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Mobile Applications in Education:
Implementation Aspects and Impact on Student Competencies Development

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ABSTRACT

The purpose of the study is to consider the features of the use of mobile applications for the development of professional competencies, in particular cognitive skills, and their general impact on the effectiveness of learning. There were 845 students from two countries participating in the research. The students were divided into two groups: one group was trained in accordance with the curriculum developed based on mobile applications while the curriculum of the second group was not changed. The results of the reinterview showed a significant increase in the cognitive abilities of respondents in Group 1 as 81% of them indicated a strong effect of the use of mobile applications on the development of cognitive skills. The analysis of the results also showed an increase in the students' motivation to use mobile applications as compared to the survey conducted at the first stage the list of professional competencies and percentage changed.

KEYWORDS

Cognitive Skills, Mobile Applications, Modern Technologies, Pedagogical Innovation, Professional Competency

INTRODUCTION

The rapid development of science and technology affects the educational process and the changes in its methodological characteristics. Today in connection with the new global context of the pandemic, online education is gaining popularity. In particular, mobile applications are used not only for entertainment but also for educational purposes (Drigas & Angelidakis, 2017; Farrah & Abu-Dawood, 2018). Research shows the effectiveness of educational technology products that contribute to the development of cognitive skills as the completion of tasks of different complexity, performance of similar actions, or acquisition of new experiences contribute to the development of the cognitive activity, memory, and concentration (Drigas & Karyotaki, 2014; Qi, 2021; Saedi et al., 2018). Modern mobile applications facilitate the integration of innovations into the learning process. Such solutions are gradually replacing traditional learning methods, in particular, note-taking, lectures, research, storytelling, and reports, which have lost their effectiveness and relevance (Teymurova et al., 2020).

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The functionality of mobile phones has dramatically expanded: they are no longer only a means of communication but also an effective mechanism for learning, increasing the level of knowledge, practical skills, and professional competencies (Ahmad, 2020). Educational mobile applications are used at all stages of education, starting from the junior age. They are proved to contribute to cognitive development and improve critical thinking as, when solving various puzzles, taking part in quests, or looking for the differences between pictures requiring knowledge and developed thinking, the parts of the brain responsible for cognitive processes are stimulated (Lawrence & Choe, 2021; Orakcı, 2021). In contrast to the traditional education system, to which the human brain has been accustomed for a long time, non-standard learning based on mobile applications leads to the development and improvement of memory by solving tasks of varying sophistication. Modern mobile applications are designed in a way allowing learners to spend little time watching videos but stay highly concentrated during this period. Such mobile mechanisms are based on the principle of the review of knowledge and skills previously acquired (Tanil & Yong, 2020). The available data on the impact of digital learning on the verbal and visual perceptual components of the cognitive skills of children of different ages obtained via psychological tests evidence that the respondents with a higher level of digital skills are better at naming, semantics, visual memory and logical thinking (Pereira et al., 2017). Mobile applications develop and improve such professional competencies as the skills of non-standard and original thinking, the ability to use the knowledge gained in practice and generate new ideas. At the same time, excessive use of mobile applications for no specific purpose can also negatively affect cognitive abilities, their deterioration, or slowdown. The most common examples here are:

- Media resources that negatively affect attention as the human brain cannot process a large flow of information and recognize true or false facts.
- Navigation systems that are associated with a deterioration in the cognitive construction of a map as a person uses ready-made answers rather than thinking and knowledge.
- Smartphones that can reduce the ability to process information.
- Search engines and Facebook that often lead to distracted attention, which has an adverse influence on academic performance (Wilmer et al., 2017).

Cognitive functioning occurs in the process of continuous learning and active thinking. Consequently, today universities strive to develop and improve the technological aspect of the education system and equip teachers with the tools needed to conduct classes with interactive technologies (Mkrttchian et al., 2019). Universities are actively enhancing the technology of online education in connection with the current situation in the world. The promotion of distance learning is explained by the need to develop new professional skills and competencies to apply various mobile applications, online learning resources, and software, as well as to maintain contact between teachers and students. Moreover, all types of modern technologies, media resources, and interactive educational programs contribute to cognitive development, particularly the improvement of attention, perception of information or images, and memory (Anderson & Subrahmanyam, 2017).

Overall, the basis for the development of human cognitive skills is formed at an early age as it is further involved in creating the foundational human qualities. At the same time, the formed prototype of human cognitive skills is capable of progress. That is, it can be developed in the course of further education of the individual in school or university (Kosunen et al., 2016).

Background

In the modern education system, there is an emphasis on student-centered learning and informatization through the active use of modern gadgets and innovative technologies (Tangirov, 2020). The use of mobile applications has a positive effect on the expansion of learning opportunities as the teacher can use interactive technologies to visualize theory and show the possibilities of its practical application. Students, in turn, can not only find the information they need with the help of mobile phones but

also watch all kinds of videos and lectures, take tests, or complete assignments online, which makes learning easier and more varied (Sung et al., 2016).

Mobile technology can be very supportive when implementing the system of cognitive skills formation in the framework of traditional education. In this respect, Meichenbaum (1976) proposed an approach to the development of cognitive skills of students through self-study that is to be carried out in several stages. The first of them implies the teacher is modeling the behavior necessary for optimal problem solving (i.e., goal setting, problem focus, performance evaluation, and mistake correction). However, already during the next stage, the student performs the task independently, first instructing themselves (which does not exclude using gadgets) and then using internalized cognitive skills to steer the task in the right direction. In doing so, the teacher plays the role of motivator and mentor.

