

Preparing future teachers to use digital educational resources in primary school

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Abstract

The use of digital educational resources is based on ensuring that control measures are fixed and that the educational process as a whole is more transparent. The purpose of this article is to research the use of digital educational resources in primary school. The methodological basis of the study is determined by the possibility of using the design method. The novelty of the study is determined by the fact that the digital educational environment is understood primarily as the function of knowledge transfer and the desire to combine conventional teaching methods with innovative principles. It was concluded that the digital environment should be designed and taught to future teachers not only as an applied subject but also as an infrastructural component. By comparing the experimental and control groups, the authors empirically confirmed that pedagogical influence using web-based technologies is more effective than previously used ones.

Keywords: blended learning; education; conventional teaching; technologies; web resources.

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1. Introduction

The use of information and communication technologies (ICT) is becoming increasingly important in everyday life and in education. The integration of ICT into the educational and methodological environment of an educational institution offers more opportunities for participants in the educational process to work better in a globalised information society. There is a huge potential for increasing the efficiency of training for teachers and students based on the pedagogically balanced use of ICT in the educational process (Orlova et al., 2019; Serdali et al., 2018). Informatisation of education is being referred to as a true revolution in education, wherein, proceeding from the achievements of classical psychological and pedagogical science, specific tasks of creating and effectively introducing ICT into educational practice are developed. Informatisation of the educational process in educational institutions is a process that creates an information environment, actively develops and uses information resources (McMartin et al., 2008; Tovkanets, 2018). ICT development has also led to changes in education (Churchill, 2017; Akhmetshin et al., 2018).

The main purpose of informatisation of the educational process of institutions of general secondary education is to prepare students for life in an informatised society: the development of students' information culture, the development of their abilities, the disclosure of their creative potential in the context of the widespread use of modern ICT in the educational process, the requirements for teacher training considerably increase the amount of their knowledge, the culture of speech, communication, behaviour (de la Guardia et al., 2021). Many specialists and practicing teachers note that numerous electronic educational resources, despite their high educational potential, are rarely, unsystematically used, mainly to control knowledge and develop reproductive skills. The benefits of using ICT in general secondary education institutions to improve the quality of education are highlighted and compared to practices of other leading countries of the world (Sampson et al., 2011; Atabekova, 2020a; Atabekova, 2020b). ICT in education is one of the priority areas of research, this subject matter will retain its relevance and require further investigation. The rapid development of ICT predetermines the improvement of new forms of interaction between participants in the educational process. Web technologies, underlying various software tools for professional activity, are of particular importance. The introduction of the latest methods and skills of working with Internet resources improves the educational process and increases the motivation for learning (Samerkhanova et al., 2020; Zinchenko, 2020). The use of web technologies can considerably improve the education system; therefore, further informatisation of education is developing and will continue developing with a mandatory focus on web technologies (Trust, 2018).

The use of web technologies provides new opportunities for the development of educational technologies. However, this vast range of new opportunities does not necessarily guarantee the effectiveness of the educational process, because the development of an effective educational process requires coordinated foundations of training based on pedagogical principles (Zong, 2015; Khoma & Huchkanyuk, 2018). Web-based technologies are potentially powerful tools for improving educational processes in educational institutions (Domingo-Coscollola et al., 2020). Their use can provide teachers and jobseekers with a wide range of new opportunities that are beyond reach with conventional teaching technologies. However, web-based technologies are still a means of activity for technical and programme experts, and not teachers and students. Therefore, often the development of design tools for courses is performed without a real understanding of issues connected with training and pedagogy (Komar, 2018; Chaikin & Kirieieva, 2020).

Technology development is often considered as a tool to ensure the effectiveness of the educational process in terms of developing a theory of education and training, competent development of educational environments in terms of the didactic potential of using computer-oriented pedagogical technologies and ICT. The use of ICT in the educational process creates significant potential for the provision of educational services (Yang et al., 2011; Zashchirinskaia et al., 2020). Often, the results of analysis of studies regarding the issues of introducing cloud technologies into the modern educational process are presented, the feasibility and necessity of their pedagogically balanced use in the educational process are justified (Deltsova, 2020; Molnar, 2018). A considerable number of publications of periodicals was analysed and common tendencies in covering the issues of introducing modern ICT into the educational process were identified (Ng, 2015; Fizeshi, 2018). The main idea is to discuss the development of an oriented learning (information-educational,

educational) environment in the institution of general secondary education (Grimaldi et al., 2019). Modern web-oriented technologies have substantially affected the education. Nowadays, to start learning, one can do without a classroom with a blackboard and desks for students. One can study remotely – for this, an access to the Internet is required (Demartini et al., 2020).

