El concepto de BYOD en la prueba de resultados de aprendizaje: comparación de aplicaciones móviles

BYOD concept in testing of learning results: comparison of mobile applications

Alla Dmitriyevna Kulik[1a], Natalia Kovalevskaia[2], Tatiana Stanislavovna Bastrykina[3], Indira Irekovna Kokhanovskaya[4] & Ekaterina Anatolyevna Shugaeva[5]

Peoples' Friendship University of Russia (RUDN University), Moscow, Russian Federation[1]
Saint-Petersburg State University, Russian Federation[2]
Russian State University of Tourism and Service, Moscow, Russian Federation[3]
Military University of the Ministry of Defense of the Russian Federation, Russian Federation[4]
K.G. Razumovsky Moscow State University of Technologies and Management (First Cossack University), Moscow, Russian Federation[5]

ORCID ID: https://orcid.org/0000-0002-1545-641X[1]
ORCID ID: https://orcid.org/0000-0003-0864-0937[2]
ORCID ID: https://orcid.org/0000-0003-0093-1158[3]
ORCID ID: https://orcid.org/0000-0002-1711-5985[4]
ORCID ID: https://orcid.org/0000-0002-0941-7633[5]

Abstract

The BYOD (Bring Your Own Device) concept provides extended opportunities for implementation of ICT into all forms of learning. The aim of this work is to propose optimum variant of arrangement of mobile testing of learning results of students using BYOD. The article reviews the scientific literature on the problem under study and presents the advantages of BYOD technology in testing learning outcomes. On the basis of online survey of the teachers, IT experts, and network administrators, the opportunities of mobile applications have been compared during testing of learning results, the optimum variant of mobile testing of learning results of students using Google services has been proposed. The results of the study show that the use of the BYOD concept expands the boundaries of testing, makes the testing procedure more flexible and systematic, introduces gameplay elements into the testing procedure, and contributes to the actualization of students' knowledge. The use of cloud services of the Google search engine for testing within the BYOD concept has several advantages over similar software services: comprehensive support of the testing system from creating appropriate forms to saving the results in the cloud data storage for processing test results and managing the testing system based on using the Google Calendar service, the ability to create a budget testing system due to the use of free Google services.

Keywords: BYOD, university, students, information services, Google, mobile application.

Resumen

[a]Correspondencia al autor:
E-mail: pesochek08@mail.ru

El concepto BYOD (Bring Your Own Device) ofrece amplias oportunidades para la implementación de las TIC en todas las formas de aprendizaje. Por ello, el objetivo de este trabajo es proponer una variante óptima de disposición de las pruebas móviles de los resultados del aprendizaje de los estudiantes que utilizan BYOD. El artículo revisa la literatura científica sobre el problema en estudio y presenta las ventajas de la tecnología BYOD para probar los resultados del aprendizaje. Sobre la base de una encuesta en línea para los profesores, expertos en TI y administradores de red, se han comparado las ventajas de las aplicaciones móviles durante la prueba de los resultados del aprendizaje, y se ha propuesto la variante óptima de la prueba móvil de los resultados del aprendizaje de los estudiantes que utilizan los servicios de Google. Los resultados del estudio muestran que el uso del concepto BYOD expande los límites de las pruebas, hace que el procedimiento de prueba sea más flexible y sistemático, introduce elementos de juego en el procedimiento de prueba y contribuye a la actualización de los conocimientos de los estudiantes. El uso de servicios en la nube del motor de búsqueda de Google para realizar pruebas dentro del concepto BYOD tiene varias ventajas sobre servicios de software similares: soporte integral del sistema de pruebas desde la creación de formularios apropiados hasta el almacenamiento de los resultados en el almacenamiento de datos en la nube para procesar los resultados de las pruebas y administrar los sistema de prueba basado en el uso del servicio Google Calendar, la capacidad de crear un sistema de prueba de presupuesto debido al uso de los servicios gratuitos de Google.