Although digital technology is becoming increasingly available in schools, international research points to its ineffectiveness in teaching students (Sahin & Yilmaz, 2020). Teachers must realize the potential of digital technology in their daily practice and use it properly. Students' attitudes toward the large-scale implementation of digital technology in their lives indicate that the digitalization of education is an integral indicator of its employment in the digital environment (Spiteri & Chang Rundgren, 2020).

In general, mobile applications are characterized by a high level of functionality that includes information search, navigation systems, communication, social networks, entertainment games, educational applications, videos and photographs, translation of texts, sales, and business capabilities (Tam et al., 2020). This fact indicates the possibility of their use in the context of all specialties, not only in the technical sphere but also in human sciences, to achieve a balance between theory and practice with an emphasis on the formation and development of practical competencies. For example, mobile applications are increasingly used in learning English as they allow learners to watch videos and listen to songs, which benefits communication and auditory competencies, as well as promotes students' vocabulary expansion (Gafni et al., 2017; Voskovskaya & Karpova, 2021). The effectiveness of the use of mobile applications in learning English as a foreign language has also been proved by students from Vietnam and Japan for whom English is not native. They confirmed the exceptional usefulness of mobile apps in mastering a language due to the interactivity they provide (Nguyen & Takashi, 2021).

The fact that recently developed mobile applications are multifunctional facilitates the process of learning a foreign language at all levels (Nami, 2020). This learning method positively influences the process of memorizing new words and constructing sentences in a foreign language (Nicolaidoua et al., 2021). The use of the interactive application "3-D Brain" in the study of psychology is explained by a focus on the activity of the brain and the central nervous system, that is, cognitive activity (Diliberto-Macaluso & Hughes, 2016). In contrast, mobile applications are widely used, for example, in mathematics to solve problems of different types of complexity (Soboleva & Surovtseva, 2020; Supandi et al., 2018).

On the other hand, an experimental study by Indonesian researchers involving 30 fourth-graders of one of the primary schools in Cimahi City as a research sample evidences high effectiveness of Science, Technology, Engineering, and Mathematics (STEM)-based learning in cognitive skills development. Its outcomes indicate a significant motivation rise after children are demonstrated the essence of technical and scientific processes' functioning. This stimulates young students' desire to learn, invent, improve, and search for solutions to various problems of nature. In line with this, it is also noticed that complex tasks delivered and described in practice evoke much greater interest among the learners and increase problem-solving efficiency (Firdaus & Rahayu, 2019).

Cognitive skill development is an essential prerequisite in ensuring the effective learning process of future professionals. Scholars argue that family and the development of children's cognitive skills in school are considered major elements in successful personality formation. In line with this, while well-targeted educational programs are found to lower achievement gaps among children from different social backgrounds, disproportionate use of early education by socioeconomically privileged families may offset the benefits of early intervention (Kulic et al., 2019).

On the other hand, researchers point out that the formation of the basis of cognitive skills occurs at a young age, so adolescents track a clear tendency for specific skills to prevail over others. The available data show that age-related improvements in perceptual-cognitive skills are evident at 11 years old. However, "decision-making" seems to develop considerably later than anticipation and pattern recall, suggesting different developmental trajectories for the different perceptual-cognitive skills (De Waelle et al., 2021).

The most common advantages of the use of mobile applications in education are the freedom to apply various teaching methods and interactive technologies and wider opportunities to visualize theory and its connection with practice (M. Camilleri & A. Camilleri, 2017; Kapina, 2019). Game-based learning is a type of learning the effectiveness of which is primarily manifested at the level of involvement in knowledge acquisition, that is, motivation increase (Elsherbiny & Maamari, 2021). In addition, on the basis of this methodology, the project The Aprender XXI was developed seeking to advance professional competencies of three types: studying scientific literature and features of applications, development (familiarization with the basics of programming), and assessment (solving tests and drawing conclusions). The results of a study of the peculiarities of the use of mobile applications at the University of Indonesia show that mobile apps are changing the learning process and making it more personalized. In this fashion, teachers acquire an opportunity to apply a wider range of technologies and teaching methods (Sulisworo & Toifur, 2016). Educational sessions benefiting from interactive technologies differ from traditional teaching methods. The former require strong concentration and motivation of students while the learning process becomes more up-to-date (Fardoun & Awada, 2017). Mobile applications of a scientific nature include sound and visual applications and tools for digital knowledge creation and exchange, which, among other things, seek to integrate theory with practice and study the level of cognitive load and practical skills in solving problems of various complexity (Zydney & Warner, 2016).

Currently, many related developments are being actively used. Indian researchers have come up with the Human Activity Recognition (HAR) Method, relying on mobile phones to make the process of thinking effective (Kumar & Chauhan, 2021). Likewise, using the mobile application, Australian researchers focused on quizzes taken after lectures and before classes as self-tuition and revealed an increase in students' academic performance (to 65.19%) compared to those not using the mobile application (Pechenkina et al., 2017). Reinforcement Learning is another modern method of learning based on mobile applications developed by Canadian scientists. It is focused on the solution of problems of varying complexity and the study of the structure and functionality of mobile applications (Shvo et al., 2021).

Problem Statement

The training program developed based on modern mobile applications will provide an opportunity to increase students' motivation to learn and acquire new knowledge, and also affect the formation of professional competencies. Hence, the current research aims to investigate the impact of using mobile applications in university students' training on the development and improvement of their cognitive skills, particularly professional competencies and cognitive stimuli. To achieve this aim, the following objectives were to be accomplished:

- Identify trends in the use of digital technology products (mobile applications) in modern higher education.
- Establish a relationship between the implementation of digital applications in students' learning and the development of their competencies.
- Elaborate a digital curriculum for an experimental group of respondents designed to develop professional and cognitive competencies.

