Baltic J. Modern Computing, Vol. 12 (2024), No.3, 248-258
https://doi.org/10.22364/bjmc.2024.12.3.02

Digital Learning Model

Sarma Cakula

Vidzeme University of Applied Sciences
Tērbatas iela 10, Valmiera, LV - 4202, Latvija

sarma.cakula@va.lv

ORCID 0000-0003-4831-2057

Abstract. Distance learning is becoming increasingly important today, it is essential to identify and explore digital learning opportunities, developing technological support and digital learning methods accordingly. One of the most important aspects of e-learning is the personal motivation of the student, so the learning process must involve the student in an active way. Additionally, technologies should be such as to support the increase of this motivation. There is a growing shift to using active learning methods in full-time study. Various e-learning platforms have been developed as more and more researchers are exploring the development of digital teaching and learning methodologies. However, there is currently no established technological framework to support the various active digital learning methods in a remote study environment. The aim of the paper is to develop and evaluate a conceptual technological model of active digital teaching and learning. Theoretical and statistical methods are used to reach this aim. The result of the paper is a technological model of e-teaching and e-learning comprising several interconnected parts of a system that promotes the active involvement of both the student and the teacher in the learning process, ensuring a higher quality knowledge sharing between both sides.

Keywords: active learning methods, e-learning, embedded systems, digital technological model.

1. Introduction

Changes in the global economy and politics are accelerating, with education, research and culture all being affected. Work equipment is becoming more sophisticated and complex, requiring more and more knowledge and skills from the workers. This leads to recognizing that knowledge is becoming increasingly valuable. The digital transformation of the global economy and society, and the speed of change is increasing the complexity of today's world as it becomes more connected and better educated. This complexity and speed of change mean that connecting education to the trends shaping the world we live in is now increasingly urgent. The information technology sector is developing rapidly in all areas of the economy but is lagging in the growing need to use it in a specific direction. The acquisition of new knowledge and skills has been seen as an important aspect of university education, signifying an increase in the importance of studies, both in full-time programmes and in individual courses. Today's education system is increasingly moving towards active learning, which includes active teaching methods, but digital tools and models that fully support active learning are still lacking. There are difficulties in

replicating traditional teaching methods resulting in unpredictable learning outcomes. Modern information systems and technologies support continuous development of digital tools, opening opportunities for strengthening the education system.

At a time when the need for distance learning is becoming increasingly important, it is essential to identify and explore digital learning opportunities, developing technological support and digital learning methods accordingly. One of the most important aspects of e-learning is the personal motivation of the student, so the learning process must involve the student in an active way. There is an increasing tendency to use active learning methods in full-time study. Various e-learning platforms have been developed as more and more researchers are exploring the development of digital teaching and learning methodologies. However, there is currently no established digital learning technological framework to support the various active learning methods.

The problem is the lack of active learning methods and knowledge management technologies in the study process. **The aim of the paper** is to develop a conceptual technological model of active digital teaching and learning.

Theoretical-technological model produces the event structure that is possible from the point of view of pragmatic competence and technology implements the event structure in accordance with pragmatic performance in order to realize surface uniqueness. The theoretical and the technological components of the model share at least three essential features: First of all, they follow the principle of modularity along the same kinds of modules, secondly, they adhere to the duality of competence and performance, thirdly, they handle the multimodal nature of real human-to-human (and, ultimately, human-to-machine) communication (Hunyadi, 2011).

Research question-what technological model improves student's knowledge in learning process. Research tasks includes developing of theoretical digital learning model, experiment of using digital active learning methods and evaluating of main results.

The paper examines the feasibility of applying digital active learning methods in a digital environment, assesses the need to personalize the study process and establishes a common technological framework for the use of active learning methods. The paper develops a conceptual model for an e-learning technological platform to enable the use of active learning and teaching methods in studies at higher education institutions.

2. Main focus of today's digital learning

2.1. Research background

Lifelong learning is one of the most important parts of today's education system, requiring the development of prior learning and professional skills in line with the requirements of the profession. Learning at a distance in a digital environment is becoming particularly important. Strategically, the main goal of sustainable national development and human well-being is to focus on education for personal development.

Historical circumstances have changed, the content of education has changed, new educational paradigms have emerged, and thus both the professional competence of the teacher and the use of technology have acquired new significance. The supply of information is increasing, and it is becoming more and more important to be able to navigate quickly and efficiently through large amounts of accessible data, to acquire new skills and competences.

