

Educational Mobile Games as a Tool for Increasing Vocabulary When Learning a Foreign Language

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ABSTRACT

The study considers the features of the algorithms of educational mobile games. The research analyzes the main functions and characteristics of 55 educational mobile games. The system of each mobile application for learning a foreign language consists of 13 key algorithms. An experiment involving three Russian (342 participants) higher educational institutions and two Kazakh (158 participants) universities was conducted. The experiment was based on the analysis and comparison of the effectiveness of Quizlet and Memrise (the first stage of the study), Tandem and ELSASpeak (the second stage of the study) with traditional learning methods (textbooks, notes, classroom lessons with teachers). The results indicate that students memorize 80-90% of vocabulary with the help of mobile applications. The synthesis of traditional learning methods and mobile pedagogy is the most effective. The results of the study can be used as an aid when using mobile learning methods in teaching foreign languages.

KEYWORDS

Educational Mobile Applications, Learning Process, Mobile Application Algorithms, Mobile Learning, Vocabulary Expansion

INTRODUCTION

Due to the extensive use of mobile devices and applications in society, they are being introduced into all areas of activity. Over the past decade, this has been especially true in the field of pedagogy, where mobile learning can help motivate and reward learners, as well as enhance the capacity of the education system (Garrison, 2016). Mobile learning became the most urgent issue during the COVID-19 pandemic (2019-2021), when there was a need to update the learning system with the help of mobile devices in the context of total distance learning. The demand for the use of mobile devices in education, the media, business and entertainment is increasing. It is projected that the growth rate of mobile device sales from 2017 to 2022 will be 2.8% per year despite the fact that the progress of the global mobile device industry has significantly decreased over the period of 2020 (by 17%) (Alam, 2021). Therefore, many educational institutions were forced to immediately create projects to improve curricula and to revise a number of pedagogical practices basing them on the concept of

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modern mobile learning (Kozyreva & Olkhova, 2020). More than 1.5 billion students have switched to the system of mobile and distance learning, and today this system cannot exist without a daily source of updating information resources (mobile devices and their services) (Dias & Victor, 2017; Hussain et al., 2020; Önal et al., 2019; Panagiotidis et al., 2018).

Today there are many ways to obtain information. Therefore, it is obvious that new learning methods need to be introduced into the curriculum; these should involve not only the improvement of traditional pedagogical practices but also the introduction of online and mobile learning technologies into the curriculum (interactive tasks, educational mobile applications and games, online lessons, etc.) (Calamlam, 2021; Hodges & Weber, 2015).

Many scholars in the field of innovative teaching methods agree that mobile applications and learning games are one of the most effective methods in learning foreign languages, which reflects their relevance in the modern learning process (Elaish et al., 2017; Kohnke et al., 2019; Üstün-Aksoy & Dimililer, 2017). Mobile applications are typically used not only for learning foreign languages but also for other disciplines (mathematics, physical education, visual arts, etc.) (Han, 2019; Tsoukos et al., 2021).

Recently, many foreign language teachers have started using the Quizlet app (Sutherland, 2005; Van et al., 2020). This is a service for language learners to expand vocabulary. Quizlet is a free application that relies on game-based learning and a convenient mobile platform for creating one's own interactive flashcards to memorize vocabulary (Sutherland, 2005; Wikipedia, 2021). The application allows users to add images and audio files to the words being studied, and to ensure effective vocabulary memorization, it suggests performing tests and exercises in a playful way (Van et al. 2020).

At this stage of research on the use of mobile devices in education, there are problems of selecting the most effective mobile applications. Such applications should act as additional factors in increasing the effectiveness of learning in combination with traditional learning methods. Also, many researchers have analyzed the operation, functions, content and algorithms of such applications (Crompton & Traxler, 2019; Toto & Limone, 2019; Zhang & Zou, 2020). The use of digital platforms in the context of distance learning has also become a means of managing the learning process and student collaboration, as well as a way of planning, delivering and tracking the learning process (Acharjya & Das, 2022).

This study provides a detailed description of the algorithms and schemes of operation of educational mobile games, their impact and degree of effectiveness in the process of learning and memorizing foreign language vocabulary. The most popular mobile applications for learning English by Russian-speaking students were also considered and described.