METHODS AND MATERIALS

Research Design and Sample

This experimental research was conducted at Sechenov First Moscow State Medical University (Sechenov University), Moscow Aviation Institute (National Research University), and Al-Farabi Kazakh National University, and involved 845 students of 1-4 years of study. Among them, the number of females constituted 678 (80.2%), while the number of males enrolled was only 167 (19.8%). The age range of the study participants was 17.4-22.7 (mean = 21.2, SD = 134). The selection of students of 1-4 study years is explained by the intention to analyze the characteristics of the attitude to the use of mobile applications in the learning process among individuals with different university training experiences. As for the specialization, this research involved the representatives of all study fields of the Faculty of Psychology, in particular those majoring in Mediation and Extrajudicial Conflict Resolution, Marketing and Coaching Psychology, Special Psychology and the Basics of Remedial Pedagogy, Educational Psychology, and Social Psychology. An important goal of this sample selection was to determine the effect of learning involving or excluding mobile applications on the attitudes of students of different study years towards education, motivation to learn, and the formation or development of professional competencies. The experiment was carried out from March to May 2021.

Survey

The research consisted of three stages.

During the first stage, a survey of students was conducted based on a Google Forms questionnaire. The questionnaire was sent to the respondents by e-mail and aimed to determine the attitude of students to modern technologies (in particular mobile applications), the level of technological development of universities under consideration, and participants' motivation to learn using mobile applications. Overall, respondents were to answer the following 5 questions: "Do you use mobile applications in the learning process?", "What purpose do you most often use your mobile phone for at university?", "What is the level of development of modern technologies, in particular the use of mobile applications, in your educational institution?", "Do you think the use of mobile applications affects the development of cognitive abilities?", "What professional competencies do mobile applications develop in the learning process?". The questionnaire was designed by the authors and included the main characteristics of the current state of digital technology implementation in education. Respondents had two weeks to submit their answers to the questionnaire. As all 845 students met this deadline, all of them were allowed to join the further experiment. All questions were open-ended, and responses were systematized according to the general social responses of the sample. Reliability test calculation resulted in a coefficient of 0.86, which means that the tool used is reliable (Heo et al., 2015).

During the second stage, a training program involving the use of mobile applications was developed on the Moodle e-learning platform. The students were divided into two groups: the first group (experimental) studied in accordance with the training program extensively using mobile applications, whereas the second group (control) followed a standard training program with no or little use of mobile technologies. It is important to note that the modernized study program was accessible to both engaged teachers and experimental group students. Students' distribution into the groups was done following the division according to the alphabetical order. That is, in each academic group, half of the list of students arranged in alphabetical order was assigned to the experimental group and the other half – to the control group. Since respondents were selected in a pre-war period, the integrity of their primary academic groups was maintained, which increases the ultimate validity of this study. To get acquainted with the program and view all its components, it was necessary to sign in with a Google account following the link and using an access code sent by e-mail. To enter the system, each teacher or student had to enter the e-mail address that they signed in with and the access code. The platform page contained the program and links to all mobile applications to be downloaded and used in the learning process. The program consisted of one thematic module ("Mobile applications

in the learning process") for studying different mobile applications in order to develop the cognitive abilities of students in the process of using interactive technologies in the educational process.

During the third stage, there was a reinterview of both groups, which was expected to reveal the level of influence of mobile applications on the effectiveness of learning, student motivation, and professional competencies. The questionnaire items and the procedure were the same as in the first survey. Comparative analysis in this study was narrowed to identifying the key characteristics of the experimental and control groups by considering their similarities. Along with this, experimental group participants were interviewed in order to determine the particularities of the implementation of digital technologies in learning. In order to interview a more considerable number of respondents, 10 educators engaged in teaching on the platform and 10 moderators (senior students) were involved. The purpose of the interviewing was to consider the most serious problems outlined by the students and form a vector of further development for another group. The interviewing was conducted 1 week after the study in small groups (15 people each). Everyone had the opportunity to point out the disadvantages/advantages of the teaching model used, as well as to comment on the relationship of a particular study mode to the improvement of their own competencies.

Statistical Processing

The responses of the respondents were processed in Statistica and Microsoft, where diagrams reflecting each question indicator and a chart to demonstrate the differences in the context of the two training programs were created.

Evaluation of the adequacy of the sample was done by means of two measures: the Kaiser-Meyer-Olkin (KMO) test (to check data suitability for factor analysis) and Bartlett's test (to assure that the correlation matrix is not an identity matrix). The KMO value of 0.786 and Bartlett's p-value of 0.001 allowed the inference about the adequacy of the constructed model and sampling. In concurrence with this, the effectiveness of the conducted study was investigated using Pearson's criterion (chi-square).

Research Limitations

The limitations of the study are associated with a small sample as the experiment was conducted at three universities only (Sechenov First Moscow State Medical University (Sechenov University), Moscow Aviation Institute (National Research University), and Al-Farabi Kazakh National University), while other educational institutions located worldwide were not considered.

Ethical issues

The survey was anonymous; it did not require the participants to provide confidential information (name, surname, age or place of residence, etc.). One of the requirements was to indicate the year of study at the time of the experiment. The study was performed in compliance with ethical standards, and the respondents gave their written consent to participate in the experiment and process the data obtained in its course.