Palabras clave: BYOD, universidad, estudiantes, servicios de información, Google, aplicación móvil.

Introduction

Computer testing as one of the forms of knowledge monitoring combines advantages of conventional testing: efficiency of evaluation of mastering the studied material, increased level of objectivity of knowledge testing, minimum time consumption to obtain reliable monitoring results (Dyganova, & Yavgildina, 2020), increased efficiency of monitoring activity by teacher due to higher frequency and regularity) and advantages of computer system (standardized procedure, automated processing, opportunity to save test results with subsequent analysis regarding various terms, etc.) (Thurlow et al., 2010; Luecht, 2005).

A significant drawback of computer systems of test monitoring is requirements to equipment for deployment of the system. The number of computers should be the same as the number of tested persons (Russell et al., 2009). It is quite natural that for most disciplines, for which testing takes much time during classes, it is not possible to transfer overall learning process to computer class (Obedkova, 2020; Vinichenko et al., 2020b).

This problem could be solved, for instance, by means of mobile devices of students for test monitoring. At present, there are numerous applications on the basis of cloud technologies, which facilitate the use of BYOD concept for testing of learning results (Hockly, 2012; Vinichenko et al., 2020a). For this reason, the BYOD concept provides opportunity for certain persons to work with available resources using own devices. In this case, users become more mobile, and mobility is mainly

based on Wi-Fi standards in companies, away and at home (Messmer, 2012). In education it means the use of students' own devices for implementation of learning purposes.

At present, the BYOD concept becomes more and more popular (Pushkarev et al., 2019). Thus, according to French et al. (2014), more than 80% of employees in USA use their own mobile devices to solve their working problems. In this case, UNESCO in the frames of implementation of the new pedagogy concept formulated the main trends of application of new ICT, which were based both on cloud technologies and mobile applications in education, including those supporting personal devices in the frames of BYOD concept in educational process (Burns-Sardone, 2014; Krivova et al., 2020).

Literature review

Sangani (2013) introduces the definition of mobile information and communication technologies of education, interpreting it as a set of hard- and software, as well as the system of methods and forms of application of such aids in learning process aiming at acquisition, saving, processing, and reproduction of audio, video, text, graphical and multimedia data under conditions of online communication with global and local resources.

On the basis of the analysis of potentials of information and communication technologies of learning (ICTL), the author (O'Bannon, & Thomas, 2014) concludes that continuous development of portable (mobile) computing devices creates preconditions for their efficient use in learning process. Portable devices and communication means become more available, efficient, and multifunctional, which provides wide opportunities to expand ICTL opportunities. The rating of parameters (Hawkes, & Hategekimana, 2009), characterizing development of ICTL, indicates at prioritized implementation of mobile communication and computing devices to create mobile educational environment.

Johnson (2012) considers convenience, mobility, information content, access at any time and from anywhere in the world, and simultaneous work of a group on a project the main advantages of BYOD technology in teaching. For its part, Song and Kong (2017) consider its advantages to be instant data fixation, creation and processing of videos, photos, easy creation and scanning of a QR code, which provides free access to information sources, access to electronic maps, dictionaries, and encyclopedias, and, most importantly, cooperation with members of the project group in real-time, regardless of positioning, as well as the implementation of operational communication through online surveys in real-time. Parsons and Adhikari (2016) highlight mobility, accessibility, compactness, speed, and modernity. However, the authors also point out the disadvantages of using mobile devices in the educational process: the negative impact of mobile devices on health; the functionality of mobile devices can differ significantly; there is always a risk that the student will use their device for non-educational purposes.

The research hypothesis is as follows: the use of Google cloud technologies for testing in the frames of the BYOD concept is an efficient monitoring tool of learning results. The research tasks are as follows:

1. to consider opportunities of BYOD in testing of learning results;

2. to compare opportunities of mobile applications upon testing of learning results;

3. to propose optimum variant of development of mobile testing system of learning results.