Same as a blackboard or a slide, web-based technologies are a powerful tool – but only a tool that should be used pedagogically in order to improve learning (Maull et al., 2012; Zashchirinskaia, 2020). Regulatory documents use the term electronic learning resource (ELR). The concept of “electronic resources” can stand for such concepts as the digital form of data presentation, computer tools, and software for their reproduction and management. ELR is understood as an electronic learning tool designed to present educational material and implement pedagogical interaction between participants in the educational process to achieve didactic goals (Kynigos & Kolovou, 2018; Kartashova & Plish, 2020). To generalise and systematise the definition of ELR, unification of the procedure for their development and implementation is approved by the regulation on electronic educational resources within the country or region, in which ELR is understood as educational, scientific, informational, reference materials and tools developed in electronic form and presented on media of any type or located on computer networks that are reproduced using electronic digital technical means and are necessary for the effective organisation of educational process, in the part which concerns its filling with high-quality teaching materials. ELR forms an integral part of the material and technical support of the educational process with the teaching purpose and is used to provide educational activities for students (Ronsivalle et al., 2019).

The practical significance of research can be defined as a function that achieves efficiency only when the teacher operates it as a working infrastructural tool. The purpose of this study is to investigate the use of digital educational resources in primary school.

2. Methods

2.1. Research Design

The purpose of the pedagogical experiment is empirical confirmation or refutation of the research hypothesis, that is, substantiation of the fact that the proposed pedagogical influence using web-based technologies is more effective than the previously used ones; for this, the experimental and control groups are determined, which are compared with each other. The difference in the effects of pedagogical influences will be justified if these two groups, which are identical in their characteristics before the start of the experiment, differ after the implementation of pedagogical influences. The methodological framework of the study is determined by the possibility of using the design method.

2.2. Participants

389 students took part at the formative and control stages of the experiment. Thus, in the experimental group ($n = 200$), training was performed using web-based technologies, and in the control group ($m = 189$) – in accordance with the conventional (generally accepted) methodology.

2.3. Data Analysis

At the first stage of statistical data processing, there should be a check of sampling for uniformity. To test the hypothesis of homogeneity (identical characteristics) of the two groups (control and experimental), various criteria were used: parametric and nonparametric. The authors shall consider some of the parametric methods. The conventional method for checking uniformity is the Student’s test. To apply it, two classical conditions must be satisfied: observation results have normal distributions; dispersions of the observation results in the first and second samples coincide. To establish normalcy, a sufficiently large number of observations is required (circa 2,500). The distribution of the results of pedagogical research usually differs from the normal to a certain extent; therefore, the authors did not use this criterion in this study. As an alternative to the Student’s test, the authors consider the Cramer-Welch criterion. To use this criterion, equality of dispersions is not required.

Compared to the Cramer-Welch criterion, the non-parametric Wilkinson (Mann-Whitney) criterion, which allows testing the hypothesis of equality of samples (equality of means, variances, and other statistical

indicators), is more sensitive, on condition that the research results are presented in the ratio scale. This scale is different in that there is an absolute zero point of reference used in measuring the duration of training sessions, the amount of didactic tools, the cost of training, reading speed, and evaluating test results. Since the results of a pedagogical experiment are rarely presented in the relationship scale, the authors used the Cramer-Welch criterion in this study.

3. Results

The methodology for using the Internet resources should be evolutionary and gradual, since it is necessary to factor in the rapid changes in society and the development of information and communication technologies. Some aspects of constant evolution of any learning system based on Web-based technologies are defined as follows:

- necessity of constant updating, changing, and improving the content of training;
- necessity of factoring in the evolution of the curriculum through institutional, legal, ethical, political, and cultural changes;
- necessity of factoring in the diverse needs and different learning styles of a large number of students;
- evolutionary context, partly dependent on the constant development of the infrastructure of information technology, including the architecture of hardware and software, language and web technologies, including mobile and smart devices;
- web-based learning affects the evolution of learning theory.