RESULTS

The survey carried out during the first research stage intended to point out the attitude of students to the use of mobile applications in the learning process, the level of development of modern technologies in the universities under consideration, motivation to learn, and the formation of professional competencies. Its results are given in Figs 1-5.

As can be seen from the below, the majority of respondents (65%) noted that they use mobile apps in the learning process (Fig. 1), while 35% were inclined to hold the opposite opinion implying non-usage of mobile applications for the goals of education.

Figure 1. Respondents' answers to the question "Do you use mobile applications in the learning process?"

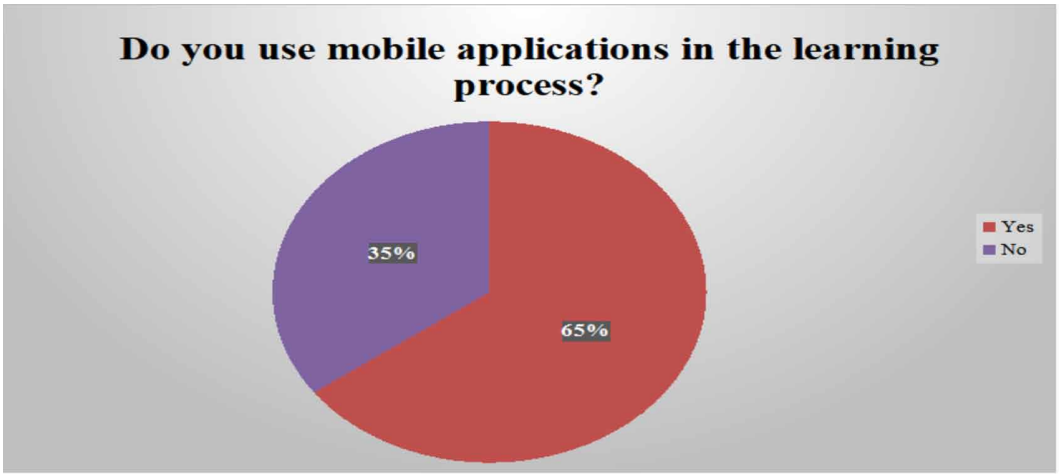
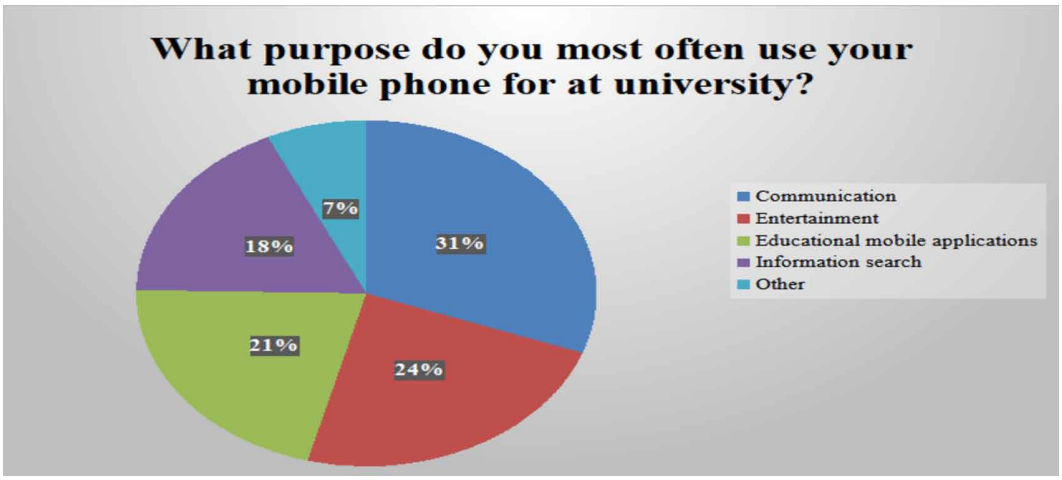


Figure 2. Respondents' answers to the question "What purpose do you most often use your mobile phone for at university?"



The second question – "What purpose do you most often use your mobile phone for at university?" (Fig. 2) – aimed to identify students' motivation to use mobile phones for general and educational purposes. Thus, the indicators of the use of mobile phones as a means of mobile applications in the learning process are low (21%) compared to their usage for other purposes: as a means of communication – 31%, entertainment applications – 23%, information search – 18%. Not common answers (1-2) were grouped into the "other" category (7%).

Fig. 3 shows the answers of students to the question "What is the level of development of modern technologies, in particular the use of mobile applications, in your educational institution?" Accordingly, 67% of students rated the level of development of modern technologies, in particular mobile applications, in their educational institution as "high." However, 20% were convinced of the average level of development of modern technologies, and 13% claimed it to be low.

The fourth question ("Do you think the use of mobile applications affects the development of cognitive abilities?") made it possible to reveal the attitude of students towards the impact of mobile

Figure 3. Respondents' answers to the question "What is the level of development of modern technologies, in particular the use of mobile applications, in your educational institution?"