Research in the field of innovative learning technologies is characterized by a general trend towards studying the tools of digital technologies and identifying the problems associated with them, as well as the benefits of the impact of mobile applications on the learning process in the study of foreign languages. As English is the language of international communication, research on the effectiveness of tools for memorizing the structure of the English language is the most common.

The purpose of the study is to consider the features of the functions and operation schemes of educational mobile games for learning English and Russian in terms of comparing the focus of the content of these applications, their effectiveness, productivity, and the degree of influence on the learning process. The assessment of these parameters is based on the user success and satisfaction.

The results of the research can be used in the study of the impact of technological progress on educational processes and the introduction of innovative methods of mobile learning, as well as in the study of modern methods of learning foreign language vocabulary.

Literature Review

The concept of *computer-assisted language learning (CALL)* appeared in the second half of the 21st century, when the computer began to be considered as a personal tutor, which makes it possible to develop all second language skills (vocabulary, grammar, reading and comprehension skills, etc.)

through the use of special language programs (Persson & Nouri, 2018). Now this concept includes new functions and definitions as everyone can freely use educational mobile applications both on a computer or laptop and on a tablet or smartphone, which is the most convenient and accessible way (Garrison, 2016).

In the modern world smartphones are the most common devices that are used everywhere not only for communication with other people but also for educational purposes (Zhang & Zou, 2020). They are characterized by ease of transportation and access to any information. Some researchers distinguish between the concepts of e-learning and mobile learning correlating the former to the PC, and the latter to mobile devices (Kabassi & Alepis, 2020). The use of mobile devices and programs is feasible not only in learning a foreign language and expanding vocabulary but also in studying the exact sciences, such as physics, mechanics, optics, acoustics, thermodynamics, etc., when it is not possible to conduct experiments with laboratory equipment (Tsoukos et al., 2021).

Researchers of mobile learning in the process of learning English introduced the term *mobile pedagogy* with no reference to one place and characterized learning by movement (class, work, home, different ways of interaction between students and the teacher, etc.). The new ELT (English Learning Teaching) philosophy involves the creation of a new framework of thinking for the teacher implying the development of mobile learning programs for students to be used both within and outside the classroom. Despite the popularity of self-learning through mobile apps, teacher value should not be missed but rather be developed through the active interaction of students, teachers, and technology (Kukulska-Hulme et al., 2015).

English is the language of international communication and the need to learn it prevails around the world (Zarei et al., 2019). English learning through mobile devices is the most popular learning method as evidenced by the Android language learning app download statistics with 50 billion downloads only in 2015 (Gangaiamaran & Pasupathi, 2017).

The developed countries of the world (the USA, France, Germany, Italy, the UK, Canada, Australia, Japan) recognize the importance of learning English in non-English-speaking countries of Europe, Africa and Asia, and also provide ongoing support for improving English teaching methods (Elaish et al., 2019). The level and quality of teaching English are the indicators of internationalization and the competitiveness of the national education system of each country in the international arena (Chan, 2013; Ma, 2014).

The term *mobile learning* is also defined as an independent process of studying disciplines outside the classroom with the help of mobile devices (smartphone, tablet, laptop, e-books, etc.). This concept involves the idea of self-learning, which focuses on individual and non-formal training programs. This allows learners to switch between activities: from completing the main task to practical actions or the formation of meaning (Kärki et al., 2018).

There is also a concept of *blended learning*, which involves the combination of traditional classroom learning with e-learning strategies. Research has shown that this method is more effective and provides more opportunities for the productive interaction between students and teachers (Calamlam, 2021).

The main trends in education, in particular in the context of the Covid-19 pandemic, require a revision of the structure of educational activities and pedagogical practices in order to integrate innovative educational technologies (Kozyreva & Olkhova, 2020; Acharjya & Das, 2022). However, there are also many challenges that learners face when learning remotely with the help of educational mobile apps or online platforms. These are changes in learning styles and pedagogy, problems with technology mastery, cost and time of study; however, most students prefer this learning method because of its flexibility and numerous advantages (Acharjya & Das, 2022).