The authors formulated criteria for using web-based technologies to create learning content as follows: development cost; flexibility of use; feedback from education seekers; clarity of presentation of educational material; pedagogical control of knowledge; motivation for learning; ability to use multimedia dynamic content; student learning activities; cooperation of teachers with applicants for education, students among themselves. The use of information and communication technologies focuses on the educational needs of students through the creation and implementation of web-oriented courses and social networks for educational purposes in the educational process. The main thing in using web-based technologies for training is the ability to integrate the content of training, pedagogy, and information and communication components (Figure 1).

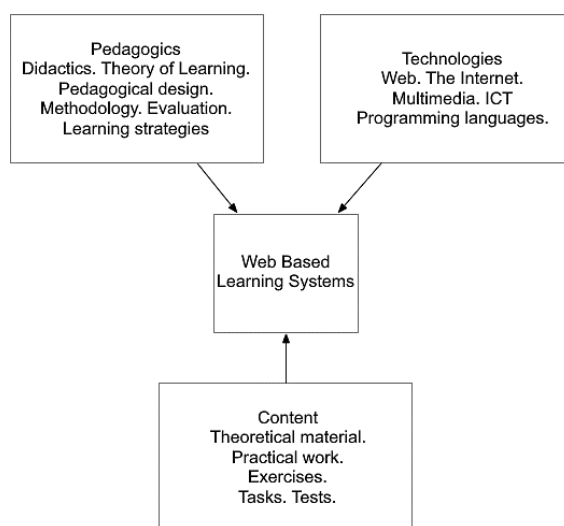


Figure 1. Web-based technologies and their main features

The main types of ELR include the following:

- electronic document – a document wherein information is presented on electronic media and for the use of which technical means are required;
- electronic didactic illustrative materials – electronic materials (presentations, diagrams, video and audio recordings) intended to accompany the educational process;
- information system – an organisationally ordered set of documents (arrays of documents) and information technology, including using technical means designed to search, process, distribute, and transmit data;
- electronic resources depository – an information system designed to ensure that modern ELR is concentrated in one place with the ability to provide access to them through technical means, including in information networks (both local and global);
- computer test – standardised tasks presented in electronic form, intended for incoming, intermediate and final control of the level of academic achievement, as well as self-monitoring and/or used to measure the psychophysiological and personal characteristics of students, the development of which is performed using appropriate programmes;
- electronic study guide – educational electronic publication, the use of which complements or partially replaces the textbook;
- electronic textbook – an electronic educational publication with a systematic presentation of educational material corresponds to the curriculum, based on which dynamic interaction of participants in the educational process is ensured;
- electronic teaching materials – an electronic educational or practical publication of explanations on a particular subject, section or question of a school subject with an indication of the methodology for performing individual tasks, a certain type of work;
- electronic educational game resource – a type of electronic educational resource for educational purposes, based on which cognitive and developmental learning functions are combined, where holistic theoretical material and practical assignments from a school subject are taught in a game form;
- distance learning course – an information system that is sufficient for studying individual subjects with the help of indirect interaction of distant participants in the educational process in a specialised environment that operates based on modern psychological, pedagogical, and information and communication technologies.

The definition of ELR is formulated as a set of electronic information objects (documents, documented information and instructions, information materials), information-object content of electronic information systems (electronic libraries, archives, data banks, information and communication networks) designed for information support of functioning and development of the education system. Based on the analysis of the definitions of ELR, the authors presented the interpretation of this term as a set of data in electronic representation created using information and communication technologies that contain information intended for educational activities. The specific feature of ELR is that the use of multimedia resources provides the opportunity to use vision, hearing, imagination, and through the use of a dynamic component, it enables a combination of explanatory and illustrative teaching method with an active one.

The concept of “educational web resources” was clarified in the following sense: educational web resources are electronic educational resources located in the web space of a local or global network in the form of various formats (text, graphic, archive, audio and video formats, etc.). In the process of using educational web resources, an ICT teacher has to do the following: search for available educational web resources on relevant topics; analyse and select the necessary educational web resources; create personal educational web resources; host educational web resources on a local or global network; use educational web resources in the educational process. The concept of web-based educational resources is understood as educational, scientific, informational, reference materials and tools developed using cloud services. In education, cloud services are used to facilitate access to ELR, which make up the semantic content of a web-

based environment, as well as to ensure the creation and delivery of educational services. The term “electronic training course” is often employed and is defined as a set of teaching materials and educational services created for the organisation of individual and group training using information and communication technologies.