Digital learning technologies support the digitization of the learning experience and facilitate online mobility and include any communication, information and technological tools that contribute to improved teaching, development, and assessment.

Digital learning technologies include:

- Mobile learning and apps
- Gamification
- Virtual classrooms
- Artificial intelligence (AI**)**
- Lifelong learning technologies
- Immersive learning technologies
- Nano-learning technologies (Cumraeg, 2022).

These technologies are developed by various EdTech companies, including the World Bank Group, based on scientific research in this field (The World Bank, 2022). EdTech companies have also been either a help or a hindrance. Technology has been positioned as the solution to pedagogic innovation, when the reality is that learners need to take responsibility for their learning in order for sustained progress to be made (Learnlife, 2022). There is some research into how digital learning has been affected by Covid pandemic. There is a growing need to advance digital education ecosystems and technologies (Mihovska et.al., 2021). All over the world, both universities and moodle create and organize a wide variety of courses in many languages, but they need to be adapted to each group of students.

Alamri et. al. provide an overview of personalized learning theory and learning technology that supports the personalization of higher education. They have analized three technological models that support personalized learning within various learning environments in higher education. Personalized learning is "an educational approach that tailors learning around each individual student's needs, interests, and abilities. Each student is given differentiated instruction based on their personal learning characteristics" (Raudys, 2021). However, they emphasize the lack of data-driven and independent research studies that could enable increased effectiveness and impact of the personalized learning and technology models on student learning (Alamri et.al., 2021). The depth of teaching properties of digital resources in guidance is discussed through the possibility of identifying orientation models in their theoretical structure (Payo et.al., 2013). It is possible to use the help of artificial intelligence to choose your own learning path (Cognitive Class.ai, 2024). Some authors describe the possibility to integrate a knowledge assessment system based on concept maps with a personalized study planning prototype and examine its use in personal study planning (Rollande et.al., 2017).

There is still a lack of extensive research into personalized digital learning technological models that focus on increasing a student's motivation.

2.2. Digital active learning methods

The paper focuses on technological solutions that provide educational methods which enhance everyone's ability to acquire knowledge, values and skills needed to participate in decision-making for individual or collective action at local and global levels to improve the quality of life without compromising the needs of future generations. Learning materials and methods in a digital environment enable the rapid and secure introduction of new knowledge and the mutually beneficial exchange of data and knowledge, which are key to sustainable education. Active learning methods develop learner's ability to react

flexibly in a competitive environment but have so far been used mainly in face-to-face studies.

Mercat Christian presents Active Learning Methodology, surveying its history, main existing tools and supporting evidence, with an emphasis on mathematics and higher education, in particular engineering (Mercat, 2021).

Student motivation, engagement and interest in their own learning are imperative for a successful and student-centred education. The global education trend has shifted to a clearer focus on '21st century skills' or transversal competences. Humanisation, accessibility, openness, and diversity of the educational environment are the guarantors of sustainable development of education. Several scholars have provided theoretical justification for distance learning ideas related to the expansion of the opportunities offered in the context of home-based education and international or cross-border education (Katane et.al., 2012). We need to develop a different orientation when thinking about new technologies in education - not just as tools or delivery systems, but as a set of resources and capabilities that enable us to rethink our educational goals, methods, and institutions (Burbules et.al., 2020). Active learning methods provide new content created by the teacher or student (Kim et.al., 2012). Technology-enhanced learning environments create flexibility and sustainability in education (Cakula, 2018).

The author carried out an experiment at Vidzeme University of Applied Sciences (VIA) that involved experiential learning and active participation based on collective coding exercises (VIA student codes), quizzes, projects, and other approaches. Experiential learning in algorithms and statistics courses took the form of practical exercises in the development of collective solutions. Work on algorithms and statistics exercises was carried out in small groups, with regular feedback data collected in a number of ways to serve as input to the knowledge discovery process to support active learning later on (Cakula, 2021). The methods used were various active learning methods such as Dotmocracy, Fishbowl, Survey, Index Card Pass, Flipped Classroom, Complete Turn Taking, Respond, React, Reply, Round Table, Think-Pair-Share, Post It Parade, including also solving different exercises on an algorithm theory (Hattie et.al.,2007).

