Device availability by students to support blended learning in graphical sciences

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ABSTRACT: Modern education is going through significant changes due to the growing use of information technologies and the implementation of blended learning at world-leading higher educational institutions. Continuous and rapid changes are also taking place in the Russian educational system. The introduction of such an efficient method as blended learning depends on the availability of modern devices and students' willingness to interact with teachers on the Internet. The primary objective of this research was to analyse the availability of personal mobile devices and computers for students to secure direct interaction with teachers. The empirical evidence obtained at one of the leading Russian educational institutions confirms that the availability of modern devices for students is sufficiently high to support the introduction of blended learning. The authors of this article propose a roadmap to accelerate the implementation of blended and distributed learning in education.

INTRODUCTION

The orientation of training towards the creation of professional competencies makes it essential that students develop the skills of independent planning with a focus on results. One of the most efficient educational methods to develop skills of individual work is blended learning. With this approach, students learn how to make decisions independently and to adjust their activities. Students develop skills to function in the *information space*; search for, select and analyse information. As well they learn to present their results with the use of various modern technologies as required of a modern mining engineer [1] and an oil-and-gas specialist [2]. These competencies support the needs of a modern economy [3].

The coronavirus pandemic has shown that education needs to have technologies that help to efficiently meet educational needs under the conditions of self-isolation or, when it is necessary, to maintain a social distancing in a classroom.

Blended learning makes it possible to successfully and efficiently monitor students' work throughout lectures, seminars and tutorials providing communication respecting social distancing. However, for a successful implementation of blended learning and the use of various e-learning tools [4], it is necessary to take into account the availability of digital tools, the Internet and communication facilities for each student.

In this context, the task was set to study the availability of modern digital tools and technologies for students of leading higher educational institutions in St Petersburg, Russia.

The purpose of this study is to provide an assessment of the availability of modern digital devices for students in one of the leading Russian universities. This could justify the introduction of blended learning in the teaching of graphical sciences. Such an assessment is necessary to make recommendations on the methodological approach, including blended learning, to teaching graphical subjects [5] and to ensure course competitiveness [6]. The recommendations which were developed based on the research results can be applied to the teaching of other technical subjects that use a significant number of graphic materials as teaching aids [7], in the training of international students [8], as well as in the training of physically challenged people [9].

The following needs to be addressed to achieve the objectives of this study:

- to summarise the global educational experience in blended learning;
- to collect statistical data on the availability of modern devices for students;
- to carry out a statistical analysis of the collected data;
- to develop an implementation plan to introduce blended learning into the graphical training of students.

REVIEW OF LITERATURE

Deynega points out that the blended learning approach is closely related to the introduction of the new National Educational Standards in the Russian vocational training system, as well as to informatisation of education and shifting of the educational focus towards independent research activities [10]. Some papers characterise blended learning as an efficient didactic tool that actively uses special information technologies [10][11].

Sumtsova and Belousova describe three basic modes of blended learning:

- asynchronous, i.e. independent e-learning;
- synchronous, i.e. remote on-line interaction between a student and a teacher in a webinar or chat format;
- conventional training in a classroom following a fixed schedule [11].

The authors assume that blended learning helps students in developing skills to independently manage their learning using advanced Internet technologies: this is also seen as a valuable skill for a future professional. The researchers note that methodological support for the syllabus plays a key role in a successful implementation of blended learning. In this case the methodological support for the syllabus comprises teaching materials, information and communication technologies. The informational support for the educational activities usually depends on the organisation of the education and the information and communication technologies used. However, there are uncertainties regarding teachers' competencies in information and communication technologies and students' technical capabilities.

Researchers have compared the competencies of Russian and foreign teachers in the application of information and communication technologies as teaching tools [12]. Questionnaires were developed as part of the research for teachers that had experience in using information and communication technologies. This revealed that Russian and European experiences tend to be similar. It was found out that Russian and foreign teachers have the same competencies in using information and communication technologies as training tools. They apply them depending on the experience in implementing distance learning services, policies of an educational institution and understanding of the blended learning approach.

The techniques of blended learning are relevant for application in various training areas. Zhou and Wang widely apply blended learning in teaching the Chinese language at Yuncheng University using the YUOC on-line platform [13]. These researchers state that this kind of technology helps to enhance teaching methodology, which is especially critical in planning in-class learning and allows optimisation of the training. Implementation of blended learning is also discussed in other papers [14][15]. The problems connected with the application of blended learning are described in other materials [16][17].

In their study, Soeparno and Muslim discussed the effectiveness of e-learning used as a part of blended learning [18]. This research highlights an important advantage of e-learning, i.e. it can be arranged in any place and at any time, provide an efficient access to materials and tasks, and facilitate the interaction between teacher and student.