Methods

To achieve the goals of the research, a mixed study design was developed. A complex of theoretical and empirical research methods was used:

• theoretical methods: analysis, synthesis, comparison, generalization. Those methods we used for analysis of publications devoted to the considered problem;

• empirical method: online expert survey;

• numerical methods: mathematical processing of respondents' results, ranking, calculation of the coefficient of concordance (Agee, 2009).

In total, 30 information sources were selected that are necessary for the implementation of the research goal, of which 2 monographs, 25 articles in scientific journals, and 3 articles based on the materials of scientific conferences.

The first group of sources: monographs, articles published in Scopus and Web of Science indexed journals, containing conceptual provisions regarding the use of BYOD technology.

The second group of sources: articles published in Scopus and Web of Science indexed journals and speeches at conferences of researchers from different countries devoted to the experience of using BYOD technology as a system for mobile testing of student learning outcomes.

The main research method was the method of expert interview in online form.

Participants of the research

The online expert survey involved educators, IT professionals, and network administrators, a total of 43 experts (Figure 1).
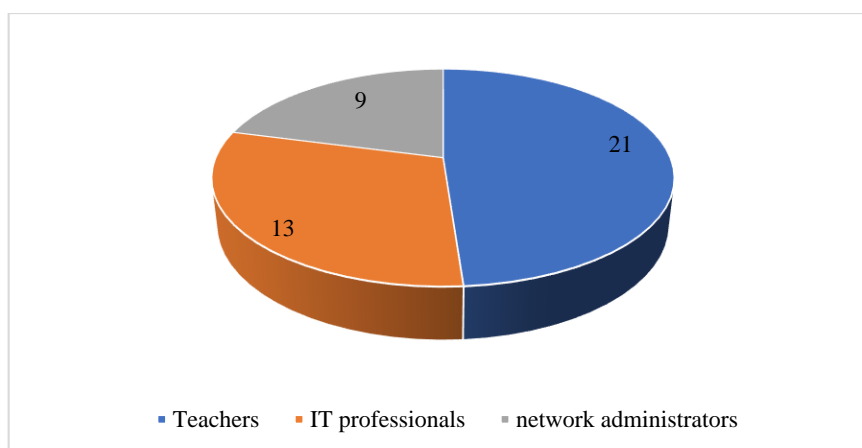
Figure 1
Distribution of respondents by occupation (people)

The selection criteria for experts were the availability of articles on this topic published in journals included in the Scopus or Web of Science citation bases in an amount of at least 3 or work experience of at least 10 years. All survey participants were warned about the purpose of the survey and that the organizers of the study planned to publish the survey results in a generalized form without specifying the personal data of the participants.

Research instruments, procedure

The experts were sent e-mails with a questionnaire "Usage of mobile applications in education" to indicate the most popular, in their opinion, mobile applications used in testing learning outcomes, as well as to rank them. The experts were asked questions from a pre-prepared questionnaire "Usage of mobile applications in education", which included six questions concerning the expert preferences of the mobile applications proposed for consideration (1 question), their functionality, including when testing learning outcomes (4 questions), and ranking the most popular mobile applications (Goggle Forms, Plickers, SurveyMonkey, Questionnaire, SMART Response VE, Mentimeter, mQlicker) used in testing learning outcomes (1 question). The selection criterion for mobile applications was the number of search results in the Google search engine.

They were told on what topic the research was being carried out and what hypothesis was put forward in the work. The same request in Russian was sent to the experts and 20 calendar days were given to respond. The limited time frame and one-time dispatch allowed for equal conditions for the experts.

