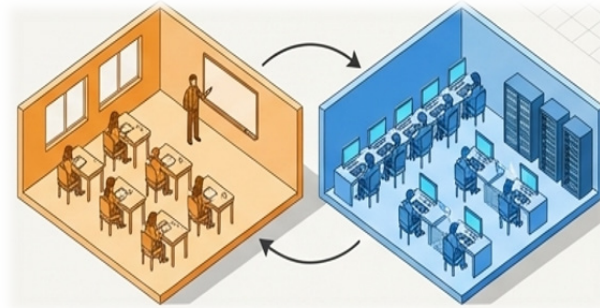
*Station Rotation Model**



** This figure was generated using artificial intelligence based on Staker and Horn (2012).*

4.2.1.2. Laboratory Rotation Model

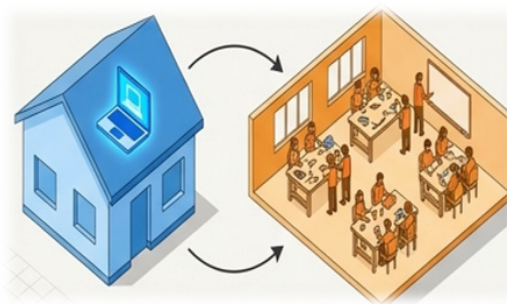
The laboratory rotation model is quite similar to the station rotation model in the context of its process. The main distinction here is that teaching is carried out in more than one formal environment. Students should take part in technology-supported activities in a computer laboratory. Since it is a model that uses more than one formal learning setting such as a classroom and a laboratory, its design is a little more complex and an assistant teacher is needed. It can therefore be seen as advantageous in the handling of interdisciplinary topics. However, the presence of multiple physical learning environments may pose difficulties when it comes to classroom management (Staker & Horn 2012).

Figure 2.*Laboratory Rotation Model**

**This figure was generated using artificial intelligence based on Staker and Horn (2012).*

4.2.1.3. Flipped Learning Model

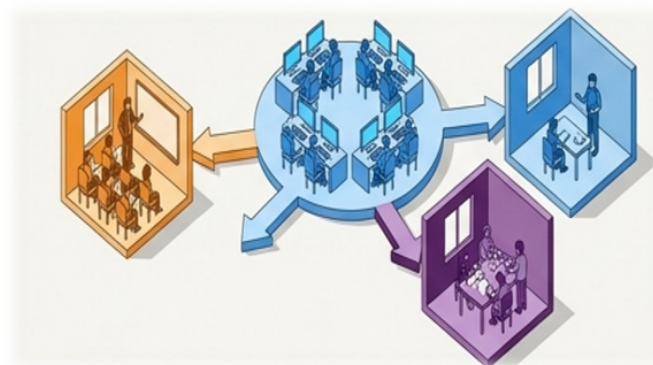
Another model is the flipped learning model. Contrary to what is usual, in the flipped learning model, the assignments and activities related to the subject are done in the classroom environment, while the theoretical part of the subject is given to the student with online content outside the school. In other words, students watch a short lecture video online in an out-of-class setting and then come to the classroom to complete group work, projects, or other activities in a teacher-guided classroom setting (Staker & Horn 2012).

Figure 3.*Flipped Learning Model**

**This figure was generated using artificial intelligence based on Staker and Horn (2012).*

4.2.1.4. Individual Rotation Model

The Individual Rotation model has an individual activity program for each student. Students learn according to this activity program and may work individually or with other students. In this respect, it differs from other station models, as students are not necessarily required to participate in all stations. The aim here is to bring the flexible structure of distance education to the classroom environment (Staker & Horn, 2012).

Figure 4.*Individual Rotation Model**

**This figure was generated using artificial intelligence based on Staker and Horn (2012).*

4.2.2. Flex Model and Enriched Virtual Model

The flex model is a blended learning model in which students support their online learning with individual or small group work and face-to-face activities with the teacher. In this model, online learning is more dominant, students complete their individual and free learning with the face-to-face support of teachers when needed. The enriched virtual model includes a school experience. First of all, learning starts in technology-supported environments and ends in a school setting where face-to-face learning takes place. This school should have many laboratories and study rooms where learning will take place outside the classrooms. In addition, it is essential to have social areas where student communication and interaction will increase. This model also enables the student to receive the learning support a teacher need in person or remotely in this model (Dakhi et al., 2020).