The authors introduce the concept of a web-based training course – it is an electronic training course containing training materials created using web technologies, the purpose of which is to ensure the achievement of didactic goals. Such courses in general secondary education institutions can be created and deployed using web-based learning material management systems. The authors formulated the requirements for a web-oriented training course – technical: efficiency, usability, cross-platform, accessibility, navigation and communication, including content design; pedagogical: division into small academic units (lessons) and logically discrete educational steps, structured presentation of information, accessibility, explanation. Upon studying the evolution of learning management systems, it can be argued that the use of such systems due to quality, accessibility, and ease of use (for example, intuitive navigation) facilitates the achievement of positive learning outcomes through a web-based training course. Using the learning management system allows creating a training course with a variety of learning resources. However, such diversity does not always benefit applicants for education. Some training courses may be oversaturated with functions and tools that are not consistent with the objectives of teaching the subject, which may be conditioned by the fact that the developer includes additional features and resources only because they can use them. To prevent this, the taxonomy of educational design is applied, the use of which helps the course developers to strategically align the features of the learning management system with the learning objectives of the course.

The opinions of students of the open distance course “Blended Learning” were analysed. The course was held in May 2019, regarding the possibilities of using blended learning. According to the majority of teachers surveyed, it is possible to use elements of distance learning in the educational process. Teachers can use separate methods of distance and blended learning. And this is just support for the educational process through the use of modern technologies (Table 1).

Table 1. Comparison of conventional and blended learning

	Conventional approach	Blended approach
Student	Work according to the “listen, remember, reproduce” scheme. Sometimes the lack of initiative and desire for independent educational activities.	The involvement of students in the educational process. Responsibility for personal education progress. Interaction with all participants of the educational process.
Teacher	The formation of knowledge, skills, control of student knowledge.	Construction of the educational situation, the formation of students' responsibility for education progress.
Methodology	Most often, information is passed from teacher to student.	Through their own cognitive activities, education seekers receive knowledge through cooperation.
Educational process development	In the classroom, education seekers listen to teacher explanations. Coming home after school, they do their homework, often unsuccessfully and without the ability to ask, get a hint.	Familiarisation with educational material (watching a video, studying a paragraph, students working together using ICT) on a new topic, and in the classroom, applying knowledge and skills in a new situation.

ICT	The use of technology and web tools in training.	The use of technology and web tools in training.
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Nevertheless, the technology of the flipped classroom is used in institutions of general secondary education as an innovative learning scenario. The difference between the “flipped classroom” learning scenario and the conventional scenario is that the theoretical material is studied independently at the beginning of the lesson (usually using information and communication technologies: video lectures, audio lectures, dynamic materials, etc.), and time in the lesson is used to analyse and solve problems, for cooperation, interaction with students, the application of knowledge and skills in a new situation, for students to create a new educational product. The authors compared the conventional and mixed approaches to teaching according to several criteria: the role of the student, the role of the teacher, the use of ICT in the educational process, the methods used for teaching and building the lesson. A survey of teachers on the use of mixed-class technology was conducted. The following benefits were highlighted as a result:

- socio-relational – the ability to collaborate, the ability to work independently and responsibly, the ability to share rules, the ability to work in a group, positive relationships between students, positive relationships between students and a teacher;
- cognitive – an effective process of memorising and obtaining data, the ability to determine communications in information, creative and original skills, analysis and problem-solving skills;
- technical and didactic – the skills of using technologies, the ability to choose and organise educational content, the use of information and communication technologies to obtain information;
- emotional-motivational – motivation for learning, a better understanding of self-esteem and self-fulfilment, a positive emotional attitude towards educational activities;
- communicative – the ability to communicate effectively using communication technologies;
- organizational and managerial – positive relations between teacher and students, cooperation between teachers, dissemination of technical pedagogical skills among teachers.