Statistical analysis

The last question of the questionnaire was devoted to the ranking of the mobile applications proposed by the experts to determine the optimal variant of building a system for mobile testing of student learning outcomes. The ranking of mobile applications consisted in their arrangement by each

of the experts in the form of a sequence in descending order of their preference. Moreover, each of the mobile applications was evaluated by the rank (number) under which it was located in the given sequence. The final rank of a mobile application was the arithmetic average of all expert ranks. When processing the research results, the Microsoft Excel application was used, as can be seen in Friesen, Kuehnle and Szaj (2003). The assessment of the consistency of expert opinions was carried out using the concordance coefficient (W), calculated in the SPSS statistical data processing software (Krippendorff, 1970).

Results

Based on the expert survey, the ranking of existing mobile applications for testing student learning outcomes was carried out (Table 1) and a brief description of their capabilities was provided.

Table 1
Ranking mobile apps for testing learning outcomes

No.	Mobile application	Rating
1	Google Forms	1
2	Plickers	2
3	SurveyMonkey	3-4
4	Anketolog	3-4
5	SMART Response VE	5
6	Mentimeter	6-7
7	MQlicker	6-7

Remark: calculated based on the online survey

The results of assessing the consistency of expert opinions using the concordance coefficient (W) showed that W = 0.765. Therefore, we can talk about the high consistency of expert opinions regarding existing mobile applications for testing student learning outcomes. It was provide a brief description of the capabilities of mobile applications for testing student learning outcomes, obtained based on the expert survey.

Goggle Forms allows one to create tests based on the use of forms of the Docs Google service, store forms with tests and results of filling out forms in the Google Drive cloud data storage results database, process test results in Google Spreadsheets, and plan and coordinate all work related to testing educational achievements, using the management subsystem of the testing system based on the Google Calendar service, as well as the presence of eight types of questions in the service.

Plickers allows one to organize testing with one smartphone or tablet for a significant number of students; use when testing QR codes, the information of which is deciphered in the program by the

camera of a smartphone or tablet. Moreover, each student has their own universal card with a QR code for all questions.

SurveyMonkey allows creating any type of survey using the builder, from the simplest to the most complex. It contains more than 15 types of questions and makes it possible to use logical rules for moving between pages and questions and skipping them, sending surveys using mobile devices and social networks. There is fast and convenient email support, as well as integration with the statistical package for the social sciences (SPSS) for the analytical analysis of the results. At the same time, as one of the experts pointed out (Nikolay, 11 years of work experience), "it is possible to receive answers in real-time and perform partition and fragmentation of data to obtain analytical conclusions".

Anketolog allows one to create questionnaires of varying degrees of complexity, which contain multiple-choice questions, complex logical branches, explanatory text blocks, etc. It provides the ability to post questionnaires on any web resources in the form of widgets, embedded blocks, or direct links, as well as take a survey from any device: a desktop computer, laptop, tablet, or smartphone. Survey results are available to their developers in the personal account.

SMART Response VE allows one to practice on any mobile device, anywhere in the world and supports various internet browsers. During classes, students can access the SMART Response VE website, allowing them to individually answer questions using their mobile devices.

Mentimeter supports interaction with respondents in real-time, as well as posing questions directly to the audience. Those present using any mobile device connected to the Internet can send answers that can be shown to the audience from the teacher's computer.

mQlicker allows one to create tests and surveys, answers to which can be sent by respondents using mobile devices. It allows for the creation of multiple-choice polls with either one or the provision of numerical or textual responses and the presentation of processed responses in real-time.

Among the disadvantages of the Russian applications, SurveyMonkey and Anketolog, the experts (Valentin G., work experience 12 years; Sergey N., work experience 7 years, 3 published articles) mention that they are aimed mainly at the arrangement of questionaries and surveying. In addition, a complete pack of the declared opportunities is provided in the framework of the tariff plan; in the case of free use of the services, their opportunities are significantly restricted.

Among the disadvantages of mQlicker, Mentimeter, and SMART Response VE, the experts (Valentin D., work experience 8 years, 3 published articles; Tatiana M., work experience 13 years) mention the absence of cloud storage, a limited toolkit for processing testing results (for instance, in the Mentimeter service, it is possible to transport the testing results into Excel for an additional fee), the existence of only English interface, which significantly reduces the opportunity of their wide implementation into the learning process in Russia.