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5.1. Web-Based and Online Learning Environments

Google Classroom: Google Classroom is actively used at the primary, secondary, and higher education levels. It is a learning management system (LMS) developed by Google. Therefore, it is integrated with document services such as Drive, Docs, Sheets, and online meeting services such as Meet, provided by Google. In this way, it facilitates communication and interaction between students and between students and teachers. Its cloud-based structure, like Google Drive, allows teachers to share course materials, create assignments, provide feedback, and monitor student performance, and all these processes continue holistically (Google for Education, n.d.).

Moodle: Moodle (Modular Object-Oriented Dynamic Learning Environment) is a learning management system that supports students in having more interactive learning experiences based on a constructivist approach. It provides this interaction through forums, quizzes, and homework modules. All of these are collaborative tools. Teachers and/or institutions can adapt and develop Moodle according to their wishes and needs. In addition, thanks to its extensive plugin support, it allows the application of different pedagogical approaches. However, the fact that the installation and management processes require technical knowledge may create limitations (Moodle, n.d.).

Canvas: Canvas is a learning management system developed by Instructure, used particularly in universities, with the aim of providing accessible learning. This system is mobile-friendly and offers various tools for organizing course content, managing assessment processes, and increasing student interaction. It provides rapid feedback mechanisms and has the infrastructure to integrate other applications into the process. Therefore, it is considered a learning management system. However, being a commercial platform, licensing costs can be a disadvantage, especially for smaller institutions (Instructure, n.d.).

Blackboard: Blackboard is a well-established learning management system that has been in use for many years. It is frequently preferred in higher education institutions. The Blackboard Learn platform includes AI-powered course management, content sharing, online assessment, and communication tools. Thanks to its synchronous/asynchronous learning tools, it enables the effective design of blended and distance learning environments. Although it offers a strong infrastructure at the enterprise level, its complexity of the interface and the sometimes-challenging user experience are among its criticisms (Blackboard, n.d.).

Zoom: Zoom is a video conferencing platform used in synchronous remote learning processes. Particularly during the pandemic, Zoom was rapidly adopted by educational institutions and is seen as an advantageous and easy-to-use platform due to its high participant capacity, screen sharing, and recording features. Its user-friendly interface facilitates interaction between teachers and students (Zoom, n.d.).

Microsoft Teams: Microsoft Teams is part of the Microsoft 365 ecosystem. It's a platform frequently used by students and teachers, offering a holistic approach to education and corporate communication. Its positive aspects include combining synchronous lessons, file sharing, team communication, and collaboration processes in a single environment. In particular, its integration with tools like Word, Excel, PowerPoint, and OneNote facilitates the creation and sharing of teaching materials (Microsoft, n.d.).

Adobe Connect: Adobe Connect is a virtual classroom environment developed for distance learning and webinars. Thanks to its customizable interface, teachers can tailor the learning environment to their pedagogical needs. Features such as interactive presentations, polls, chat areas, and multi-content sharing support active participation in learning processes. The persistent room structure facilitates monitoring of learning processes (Adobe Connect, n.d.).

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Udemy: Udemy is a learning platform where instructors and institutions can offer online courses on a wide variety of subjects. Supporting a lifelong learning approach, Udemy provides accessible and flexible learning opportunities for individuals who want to develop skills in different areas. It supports the learning process through video-based content as well as assignments and quizzes (Udemy, n.d.).

Coursera: Coursera is a learning platform that offers online courses, specialization programs, and certificates in collaboration with universities and leading institutions. By making academic content accessible to a wide audience, Coursera provides a structured learning experience with video lectures and assessment tools such as peer reviews (Coursera, n.d.).

edX: edX is an online learning platform founded by Harvard and MIT and later expanded globally with the participation of numerous universities. Providing access to higher-level content through open courses (MOOCs), edX offers learners a flexible and self-paced learning environment. The platform supports academic and professional development with micro-degree (MicroMasters) and professional certificate programs. Its open-source Open edX infrastructure also allows institutions to create their own learning environments. However, the fact that some programs are fee-based and require significant self-regulation can affect participation and completion rates (edX, n.d.).

6. Conclusion

In conclusion, the interaction between science, technology, society, and education has become more complex and dynamic, especially with the digitalization process. Technological advancements have fundamentally changed not only the processes of knowledge production but also the ways of learning, the roles of teachers and students, and the structure of education systems. Global crises such as the COVID-19 pandemic have clearly shown that technology-supported learning environments are no longer an option but a necessity. However, achieving goals such as equal opportunity and accessibility in education requires the effective and conscious use of technology. Türkiye's historical experience in education also shows that the development of educational technologies is constantly transforming in parallel with societal needs and technological advancements. Therefore, the more widespread and effective use of web-based, online, and blended learning models in future education systems seems inevitable. From this perspective, many platforms, especially learning management systems, need to be used as technology-supported learning environments.

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