The studies focused on the application of the modular object-oriented dynamic learning environment (Moodle) platform in blended learning and are described in several articles [19-21]. Moodle is a user-friendly on-line learning management system, used all over the world for on-line training of undergraduate, post-graduate and doctoral students. Researchers Memon and Rathore are successfully using this platform in medical education [20].

In the research, the application of the Moodle Platform is described for training students in tooth decay diagnostics using panoramic images. The authors come to the conclusion that modern information technologies are very efficient and strongly recommend using open-source software, learning management system (OSS-LMS) packages in dental training [22].

Kulkarni et al report positive results in the application of blended learning technologies as compared to conventional teaching methods [21]. The success rate was 21% higher in comparison to a control group. Statistical analysis found in favour of strong participation with a t-value of 2.617 and a p-value of 0.013. The result is relevant for $p < 0.05$. The survey was done as a part of the Moodle efficiency analysis.

The results of the research in blended learning based on the m-learning mobile educational platform are published in several articles [22-29].

Researchers Lam et al in their paper study the evolution of mobile learning. M-learning is perceived as an extension to e-learning that is accessible at any time and in any place [23]. The authors note that during the implementation of m-learning it is required to verify the technical capabilities of students.

In the article by Elyakim et al, the research involves the use of smart phones for all-round studies of the English language at the Central University of Venezuela [30]. This experiment included questions regarding the characteristics and capabilities of mobile devices owned by students. The key requirement is Internet access, as well as the students' skills in using Internet resources from their mobile devices.

A questionnaire was made up for ten students who studied in the 2nd term in 2016. The outcome of the experiment revealed a positive reaction to personal communication with smart phones as a part of the educational process in the classroom. The use of this digital tool helped to create a social and interaction network within the group.

The topic of mobile learning is also touched upon in several studies that describe further enhancement to blended learning through the implementation of mobile learning based on the MLE learning theory [28-30].

The studies related to augmented reality (AR) are presented in an article Trifunović et al [31]. In this article, the authors discuss the challenges of spatial visualisation used as a new information technology for training using mobile devices. The same problems connected with the use of AR technology in an educational process are also addressed by Jantjies at al [32]. This paper reviews publications assessing the potential use of AR and virtual reality (VR) technologies in the training process based on the experience gained at educational institutions in South Africa. Despite the fact that assessment of the educational efficiency of AR and VR technologies in such areas as mine safety in South Africa has been carried out, there is still a need for the research that would focus on the potential of AR and VR application to expand the capabilities of such educational institutions as universities and technical/vocational schools that require their students to undertake experimental training in order to get their degree or qualification. The research objective is to establish a potential role that AR and VR technologies can play in the modelling of specific learning environments in order to enhance the experience-based training by providing the students with practical work experience in various educational spheres.

RESEARCH DESIGN

Data Collection and Analysis

A questionnaire was developed using the Google Forms on-line service to assess the availability of computing and mobile devices for students. The selection of the Google Forms was determined by the following factors: they are easy to create and use; they have high accessibility; it is possible to have individual designs; they are free-of-charge; they are secure; they are easy to adapt for mobile devices. The questionnaire could be used on any device and students could be surveyed in a classroom which enhances the reliability of the survey results; it helps ensure completion of the task of filling-in the questionnaire, as well providing technical advice. The questionnaire included 19 simple closed questions with the average answering time varying from 2 to 5 minutes. The use of the closed questions at the initial stages of the experiment helped to promptly analyse the results by applying automatic processing. All the questions in the questionnaire were divided into the following three groups:

- the first group aimed to provide information on the personal data of a respondent, i.e. living conditions, nationality, gender, age and the training profile of a student;
- the second group focussed on technical specifications of the devices and IT technologies used by a respondent, as well as the level of their satisfaction with these;
- the third group explored the attitude of a student towards interaction with a teacher on the Internet.

Calculation of the Sample Size

Three thousand students study at the Department of Perspective Geometry and Graphics at the university chosen for this study. Students that study at different departments and with various training profiles were randomly selected for the survey. The representative sample size was calculated using a well-established equation:

$$n = \frac{t^2 qpN}{\Delta_p^2 N + t^2 pq} \tag{1}$$

where N is the total number; $p \cdot q = \sigma^2$ is the dispersion of alternative characteristic; for the case when the p is not approximately known, it is possible to make a rough calculation of the sample size by introducing the maximum value of the dispersion share equal to 0.25; Δ_p is the admissible error share which in the sample equals 10% ($\Delta_p = 0.1$); t is the trust (confidence) coefficient, that depends on the probability with the help of which the admissible error is calculated for the sample.