Discussion

Based on the expert survey regarding the choice of application to develop a budget and user-friendly system of mobile testing, it is possible to conclude that it should be based on Google services (Galizina et al., 2020). As mentioned above, the system of mobile testing based on Google services is comprised of the following components. The process of testing learning outcomes based on Google search engine services using BYOD includes the following tests form (Song, & Kong, 2017). By its part, Parsons and Adhikari (2016) test development in the form of a Google form. Registration of test participants; creation of a Google Calendar with events for managing testing and providing test participants with access to the created calendar; connecting mobile devices of test participants to the created Google Calendar; passing the test by test participants; processing of test results in Google tables (Obedkova, 2020).

At the same time, eight possible types of questions verify the assimilation of almost all the material covered. In this case, the work of Kim (2008) considers the classification of 24 different forms of test items. The eight types of Google-form questions do not cover all possible variants of the test item forms. However, they are sufficient for the development of reliable and technological test items for all classification groups given in this work.

Assignments with the selection of correct answer are formed in Google form using the question "One from the list", the assignments with the selection of several correct answers – using the question "Several from the list". On the other hand, assignments with rated answers in tests contain variants, which may all be correct. The answers are ranked in terms of correctness. These tasks are implemented in Google form using the "Scale" question (Galizina et al., 2020).

Assignments for detection of matching, which require finding matching between elements of two sets, can be presented in the form of the "Grid" question. In this question, the elements of one set are positioned in lines, and the elements of another set – in columns. The same type can be used for assignments on setting the correct sequence, where a tested person should select not only respective answer elements but also place them in the correct sequence (Kim, 2008). In this case, the respective elements are positioned in strings and their numbers are in columns in random order. In this case, it is required to find the correspondence between the elements and their numbers.

According to Song and Kong (2017), with a significant number of tests on a discipline, it is convenient to manage the testing events using Google Calendar cloud service, which allows scheduling the activities related to testing. Each testing in Google Calendar is accompanied by two events with adjusting of notifications by SMS, e-mails, and/or messages in social networks. One message contains a notification about testing on a predefined topic. The second message is sent at a predefined time to the users of the testing system with a link to the form with a test. In addition, one

of the components of Google Calendar is List of tasks, where future and current tasks are determined, for which the user can set priority. This is especially convenient to schedule test assignments.

To combine all events related to testing in one calendar, it is required to create a new calendar in "My calendars", for instance, entitled "Test". To provide receiving of notifications about test events by the participants, it is required to provide common access to the Test calendar (to create a list of e-mails of the participants in the menu option "Open common access to the calendar"). To receive SMS notifications, all participants should connect their mobile devices to the Test calendar (Szabó & Pšenáková, 2017). After creation in Google Calendar of Test events, it is necessary to notify the participants in the testing (reminder about the time of testing and sending forms with tests). In respective SMS with a reminder, the participant in the testing pushes the button to accept the invitation and the organizer of the event receives notification in the Test calendar about the consent of the participants to pass testing.

According to Russell, Hoffmann and Higgins (2009), meeting the needs of all students: A universal design Using the obtained link, the created form is opened on the mobile device and the tested student consecutively answers the test questions in the form. After filling the form and pushing the "Submit" button, the test result is recorded in the cloud in Google sheet. The obtained answers can be reviewed using four methods: in the form of introduction; in the form of answers of single users; in a table; in a CSV file (text format intended for presentation of sheet data) (Google, 2021b).

The test results are sent in the mode of shared access of users to files stored on Google Drive (Google, 2021c). Here it is necessary to dwell in more detail on the possible use cases of test control based on BYOD using mobile applications. Possible variants of test monitoring based on BYOD should be considered more thoroughly (Keyes, 2013).