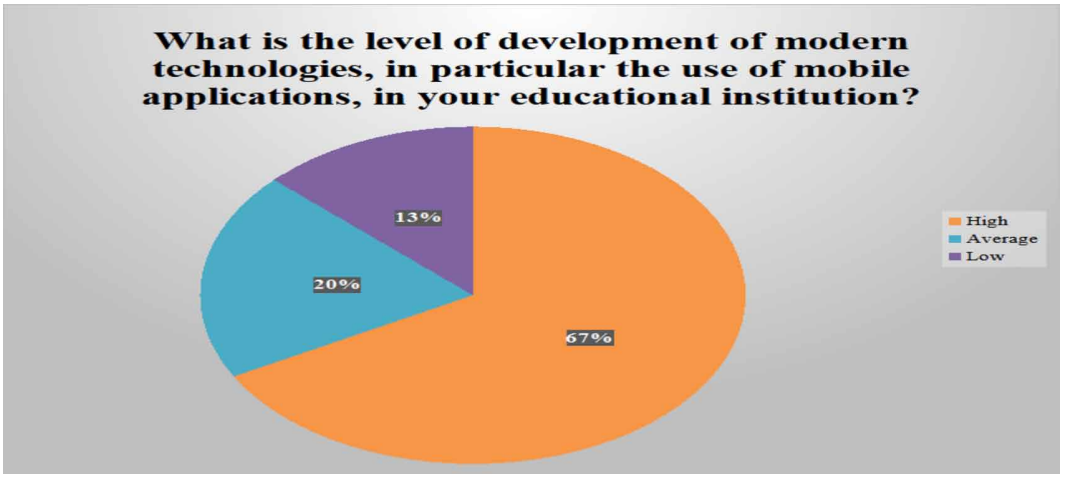
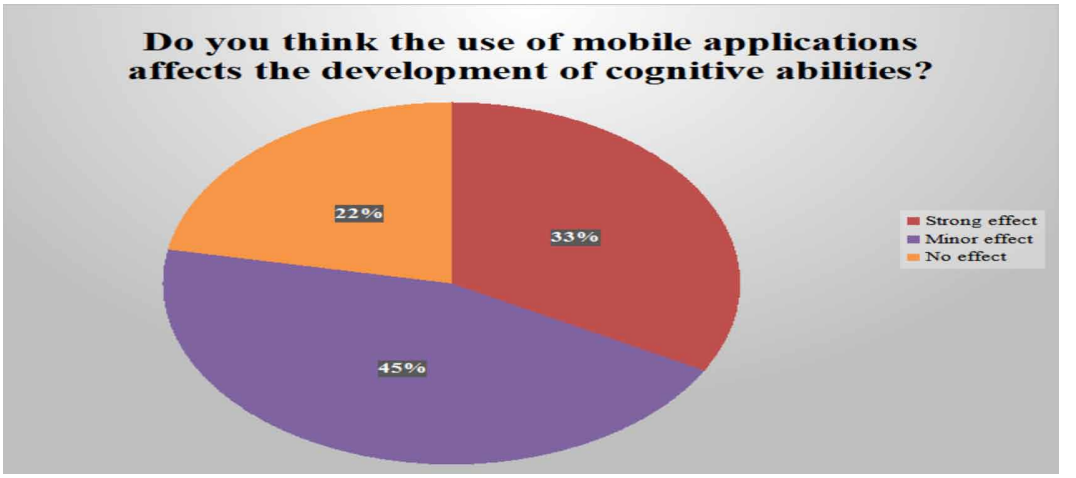


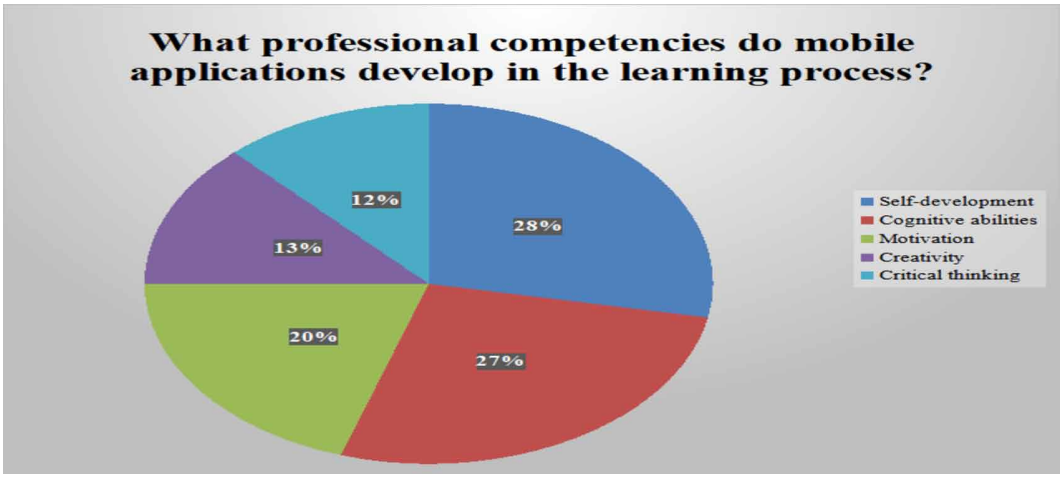
Figure 4. Respondents' answers to the question "Do you think the use of mobile applications affects the development of cognitive abilities?"



applications on the development of professional competencies, in particular cognitive skills (Fig. 4). Thus, the majority of respondents (45%) confirmed that mobile applications influence the development of cognitive abilities; however, in their opinion, this impact is minor. At the same time, 33% reported a strong influence of mobile applications on professional competencies in the learning process. The results also show that the number of those who saw no effect of mobile applications on cognitive abilities (22%) is relatively big, which indicates a lack of knowledge or use of the learning method.

Fig. 5 shows the results of the analysis of respondents' answers to the question "What professional competencies do mobile applications develop in the learning process?" (Fig. 5). The most frequent indicators include self-development (28%), cognitive abilities (27%), motivation (20%), creativity (13%), critical thinking (12%). At the same time, the percentage does not differ greatly and is characterized by relatively similar indicators.