Many people note the benefits of introducing not only standard mobile games but also VR games (Virtual Reality) in educational practices to teach many disciplines, including the English language (Chandra et al., 2021). Many people perceive games as entertainment and this perception is key to start integrating VR applications into educational practices as the learning process itself does not

seem boring or forced. Students consider it as a kind of meditation accompanied by concentration and effective motivation. This is a new method that makes it possible to present complex data in an accessible way while simulating a real environment (Alfadil, 2020).

The process of learning foreign language vocabulary is accompanied by a number of problems, such as limited interaction with the target language, inadequate amount of time and attention devoted to learning the language, wrong distribution of tasks, or the incompetence of teachers (Ergen & Elma, 2018). The use of mobile devices is considered as one of the solutions to this problem as it provides easy access to information regardless of the learner's location and takes into account their preferences (and not only the learning plan drawn up by the teacher); in addition, there are no time constraints and it is characterized by portability and the entertaining nature of learning in contrast to traditional learning methods or online learning with a teacher on educational platforms (Mirzaei, 2016). The main advantage of mobile learning compared to online learning is that it is individualized and focused on the learning path of each student while online learning is based on the freedom of movement but with the preservation of the idea of classroom learning time with a teacher (Dumford & Miller, 2018).

Materials and Methods

The research consisted of two stages. The first stage is an exploratory study while the second one involves the verification of the results of the study. **At the first stage of the study**, the following research methods were used:

1. The method of comparative analysis of the content of educational mobile games involving the analysis of the main functions, characteristics, topics, and focus of applications as additional tools for learning a foreign language within the educational process (Kärki et al., 2018; Van et al., 2020).
2. The method of the identification of components and items from other literary sources, positions and opinions of experts in the field of research on modern teaching methods with the use of mobile games (Elaish et al., 2019; Panagiotidis et al., 2018; Wang et al., 2020).
3. The method of empirical analysis of the usability of each mobile application below based on testing its functions, operation schemes and features: *ELSA Speak, Duolingo, Memrise, Babble, Mondly, Bussu, Quizlet, FluentU, Tandem, Coursera, Lingualeo, Puzzle English, Anki, Tinycards by Duolingo, Flashcards+, Tandem, HelloTalk, Pimsleur, Easy Ten, Words, Rosetta Stone, 15 000 Useful Phrases, WordBook, Extra English Conversation, Puzzle Movies, Listening, LearnEnglish Videos, LyricsTraining, SpeakingPal, Voscreen – Learn English, Idiom, Daily Dictation, Supiki, English Grammar in Use, English Grammar Test, English Grammar Book, English Grammar Book by TalkEnglish, LearnEnglish Grammar by the British Council, English Tenses Practice by MagikHub, The House of Languages, Virtual Speech, Alt space VR, Class VR, Immersive VR Education* and others.

In the study, it was decided to investigate the processes of learning English with the help of educational mobile games and applications in order to demonstrate the stages of development, improvement and expansion of the vocabulary of Russian-speaking students.

Thus, 55 educational mobile applications for learning English, which are considered the most popular and relevant among users (Barber, 2021; Duffy, 2020; Harasewich, 2021; Kim et al., 2021; Shumer, 2020) have been studied.

At the second stage of the study, an experiment consisting of two parts was performed.

The First Part of the Experiment

Research Design

The purpose of the experiment was to reveal the effectiveness of learning foreign language vocabulary by Russian-speaking students with the help of Quizlet and Memrise, as well as to identify the most effective way of learning vocabulary according to the subjective opinion of students and the results of their academic performance.

How Quizlet and Memrise Work

It was decided to use the above two applications in the experiment as they are the most versatile platforms that allow teachers to create their own courses, modules, and folders with the necessary flashcards, as well as to add their own educational material; these are the most relevant functions for students.

In Quizlet, students can join a course created by a teacher. They learn words with the help of double-sided cards and then complete game-based tasks to review new vocabulary. Vocabulary card is a card bearing a new word on one side and its translation on the other, which forces the user to turn it over until they remember the lexical unit. In timed tests, students can see the ranking of the most successful students, where each one is awarded 1, 2 or 3 place in the chart, which is a kind of reward and motivation system.

In Memrise, on the contrary, students have to create dictionaries with thematic flashcards or learn the vocabulary given in the application. A difference between the flashcards of both applications is that in Quizlet they look like ordinary flashcards (new word + translation and definition + audio recording of correct pronunciation), and in Memrise they are accompanied by short videos featuring the pronunciation of the word by a native speaker.