We propose the following training schemes with such test control:

- Input monitoring on the topic of previous class;

- 2-3-fold current monitoring during classes aimed at detection of the degree of assimilation of the material presented;

- Final monitoring, which covers all material presented during the class.

Under usual conditions of classes, a teacher has neither time nor opportunity to execute regular test monitoring (Vinichenko et al., 2020a). According to the recommendations by the experts, under conditions of adjusted access to test forms, the monitoring consumes from 5 to 10 minutes. As for current monitoring, the number of test assignments, in this case, should be from 3 to 5, and the time for answers should be 2-3 minutes. Such progress of classes enlivens the work environment, modifies the rates, and adds competitive elements and, hence, motivation of tested persons to studying material (Vinichenko et al., 2020a). Herewith, according to one of the surveyed, due to simple and available testing procedures based on BYOD, the number of tests on a discipline can be sufficiently high.

BYOD eliminates this restriction, and due to own mobile devices, the computer testing of learning outcomes can be carried out both in classes and outside (Kong & Song, 2015). Such an approach allows implementing systematic test monitoring at all stages of the didactic process: from the initial knowledge acquisition to its practical application (Dermo, 2009). In turn, implementation of systematic test monitoring at all stages of the didactic process promotes actualization of knowledge due to extraction from short- or long-term memory of previously learned material for its use during testing and, respectively, reduces the portion of learning material that is forgotten (Ahmed, 2012).

Even though the testing process takes place outside the class, in such form, it is somehow converted into a quest, where the key role is given to the solution of problems, requiring from a participant mental efforts and necessary knowledge on respective discipline irrespective of the location of the participant (Hillier, 2015). Based on systematic monitoring of testing, the interactive history is developed with the main hero – participant in the testing, who passes the tests, level by level. After completing the quest, the student acquires experience, points, rating (reputation), etc. (Burns & Lohenry, 2010). Such an approach allows making the learning process more dynamic and interesting.

The use of Google cloud services for testing in the framework of BYOD is characterized by a set of advantages in comparison with similar software services. First of all, this is the integrated support of the testing system from the creation of respective forms to the storage of results in the cloud to process the test results and management of the test system using Google Calendar service (Krivova et al., 2020). Another significant advantage of the proposed approach is the opportunity to create a budget test system due to the free use of open Google services (Pushkarev et al., 2019).

Despite certain difficulties (standardization of mobile devices, engineering and pedagogical problems of implementation of mobile devices into the learning process, etc.), the use of BYOD expands the boundaries of testing in space and time, makes testing more flexible and systematic, and adds game features into the testing (Welsh et al., 2018; Song & Wen, 2018). The opportunity to organize systematic monitoring of learning achievements anywhere at any time promotes the actualization of students' knowledge (Hung, 2017). As mentioned in the studies by Terzis and Economides (2011) and Maqableh et al. (2015), despite all positive advantages of computer testing, its wide use is sometimes restricted due to the unavailability of the required technical base.

Finally, this study has certain limitations: the selection of applications by popularity for evaluation by the experts, on the one hand, increased the quality of the results. On the other hand, we selected applications by only one criterion (the number of queries in the Google search engine), which makes it difficult to transfer the results to all mobile applications used to test learning outcomes.

Conclusion

Students use their mobile devices for learning purposes; therefore, it would be quite natural to use these devices for arrangement of classes and to consciously incorporate these devices into the learning process. Analysis of state and potentials of development of ICTL has demonstrated prioritized implementation of mobile devices for development of mobile educational environment. Due to the fact that mobile devices become more and more available, efficient, and multifunctional, it is possible to expand opportunities of ICTL based on BYOD.

Therefore, this concept is capable to provide implementation of ICT in all forms of learning and, in particular, in testing of learning achievements. Finally, the research hypothesis has been confirmed that the use of Google cloud services for testing in the frames of BYOD concept is an efficient tool to monitor the learning results.

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