2.3. Personalized learning process

Instruction tailored to the unique pace of different students is known as personalized learning. Personalized learning is a method of teaching in which the content, technology and pace of learning are based on the abilities and interests of each learner.

There are five steps to personalizing learning:

- set clear and specific goals,
- make goals challenging and realistic,
- make goals dynamic and review them regularly,
- let learners know their progress,
- involve supporters (parents, friends, etc.) (Rogers, 1997).

In this case, the academic goals remain the same for the group of students, but individual students can progress through the curriculum at different speeds based on their specific learning needs. This is particularly true in e-learning, where each student chooses to study at his or her own time, place, and pace. Personalised learning includes adaptive learning, individualized learning, differentiated learning and competency-based learning (Briggs et.al, 2009). Adaptive learning is when technology is used to assign human or digital resources to learners based on their unique needs. Personalized learning states that

the pace of learning is adapted to the needs of individual students. Differentiated learning approach states that learning is adapted to the needs of individual students. Competency-based learning provides learners with the opportunity to progress through a learning pathway based on their ability to demonstrate competence, including the application and creation of knowledge, as well as skills and dispositions. Academic objectives, curriculum, and content, as well as method and pace may vary in a personalised learning environment. Unlike individualized learning, personalized learning involves students in the design of learning activities and is based more on the student's personal interests and motivation to acquire knowledge and skills.

Individual perception can be classified as a form of nomothetic psychology and is developed by Socionics' theory based on Jungian four personality types. Jung mostly focussed on personality types as individuals. Meanwhile, Socionics states that there are 16 types of personalities and respectively 16 types of possible perception of information. All of people have their strengths and weaknesses and Socionics has defined what the strengths and weaknesses of each sociotype are in perception of information (Desmarais, 2006; Grant, 2014; Sampson et.al., 2002). To ensure the highest quality e-learning, the individual characteristics of learners must be considered. It should be noted that this is one of the biggest advantages of e-learning, because unlike a standard learning environment where students listen to a lecture together and do the same homework and tests, e-learning can provide tailored information based on the student's most pronounced perceptual channel. In the literature, these are also referred to as modalities, Fleming's VARK model or simply as perceptions. Four perceptual channels are distinguished:

- auditory
- visual
- reading, writing
- kinaesthetic (Othman et.al., 2010).

Building on all these aspects, smart learning environments provide students with adaptive and personalized learning and assessment, including multimodal/multisensory interaction technologies and advanced interfaces. An industry-driven approach in collaboration with academics will lead to market-oriented education. New learning individually oriented methodology should be developed based on individual human perception – how individuals select and process information - Neil Fleming's pedagogic theory, educational psychology, and artificial intelligence for formal and informal education, including workplace learning. Increasingly, the course leader collaborates with students in their studies, which promotes faster and more effective knowledge sharing and the creation of new knowledge.

3. Digital learning framework

3.1. Participants

Research base is 348 students from Information technology and Business Management bachelor programs in Vidzeme University of Applied Sciences, who participated in the experiment learning course "Statistics" between the years of 2014 and 2023. 89% of them chose to use the Learning Support System.

3.2. Material

The basis was the Moodle platform, which integrated various modules. Information Technology students took 6 ECTS Statistics course, while Business Management students took 3 ECTS Statistics course. Boths groups got 2nd year bachelor program course according to business management and information technology accredited study programs in Latvia.

At the beginning of the experiment, the basic content and materials were prepared by the lecturer, but the students had the opportunity to prepare the course content of each meeting in various forms under the guidance of the teacher - both text documents, using images, colors, video, audio, multimedia, etc. according to their sociotype. These materials were placed in the moodle system for use in the following years of studies. A database of various materials was formed, where it was expanded in each subsequent year. Students determined their sociotype using Jung's short test consisting of 60 questions (Similarminds, 2024).

3.3. Design

The digital learning framework is built on advances in neuroscience, pedagogical and learning theories, educational psychology as well as artificial intelligence including modal/multisensory technologies. It provides gaining access from both sides - teacher and student (Fig. 1). Framework includes 4 main parts: course content, active learning environment, learning support system and feedback to both - student and teacher. Course's content foundation is developed by the teacher and may be supplemented by student-generated content under the guidance of the teacher. It is very important that students take part in developing content – this is one of the most powerful methods of enabling students to look at things from a teacher's perspective. It develops a deeper understanding of necessary knowledge and skills. Active learning environment includes three main parts – possibility to build a course map choosing between different active learning methods and using tools embedded in the learning environment for using active methods in both group and individual work (Sampson et.al., 2022).