Figure 5. Respondents' answers to the question "What professional competencies do mobile applications develop in the learning process?"



In the second stage, a training program based on mobile applications was developed (Fig. 6). Following this, all research participants were divided into two groups: the first group was trained in accordance with the program involving the use of mobile applications, whereas the second followed traditional curricula. The experimental program was developed based on modern mobile applications and focused on practice.

The program consisted of one thematic module "Mobile applications in the learning process" divided into several classes aimed at developing professional competencies and increasing the level of students' motivation for learning (Table 1). To follow the program, students needed a mobile phone and earphones to watch videos. The applications utilized in the learning process could be downloaded from AppStore, Google Play Market, Amazon Appstore, or Opera Mobile Store. No additional resources except for an interactive whiteboard for the teacher in order to demonstrate the possible stages of working with applications were required. The human resources necessary for the implementation of the learning process included students of the first group who studied following

Figure 6. The structure of the training program based on mobile applications

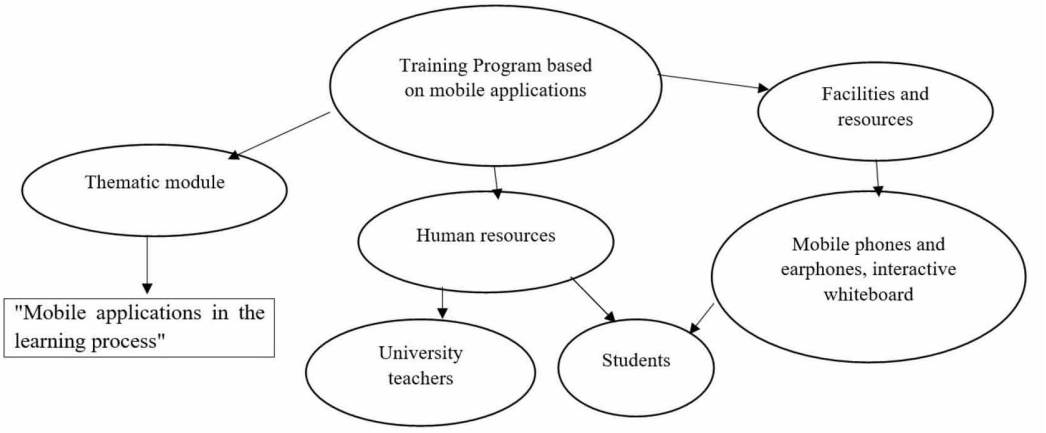


Table 1. The content of the training program based on mobile applications

Thematic module	Thematic module components	Tasks	Resources used
"Mobile applications in the learning process"	• TED • Codeacademy • A.R.T.S.Y.	Formation of the skill of working with mobile applications in the learning process	Mobile phone with access to AppStore, Google Play Market, Amazon Appstore, or Opera Mobile Store

the modernized program and university teachers. All classes were conducted in specially designated university classrooms. For the convenience of students, they were divided into several groups of 20 people; thus, 20 desks were needed for each class. The duration of the program was one month.

The first mobile application taken advantage of was TED. It seeks to broaden the general students' outlook (as it contains online lectures on various topics) and contribute to the development of communication skills (as all lectures are in English). The second application used was "Codeacademy." It allows learners to study the basics of information technology through interactive technologies and practice, which is different from traditional computer science classes. The third and the last chosen was A.R.T.S.Y. – dedicated to studying art. Even though the applications contributing to the development of students' cognitive abilities in various knowledge areas were selected not by students, each of them could try working with different applications, decide which one is more interesting and useful, and continue learning on its basis. At the same time, if a student wanted to study via more than one application, they could also join other classes since they were held at different times. The teachers also familiarized students with the learning platforms, such as Coursera, EdX, and Khan Academy, offering various courses to be engaged in.

During the third research stage, a reinterview was conducted in order to determine the influence of training based on modern mobile applications and the traditional program on the learning effectiveness, student motivation, and the development of professional competencies, in particular cognitive abilities. The experimental group's reinterview outcomes showing the influence of mobile-based training on the development of professional competencies, motivation to learn, and the frequency of using mobile applications are presented in Figures 7 and 8. It should be noted that the indicators of the control group remained at the same level as these students followed their regular curriculum and did not change their attitude toward the use of mobile applications in learning.

Accordingly, the indicators show that the level of development of cognitive skills of experimental group students has significantly increased. Compared to the first survey results, more respondents (81%) noted a strong influence of mobile applications on the development of cognitive abilities (Figure 7). At the same time, 12% of respondents believed that the impact is minor and only 7% were convinced that mobile applications do not affect the level of cognitive development.

Figure 8 shows the results of the analysis of respondents' answers to the question "What professional competencies do mobile applications develop in the learning process?" The analysis of the results indicates an increase in the frequency of noting "motivation" (42%), which testifies to an increase in the students' motivation to use mobile applications after training. However, along with this, "cognitive abilities" (28%), "self-development" (15%), and "creativity" (15%) were also quite frequently chosen answers.

In order to systematize the results obtained, a multilevel modeling analysis was conducted, which enabled comparing the mean deviation of each evaluated criterion before and after the program's implementation (Table 2). Since the mean deviations appeared to be quite significant among all the criteria, the effectiveness of the program can be deduced.