In this particular case for the representative survey with non-repeated sampling, admissible observational error of 10%, probability of 95% and the total number of students equal to 3,000, it was required to survey at least 97 respondents to perform a preliminary analysis and create a model.

Processing the Survey Results with the Cluster Method

Cluster analysis was selected to analyse the survey data. This technique does not require any prior assumptions about the datasets, does not impose any limitations on the representation of the studied objects and enables analysis of various types of data (interval, frequency, binary).

The Statgraphics software package was used for the initial data processing and cluster analysis. The cluster division was done by using Ward's method, which takes the distance between the clusters to equal the increment in sum of squared distances between the objects and the cluster centres. In comparison to the other methods of cluster analysis to assess the distance between the clusters this technique applies analysis-of-variance. This method is most appropriate if the sample size is not big, i.e. below 200 people.

RESULTS

One hundred and forty students were surveyed over two working days using mobile phones and Google forms. This was 43 respondents more than it had been planned, which reduced the survey error down to 8%. The participants of the questionnaire were students aged from 18 to 28 with the citizenship of Russia and other countries, i.e. African countries (3%), Asian countries (2%) and the CIS countries (2%). The majority of the surveyed students reside at the university hostel (70%), the rest live in their own flats (15%) or rent an apartment (15%).

The key results of the survey data are given in Table 1 and Figures 1-5.

Table 1: Survey results.

No.	Parameter	%
1	Availability of a laptop	95
2	Availability of a desktop	19
3	Free access to the Internet	90
4	Presence of a Web-camera in a computer	88

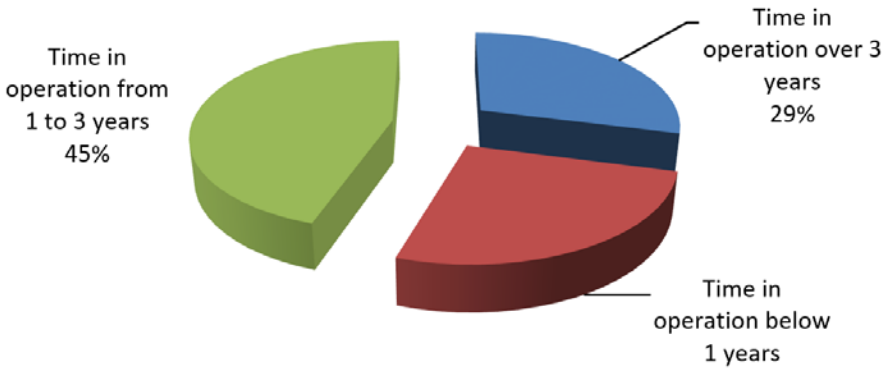

Figure 1: Time in operation of the computing devices.

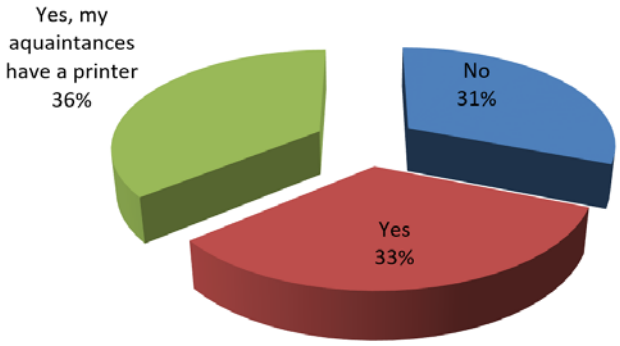

Figure 2: Access to printing devices.

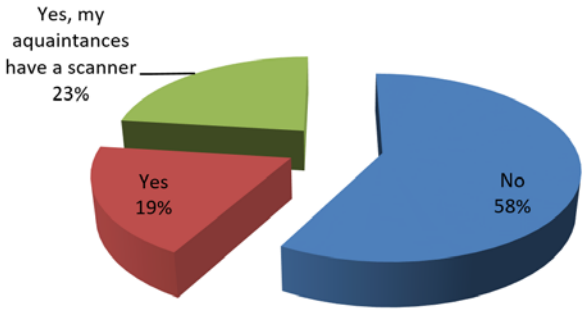

Figure 3: Access to scanning devices.

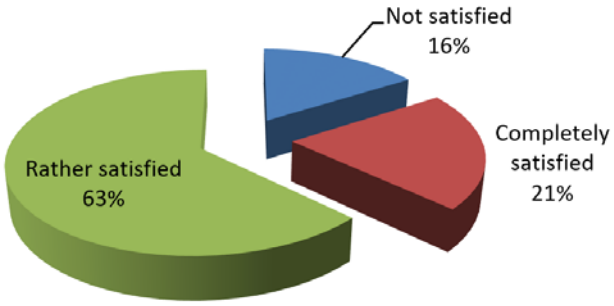

Figure 4: Quality of the Internet connection at home.