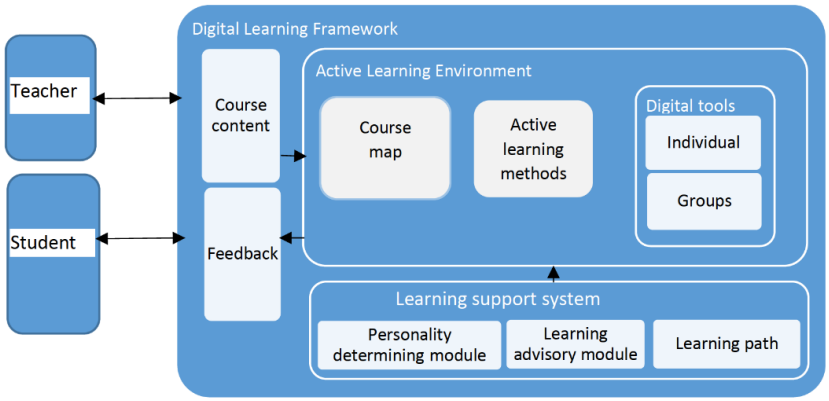

Fig. 1. Digital Learning Conceptual Model

Learning support system includes personality determining module (Cakula, 2018), learning advisory module (Cakula et.al, 2019) and learning path (Nabizadeh et.al, 2020) that can be developed for every individual student. Course content in the beginning is created by the teacher and later developed by students using course map and active learning methods. In the leaning process personality determining module, learning advisory module, and learning path could be accessed depending on student's choice.

Personality determining module will profile users, assessing their personality based on Socionics theory, Neil Fleming's pedagogic theory, educational psychology, and artificial intelligence to provide adaptive learning content for improving performance in learning. Learning advisory module system will manage the learning path for each learner through the course content, using different course units, access from different devices and evaluation feedback. As a result, it will be able to advise the learners to follow a different learning design (relevant to their personality type) or access different learning resources (relevant to their information processing preferences). The tutor / administrator will also be informed for the learners' progress during each module / course.

Learning path can be created based on an algorithm developed by scientists in Chine where they have designed a multidimensional knowledge graph framework that separately stores learning objects organized in several classes and proposes six main semantic relationships between learning objects in the knowledge graph. Learning path recommendation model is designed for satisfying different learning needs based on the multidimensional knowledge graph framework, which can generate and recommend customized learning paths according to the e-learner's target learning object (Daqian, 2020).

Digital Learning Environment, for example Moodle, is the main system where access from teacher and student will start. The course is divided in several learning units. Course content is organized using questions in the beginning of every learning unit. This will offer next steps for each student based on their choice in using Learning Support System. Both – Learning Support System and Active Learning Environment - are embedded systems included in the main Digital Learning Environment. Digital Tools are accessed by links from every learning module. In the future there should be further research into embedding this in the main Digital Learning Environment Digital Tools system.

3.4. Procedure (Research Process).

At the beginning of the course, each student was offered the opportunity to study in a traditional way or use the opportunity to determine his sociotype and use the approach of the system mentioned in the article. 85% of the students were full-time students, and 15% were e-study students. Those students who chose to use the study materials offered to the sociotype (87% on average) could, respectively, voluntarily use the learning advisory module and learning path module integrated in moodle. All students took part in active Learning environment managed by teacher.

Evaluation for each student took place in accordance with the accredited and approved course description by the teacher using tests and activity in the course. All students took all tests included in the course.

Questionnaires and interviews were performed at the end of the course to obtain students' views on learning process.

4. Main research results

There is a correlation between personality type and the learning program – Information Technology students were mostly found to be Introvert and Judging (characteristics defined by Socionics) but Business Management students covered all personality types in every study year.

Depending on the personality type students took part in the developing learning materials for every course content module. There were different evaluation methods in every course content unit and the final grade constantly improved, starting with an average grade of 6,34 in 2014 and reaching 8,14 in 2023 (Fig. 2).

Kalmogorov-Smirnov nonparametric tests were used for testing normal distribution (Fig. 3).