Analysis is a necessary element of research, an obligatory preliminary stage in the preparation of any level of strategic and marketing plans. An analysis of the use of distance education technologies was performed, an analysis of the possibilities of creating an educational information environment and the use of distance learning technology in general secondary education institutions was described. The authors built a matrix (Table 2), comprising strengths and weaknesses, opportunities and threats of using web-oriented technologies.

Table 2. Analysis of the use of web-oriented technologies

Strengths	Weaknesses
<ul style="list-style-type: none"> • Use of educational ICT technologies; • access to educational materials at any time; • education seekers absent from the lesson know what material was passed in the classroom; • operational distribution of educational material; • access to education; • use of various forms of filing educational material; • possibility of a rational distribution of time in the learning process; 	<ul style="list-style-type: none"> • Use of web-based technologies is still the domain of technical and program experts, not teachers and education seekers; • high complexity of developing web-based courses; • teacher content management system administration; • rarely and haphazardly used, mainly for the purpose of controlling knowledge and the formation of reproductive skills;

<ul style="list-style-type: none"> • feedback from the teacher; • use of multimedia dynamic content; • use of a visual presentation of educational material; • use of pedagogical design; • teacher-student collaboration; • expanding the cognitive abilities of students; • training using mobile devices; • development of students' independent work skills; • formation of the image of the educational institution. 	<ul style="list-style-type: none"> • constant updating, changing and improving the content of the course; • oversupply of functions and tools that are inconsistent with the objectives of the course; • difficulty of measuring the efficiency of using a web-based training course; • contradictions in the choice of a learning management system; • lack of motivation for teachers to create web-based courses.
Opportunities	Threats
<ul style="list-style-type: none"> • Learning anywhere; • use by education seekers during quarantine, illness; • training of applicants for participation in the academic competitions; • methodology should be evolutionary and gradual, since it is necessary to factor in the rapid changes in the information society; • updating or changing the content of the course by the teacher; • use of multimedia technologies; • automated control, assessment, diagnosis of problems of assimilation of content; • using the learning management system, a variety of learning resources can be added to the training course; • the possibility of multiple revision of the content. 	<ul style="list-style-type: none"> • Internet connection loss; • creation of an IT course by specialists is performed without understanding the issues related to training and pedagogy; • increasing demands for teacher's professional training, the volume of their knowledge, communication; • insufficient number of certified web-oriented courses; • social isolation of course users; • emergence of "poor quality" training in educational institutions; • filling the course with copied text from a textbook or book; • student identification during testing; • teachers using educational technology for the sake of technology, as opposed to achieving an educational goal.

Depending on the results obtained, a plan should be developed to use the advantages and opportunities, including the elimination of weaknesses and mitigation of threats. Using analysis elements, specific strategies are formed. Proceeding from them, it is necessary to choose the right direction for the development of the use of web-oriented technologies. For this purpose, the authors conducted an experiment to ensure the quality of web-oriented courses at school.

The algorithm for determining the reliability of the general and distinctive characteristics of the compared samples for the experimental data presented in the ratio scale using the Cramer-Welch criterion looks as follows:

Step 1. For the compared samples, the authors calculated the temporal-empirical value of the Cramer-Welch criterion using the (Eq. 1):

$$T_{emp} = \frac{\sqrt{mn} |x - y|}{\sqrt{ms_x^2 + ns_y^2}}, \quad (1)$$

where m, n are sample sizes; x, y are average values of samples; s_x^2, s_y^2 are variances of comparative samples.

Verification of the level of educational achievements of students in the control and experimental groups was performed per the average score of the certificate of basic secondary education of students. Thus, for this study, the authors have the following results (Table 3).

Table 3. Statistical data of the results of the average score of the certificate

	CG	EG
Average value	39.14	38.7
Sample size	189	200
Dispersion	10.408867	7.278325123
Cramer-Welch test value		Critical value
1.472348071	<	1.96

Step 2. The authors compared the obtained criterion value with the critical value $T_{0.05} = 1.96$: the obtained value of $T_{emp} < 1.96$, hence the hypothesis that the characteristics of the control and experimental groups are equal before the start of the experiment is accepted at a significance level of 0.05.