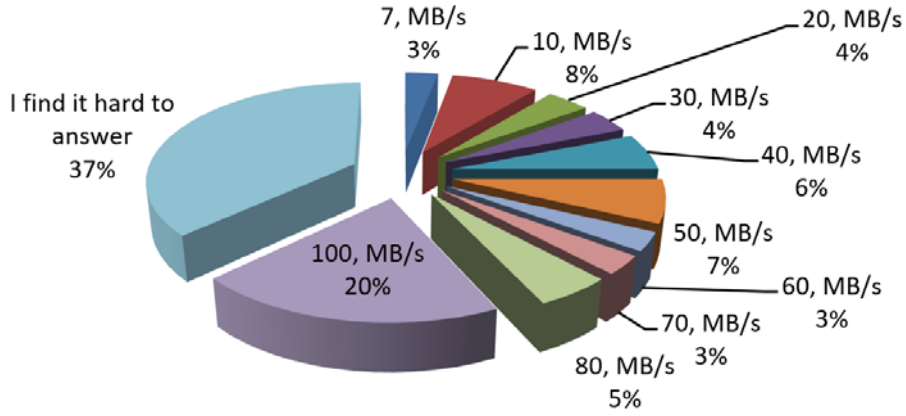

Figure 5: Speed of the Internet connection at home.

The above results indicate a high level of technical means available to the university students. In particular, this refers to mobile devices and access to the Internet. Around 27% of the devices are of the recent generation with the time in operation of less than one year. An important aspect for the implementation of blended learning is students' access to the Internet with sufficiently high-quality and high-speed connection, which is available to around 80% of the respondents. That is crucial for transmission of high-quality graphics, videos, computer animation and for training simulators.

Summarising the survey results, the minimally required number of devices and resources is available to students for the unhampered execution of on-line counselling, tests, examinations, surveys, laboratory and practical trainings. In this connection, when designing interaction activities for students the key focus should be placed on the use of portable devices, e.g. laptops, mobile phones, tablets, as they predominate.

The answers to the following three questions of the on-line questionnaire were selected for the cluster analysis:

Question 1: What ideas and knowledge do you have about augmented reality? Score yourself from 1 to 10.
Question 2: Is it necessary to use modern IT and Internet technologies in studying graphics? Score yourself from 1 to 10.
Question 3: How acceptable is it for you to communicate with a teacher on the Internet? Score yourself from 1 to 10.

As the result of the cluster analysis, it is possible to divide the students into two main groups, which characteristics are provided in Table 2.

Table 2: Cluster analysis results.

Cluster	Share of surveyed, %	Average score		
		Question 1	Question 2	Question 3
1	60.14	6.02	8.64	7.62
2	39.86	3.33	6.47	5.70

Generally speaking, the students in the first cluster tend to possess rather good knowledge of IT. As the result these students are ready to use any IT technology in their learning. A significantly high Internet user level enables this group to master any kinds of new educational Internet technologies without spending significant time and effort.

The students in the second cluster do not feel comfortable in using Internet technologies although they have some basic Internet skills. Limited practice and experience in using educational Internet resources largely determine their unwillingness to familiarise themselves with innovative educational technologies. A significantly high number of such students (around 40%) calls for a closer attention to be paid to this group.

The following activities can be recommended as a roadmap for the implementation of new educational technologies:

- to introduce and practise the use of personal CRM accounts in the Bitrix-24 platform, augmented reality, chatbots and other intensively developing technologies in existing curricula;
- to provide extra hours and counselling when assignments based on the Internet technologies are given;
- to develop and use various methods of stimulation for students who intensively use the latest Internet technologies;
- to engage the most active first- and second-year students into research activities with application of modern learning technologies and their adaptation to specific tasks of each particular educational subject.

CONCLUSIONS AND IMPLICATIONS

The qualitative assessment in this article of students' capability and their interest in using available technical means supports the introduction of blended learning techniques in studying graphical sciences. The implementation of blended learning will help to boost students' performance in graphical sciences due to the open character and flexibility of the training. In turn, this should enhance students' motivation and stimulate their interest towards the academic subject, as well as to create stable and prompt communication between all the participants in the training.

There are various materials prepared by teachers of the Department of Perspective Geometry and Graphics with wide application in blended learning. The presence of these materials combined with the high availability of personal computing and portable devices by students helps support the following activities required for mastering engineering graphics, e.g. to arrange virtual tours to simulated facilities of the mining industry; to study the operational principles of the processing equipment; to collect and analyse students' test and examination results in a prompt manner. Furthermore, it is necessary to enhance and redesign the available teaching aids by adapting them to the most recent computer technologies and to create new training materials.

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