As is evidenced above (Table 3), the implementation of the proposed program resulted in significant shifts in motivation and cognitive skills among experimental group participants. A chi-square analysis used to compare the experimental and control samples indicates that the training

Figure 7. Respondents' answers to the question "Do you think the use of mobile applications affects the development of cognitive abilities?"

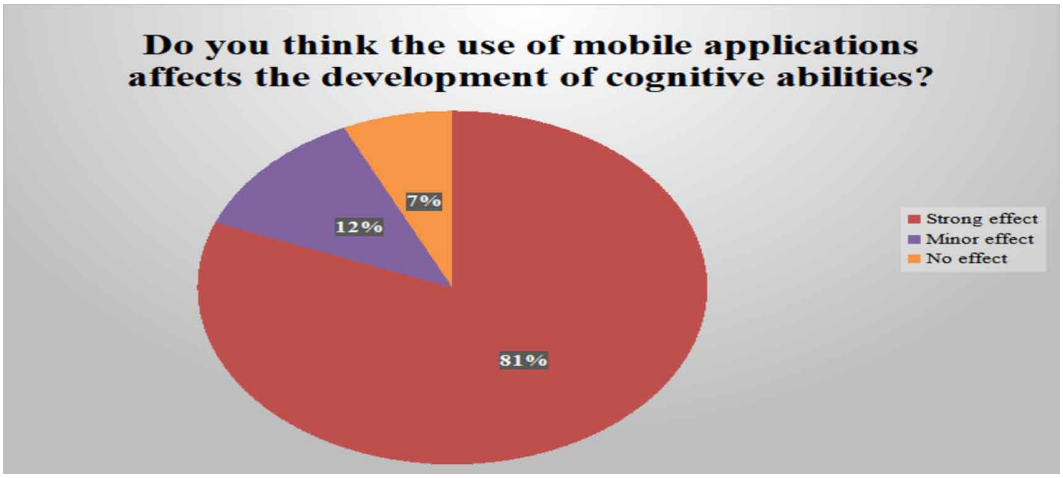
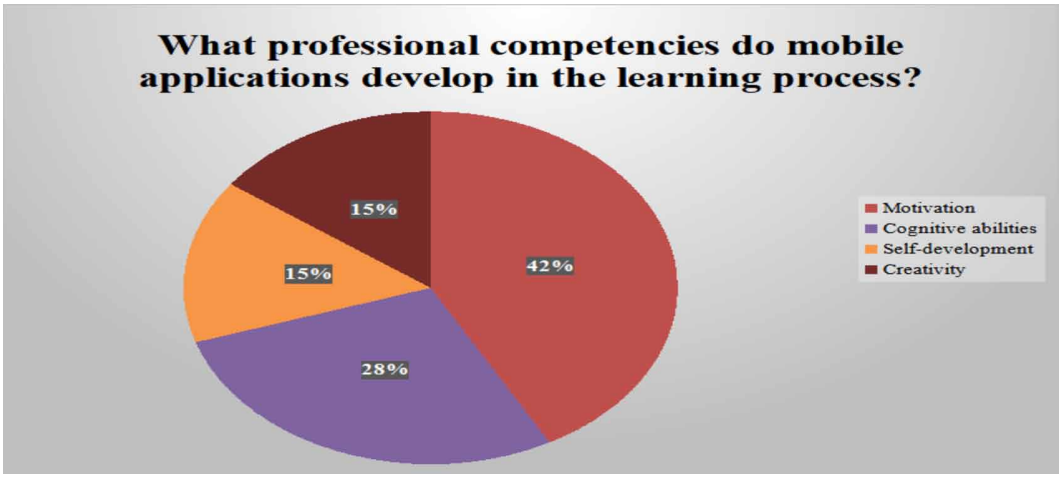


Figure 8. Respondents' answers to the question "What professional competencies do mobile applications develop in the learning process?" after the completion of training



model presupposing the use of mobile applications became a powerful stimulus for the progress in motivation and cognitive qualities. Given that the indicators of motivation and of the development of professional competencies (including cognitive skills) enhanced, the rise in demand for the proposed learning method can be proclaimed. As regards the chi-squared explanations, the overall fit indices ($\chi^2 = 122.77$ and $\chi^2 = 120.09$) suggest a reasonable fit to the data.

DISCUSSION

The results of the study indicate a high level of effectiveness of the use of mobile applications for the development of cognitive skills in the learning process, which makes it possible to draw conclusions about the relevance of this issue in both Russian and foreign studies. As in the case of the current work, an experiment conducted by Czech researchers showed a high level of influence of the use of

Table 2. Mean deviation of each criterion before and after the experimental training (data for the experimental group)

	Criterion (question)	Mean	Mean square deviation
1	*"Do you use mobile applications in the learning process?"*	12.87	0.1906
2	*"What purpose do you most often use your mobile phone for at university?"*	8.51	0.852
3	*"What is the level of development of modern technologies, in particular the use of mobile applications, in your educational institution?"*	11.47	0.1907
4	*"Do you think the use of mobile applications affects the development of cognitive abilities?"*	9.73	0.7991
5	*"What professional competencies do mobile applications develop in the learning process?"*	8.55	0.1953

Table 3. Chi-square analysis of motivation and cognitive skills after the experimental training (N = 845)

	Experimental group	Control group	χ^2
Motivation	42%	20%	122.77*
Cognitive skills	81%	45%	120.09*

*p = .00.

educational applications on the development of practical skills and cognitive abilities (Klimova & Sanda, 2021). First of all, the similarity of the results with our findings can be seen at the level of the influence of mobile applications on the effectiveness of learning and significant improvement in students' cognitive abilities. The researchers also performed a comparative analysis of student learning in the context of two different training programs: a traditional program and a training program based on the use of mobile applications. The analysis outcomes make it possible to infer the highest level of effectiveness of learning with the use of interactive technologies, in particular mobile applications, compared to traditional training (Wang et al., 2017).