H0 - final grade for IT students in Statistics course follows normal distribution is accepted on probability level 95%.

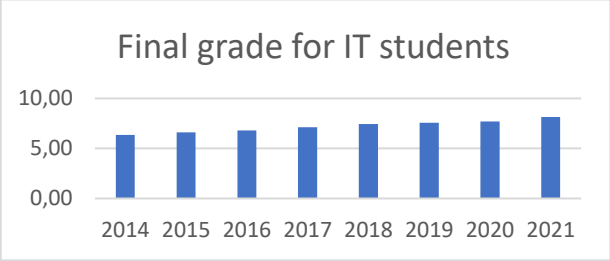

Fig. 2. Final grade for Information technology students in Statistics course

		Final grade of IT students
N		**214**
Normal Parameters	*Mean*	7,22
	Std. Deviation	1,52
Most Extreme Differences	*Absolute*	,05
	Positive	,03
	Negative	-,05
Kolmogorov-Smirnov Z		,73
Asymp. Sig. (2-tailed)		,658

Fig. 3. Kalmogorov-Smirnov nonparametric test for normal distribution

From 2018 in addition active digital learning methods and course map was included. Until 2018, the average results for IT students improved by 6.9% per year, but in 2018 and

after the results improved in average by 7.5%. Different situation is for business students - there were no regular progress from year to year (Fig. 4).

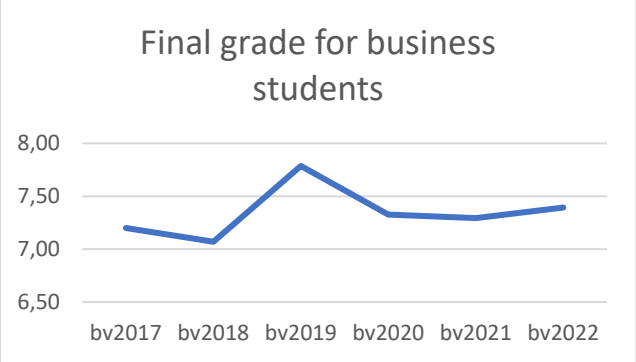

Fig. 4. Final grade for business students in Statistics course

Active digital learning methods positively influence results but there is no clear trend for growing results. In discussion students accepted that this solution is much better for them than tradition learning, and they were very interested to understand their sociotype.

5. Conclusion

Today, the pedagogical paradigm is shifting from teaching to learning and, by extension, focuses on what the student requires from the teacher. Students and their activities have a great influence on teaching methods, content and technological tools used. A technologically supported information system is necessary to ensure the delivery of relevant content and the promotion of a coherent study system. Furthermore, it can motivate students to delve deeper in the courses offered and to acquire the competences needed in the labour market. In a quickly evolving information society it is increasingly important to deliver the right information to the right learner, quickly.

The working environment is changing with the rapid development of technology and knowledge, so it is important to keep abreast of changing market conditions and not only apply available technological solutions but also develop new applications of technology in areas of societal need to contribute to the overall growth of the economy. The development of a sustainable society is influenced by the variety of methods and technologies available.

The level of students' motivation to learn is becoming more and more important. In the digital environment, there is much less support from other students and from the lecturer, so the digital environment should be one that includes personal support for each individual student and offers learning according to the way each one perceives information.

The technological digital learning model created draws on advances in learning theory, neuroscience, artificial intelligence, educational psychology, and modal/multisensory technology. It allows for teachers and students to cooperate in a common system using different embedded tools supporting active learning methods.

References

Alamri, H. A., Watson, S., Watson, W. (2021). Learning Technology Models that Support Personalization within Blended Learning Environments, In: *Higher Education*, TechTrends, **65**(1), 62-78.

Briggs Myers, I., McCaulley, H. M., Quenk, L. N., Hammer, L. A., Wayne, D. M. (2009). MBTI Step III Manual: Exploring Personality Development Using the Myers-Briggs Type Indicator Instrument, *Consulting Psychologists Press*.

Burbules N.C., Fan G., Repp P**.** (2020). Five trends of education and technology in a sustainable future, *Geography and Sustainability*, **1**(2), 93-97.

Cakula, S. (2018). Smart Technological Learning Conceptual model, *International journal of Engineering and Technology*, **7**(2), 152-156.