4. Discussion

Measuring the efficiency of using a web-based training course can be challenging. There are various approaches, although there is no standard, generally accepted approaches and recommendations for assessing the course as of now. An example of an approach to making online courses effective is Quality Matters. As part of the performance verification process, proposed online courses are reviewed using a standardised section. The section proposes to evaluate the structure of the course, approaches to the control of knowledge, learning objectives, the content of educational materials, the organisation of interaction of participants in the educational process, teaching technology, user support and accessibility. According to T. Batane and A. Ngwako (2017), pedagogically balanced use of the developed web-oriented courses has a positive effect on improving the level of knowledge, skills, and abilities.

The use of modern ICT in academic activities in educational institutions enables teachers to transform their practice, create, edit, and expand the content of educational material. The use of ICT in the educational process facilitates the increase in the level of motivation for the educational and cognitive activities of the applicant for education and helps to master basic knowledge, skills. ICT is a system of modern methods and means of activity, the use of which provides an opportunity to improve training. Recently, the term “blended learning” has been spreading in world science. It is the integration of conventional forms of teaching with teaching using distance learning technologies. On the basis of an analysis of the scientific literature and practical experience of the pedagogical community, the content and characteristics of the concept of “blended learning” are refined, blended learning models are classified, and the strategic stages of its implementation in pedagogical activity in higher education institutions are proposed.

D. Chambers and A. Coffey (2019) note the artificiality of the term “blended learning”, proceeding from the position that the use of ICT in the educational process is not an innovation, but a demand of the present. It may be inappropriate to distinguish such forms of training as learning using electronic learning tools, mobile or distance – currently there are training tools that the teacher must use in their activities, and teach students to do the same. Blended learning combines the conventional classroom system with web-based learning

using the appropriate content management system. Some researchers believe that blended learning is an effective option for obtaining education in a general educational institution (Grimaldi et al., 2019)

Blended learning approaches turned out to be one of the most popular technologies of today, because the flexibility and convenience of a distance course can be added to the advantages of the conventional classroom. The content of a mixed (hybrid) course is proposed as a result of the integration of online courses (30%-70% of the educational process) with conventional classroom pedagogically-reasoned measures. Blended learning models that were researched and identified on the basis of experience with their use in higher education institutions became widespread and include the following (Kaban 2021):

- a model where online learning is supplemented by classroom instruction and access to electronic resources is provided from a computer classroom, laboratory, home (Model 1: face-to-face Driver). For example, the “flipped classroom” model;
- a model where online learning and conventional teaching alternate in accordance with the schedule (Model 2: Rotation). For example, the “rotation groups” model;
- a model where most of the learning process takes place in the learning environment with full-time support from the teacher (Model 3: Flex);
- a model where training is conducted in an online laboratory, which is equipped as a special classroom, where education seekers can receive online teacher advice and technical support is provided by laboratory staff (Model 4: Online lab);
- a model where education applicants choose online courses as additional materials for studying subjects in full-time mode (Model 5: Self-blend). For example, preparation for the academic competitions;
- a model where education seekers study remotely using the digital environment online, and pass on-site certification (Model 6: Online driver). For example, training during a long illness.

The combination of the conventional teaching in the classroom under the guidance of a teacher and independent work using information resources online facilitates the individualisation of the educational process and its approximation to the real needs of students of various levels of training.

5. Conclusions

The learning ecosystem is related to an integrated environment where all actors: students, teachers, administrators, parents interact with each other, and also use a large number of innovative products, technologies, teaching methods, and other elements of the learning ecosystem, using which the conditions of education are identified. Instead of exchanging energy between the components of the natural ecosystem in the learning ecosystem, data is exchanged. It is assumed that such an ecosystem may be in continuous development.

A study of the issue of introducing a synthetic learning environment for educational institutions was conducted. The synthetic environment is considered in two aspects – as artificial and as formed through a combination of the use of objects of the real physical world and the results of simulation and modelling. Criteria for using web-based technologies to create learning content have been formulated. In addition, traditional and blended learning approaches have been compared. The authors concluded regarding the acquisition of the level of the subject of education by the synthetic learning environment due to the expansion of its substantial and didactic potential, the transformation of the individual as a knowledge seeker into a synthesising factor of the educational process.

Recommendations

Based on the results of the study, several recommendations are drawn as follows:

1. Further study may include wider participants.
2. Further study may include the use of distance learning technology in higher education institutions.

3. Blended learning models are also worthy of being explored further.

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