The results of analogous studies show that most often, students use mobile phones for the purpose of chatting on social networks (43.7%) or communication (31.1%). Also, 17.6% of respondents note the use of mobile phones for entertainment purposes (taking photos, recording videos, playing games). Only 6.7% of students believe that a mobile phone is an information search tool, and 0.8% need their devices to improve productivity (camera, calculator, alarm clock) (Tanil & Yong, 2020). In the context of our research, it can be concluded that the percentage is almost identical: the top smartphone usage purposes encompass communication (31%), entertainment (23%), and information search (18%).

After the experiment involving 2000 students from two American universities and focusing on the features of the use of smartphones in education, researchers from the US have agreed on the effectiveness of using mobile applications under the cooperation of educators teaching different subjects (Clayton & Murphy, 2016). As the students involved in their research studied media and video production, the effectiveness of training was evidenced by the raised YouTube video making skills and abilities to work with camera and sound (all this by means of a smartphone).

Similar studies were carried out at the technical faculty of the Iranian University. Their shared purpose was to unveil the characteristic features of using mobile technologies in the context of the available learning approaches and theory (Hamidi & Chavoshi, 2018). Compared to Russian research works devoted to this area of knowledge, the fact of a positive impact on seven indicators is similar: ease of use, trust, character and personality traits, context, perceived usefulness, behavioral intention, and culture of use of the research model. Experiments conducted in the US have shown the

effectiveness of using digital journals developed based on the Flipboard application and their effect on increasing the level of interest and pleasure of students in the learning process (Luna-Nevarez & McGovern, 2018). Comparing these indicators with the Russian ones, one should note that the use of modern mobile applications for educational purposes is only gaining popularity. Currently, there are no fundamental studies on the use of the Flipboard application in the Russian Federation, which indicates the need for the more active development and introduction of mobile applications in the education system. However, despite this, interactive foreign language learning applications, such as Duolingo, Memrise, and LangBook are pretty popular in the Russian Federation (Odinokaya & Kollerova, 2017). According to the data available, they exert an exceptionally positive effect on the process of memorizing new words and contribute to the expansion of students' vocabulary. Moreover, the mobile application GrammarUp helps learners improve their grammar knowledge while focusing on the practical application of theoretical material based on the performance of tests.

Finnish researchers have also considered modern educational mobile applications. Based on the study of the ReFlex and TeamUp applications aimed at increasing professional competencies and mastering teamwork and communication skills, researchers confirmed the development of different types of reflection: dialogical, transformative, and critical (Leinonen et al., 2016). Theoretically, these applications can be introduced into the educational process in the Russian Federation. However, this requires certain resources, such as audiovisual technologies, microphones, webcams as well as mobile phones or devices for downloading audio files (McNicol et al., 2014). It should be noted that the disadvantages of the applications are associated with the limitations of their usage as they are focused on the development of video and audio content, which is relevant only in some knowledge areas, as well as require a large number of resources to be implemented. The experience of Russian scholars in the field of mobile applications and their effect on cognitive skills development indicate that in 78.5% of cases, students do believe that mobile apps make learning easier. In line with this, as many as 46.8% of respondents indeed make use of mobile phones to support their mobile learning and cognitive skills, and 53.8% express the need for video lessons to be introduced in the activities involving the use of mobile apps (Parsazadeha et al., 2018; Shomova, 2017).

CONCLUSION

The main conclusion this paper promotes suggests that, in contrast to the traditional education system, to which the human brain has already got used, non-standard learning based on mobile applications leads to the development and improvement of memory by solving tasks of varying complexity. In view of this, the study of the relationship between the implementation of digital tools and cognitive skills' advancement remains particularly relevant these days.

An initial survey of a sample of 845 respondents at three higher education institutions revealed notable gaps in the implementation of digital applications in student learning. First of all, the analysis showed that the majority of respondents (65%) indeed use mobile applications in the learning process. In concurrence with this, 45% of the sample confirmed that mobile applications influence the development of cognitive abilities, although this impact is minor. A strong effect of mobile applications on professional competencies was declared by only 33% of the surveyed.

In sum, this study revealed that the advancement in cognitive skills after going through the developed training course was reported by 81% of students. In alignment with this, as declared by almost half of the total number of respondents from the experimental group, the proposed program was proved to contribute to the rise in motivation to learn (the indicator of motivation was 42% in the experimental group and 20% in control). Another confirmation of the positive effect from the use of mobile applications in learning stems from the chi-square values collected (122.77 and 120.09 for motivation and cognitive skills, respectively). Hence, the consequences of using mobile applications in education may well be deemed favorable.

The practical value of the results obtained and the prospects for further research are explained by the possibility of using the proposed program for training university students in different countries. This can simultaneously serve as a basis for a comparative analysis of the effect of the use of mobile apps in learning.

Recommendations

Further research in the field can concentrate on implementing more complex training programs integrating mobile applications in university education while making allowances for national, regional, or any other distinguishing characteristics of students. At the same time, future works are proposed to pay more close attention to the peculiarities of mobile apps' implementation in a variety of areas (medical education, engineering, etc.). The need to develop different types of memory in children as a global problem of today should be explored.

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CONFLICT OF INTERESTS

Authors declare that they have no conflict of interests.

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