Cakula, S., Majore, G. (2019). Future Generation Education Technological Model, *Proceedings - 2019 IEEE 9th International Conference on Intelligent Computing and Information Systems, ICICIS 2019*, 9014852, 371-376.

Cakula, S. (2021). Active Learning Methods for Sustainable Education Development, *Rular Environment. Education. Personality*, **14**, 59-65.

Cognitive Class.ai (2024). learning Path. https://cognitiveclass.ai/learn

Cumraeg - North Weles Management Scool (2022). What are digital learning technologies. https://online.glyndwr.ac.uk/what-are-digital-learning-technologies/

Daqian Shi, Ting Wang, Hao Xing and Hao Xu. (2020 May). A learning path recommendation model based on a multidimensional knowledge graph framework for e-learning, *Knowledge-Based Systems*, **195**, 11, 105618.

Desmarais, M.l C., Gagnon M. (2006). Bayesian Student Models Based on Item to Item Knowledge Structures , *EC-TEL 2006: Innovative Approaches for Learning and Knowledge Sharing*, 111-124.

Grant, P., Basye, D. A. (2014) Personalized Learning: Guide for Engaging Students with Technology, *International Society for Technology in Education*. Oregon, Washington.

Hattie, J., Timperley, H. (2007). The Power of Feedback, *Review of Educational Research*, **77**(1), 81-112.

Katane, I., Katans, E., Vavere, G. (2012). Environment of distance learning for humanization and democratization of education: the historical aspect", In V. Dislere (Ed.), *The Proceedings of the International Scientific Conference Rural Environment. Education. Personality (REEP)*, **5**, 35-42.

Kim J., Hwang J., Chi S., Seo J. (2020). Towards database-free vision-based monitoring on construction sites: A deep active learning approach. *Automation in Construction*, **120**, 103376.

Learnlife. (2022). Technology & Digital Learning Platforms. https://www.learnlife.com/learning-paradigm/technology-digital-platforms

Mercat Christian . (2022). Introduction to Active Learning Techniques**.** Open Education Studies **4**(1):161-172.
file:///C:/Users/Admin/Downloads/Introduction_to_Active_Learning_Techniques.pdf

Mihovska, A., Prevedourou, D., Tsankova, J., Manolova, A., Poulkov, V. (2021). Building Adaptive and Inclusive Education Readiness through Digital Technologies, *Joint 6th International Conference on Digital Arts, Media and Technology with 4th ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunication Engineering, ECTI DAMT and NCON 2021*, **9425728**, 384-388.

Moodle (2024) Making quality online education accessible for all. https://moodle.com/services/learning-design/

Nabizadeh, A. H., Leal, J. P., Hamed N. Rafsanjani, H. N., RatnShah, R. (2020 November). Learning path personalization and recommendation methods: A survey of the state-of-the-art, *Expert Systems with Applications*, **159**, 30, 113596.

Othman, N., Amiruddin, M. H. (2010). Different Perspectives of Learning Styles from VARK Model, *Procedia - Social and Behavioral Sciences*, **7**, 652-660.

Payo, A. R., Martín, S. N., Sánchez, E. M. T. (2013). The technological model in the school guidance into digital educational resources, *ACM International Conference Proceeding Series*, 585-589.

Raudys, J. (2021). Personalized learning strategies to implement in class and examples. https://www.prodigygame.com/main-en/blog/personalized-learning/

Rogers, J. (1997). Sixteen personality types at work in organizations, London, Management Futures.

Rollande, R., Grundspenkis, J. (2017). Personalized Planning of Study Course Structure Using Concept Maps and Their Analysis, *Procedia Computer Science*, **104**, 152-159.

Sampson, D., Karagiannidis, C., Kinshuk (2002). Personalised Learning: Educational, Technological and Standardisation Perspective, *Interactive Educational Multimedia*, *Special Issue on Adaptive Educational Multimedia*.

Similarminds (2024). Free Jung Personality Test (similar to MBTI / Myers Briggs) https://similarminds.com/jung.html

The University of Texas at Austin (TEXAS). (2020). Flipped Classroom. https://facultyinnovate.utexas.edu/instructional-strategies/flipped-classroom

The World Bank. (2022). Digital Technologies in Education. https://www.worldbank.org/en/topic/edutech

Received February 13, 2024, revised June 28, 2024, accepted August 8, 2024