Either application provides different memorization techniques and approaches to learning new vocabulary in the context of mobile learning and classroom learning. Thus, traditional method (old education system) relies on students' own efforts, motivation and potential to learn new words; Quizlet places an emphasis on auditory and visual memory combined with playful learning; Memrise focuses on auditory and visual memory along with the imagination and memorization of people images and voices.

Participants and the Process

The experiment involved 342 first-year students from three Russian higher educational institutions, namely from the State Academic University for the Humanities (Russian Academy of Sciences), Sechenov Moscow State Medical University, and Moscow State Psychological and Pedagogical University. It was decided to select three universities and groups of students with different specializations in order to analyze the efficiency and effectiveness of the assimilation of a particular vocabulary using the Quizlet and Memrise applications.

Approximately 110 volunteers were selected from each university and divided into three groups: group 1 involved students who studied vocabulary based on traditional methods (textbooks and dictionaries); group 2 - students who studied vocabulary using Quizlet; group 3 - students who studied vocabulary using Memrise.

The duration of the experiment was 25 days; every 5 days a commission of 6 teachers of English, 3 teachers of Latin within medical discourse, 3 psychologists and 5 teachers of pedagogy conducted student surveys, delivered dictation exercises and tests. Every academic day, the three groups gathered in their classrooms and studied vocabulary using the methods above for 45 minutes. Group 2 and 3 had to install Quizlet and Memrise on their mobile devices, as well as to track and save their progress in the apps. In contrast to group 1 that studied exclusively in the classroom and based on traditional learning methods, group 2 and group 3 students had to study both within and outside the classroom.

It should be noted that medical students belonged to the experimental group that studied medical terms in Latin with the help of Quizlet and within the training course specially designed for them. Humanities and pedagogical students learned the English vocabulary relevant to their field of study with the help of both applications.

On a daily basis the students learned 5 new words and every 5 days, the progress of the groups was evaluated based on the dictation of 25 words and tests containing three tasks: 1) match 15 words with their translation; 2) fill in the gaps in 10 short sentences with the most suitable words; 3) make up 5 sentences with the word given (to be precise, with its translation). Throughout the experiment, the views of some students and members of the commission regarding mobile learning were listened to and analyzed. At the end of the experiment, an anonymous survey was also conducted based on the Technology Acceptance Model. The questionnaire contained two questions: 1) What is your attitude to and perception of the technology used?; 2) What are your impressions of the use of the technology?

The Second Part of the Experiment

Objectives

The main goal of the second experiment was to reveal the effectiveness of using ELSASpeak and Tandem to form literate speaking skills, improve English speaking skills, expand vocabulary, and develop listening comprehension skills.

How ELSASpeak and Tandem Work

ELSASpeak and Tandem are aimed at developing speaking skills, proper articulation of foreign language sounds, as well as listening comprehension skills.

ELSASpeak uses algorithms to evaluate/correct the pronunciation and accent of the user while comparing the results with the quality of the native speaker's pronunciation in percentage terms. The application also allows the user to create their own flashcards with audio recordings and provides them with an opportunity to record and check their own pronunciation.

Tandem is a kind of platform or chat for learning a foreign language, with the help of which users can find a teacher, tutor or foreign friend to directly develop their foreign language skills. In addition, the application matches the right people based on the algorithms of common interests and motivation in learning a language.

Participants and the Process

The experiment involved 158 students from the K. Zhubanov Aktobe Regional University and Eurasian Humanitarian Institute in the city of Nur-Sultan (Kazakhstan) who were divided into three groups of about 50 people: group 1 - students developing English communication skills through communication with peers and teachers and attending English speaking clubs (all native speakers of the Russian language); group 2 - students who found 1-2 penfriends from the UK or the USA in the Tandem application and practised speaking skills with them; group 3 - students who studied English on their own using the ELSA application. All students were asked to expand their "Travel and Friendship" vocabulary. They were provided with a reference list of words on the topic (250) with the possibility of supplementing it with individually selected vocabulary and a list of 15 standard topics for final discussion and comparison of results. In order to ensure an objective overall performance assessment, students with approximately the same level of English proficiency (B1-B2) were selected with the help of the entry test. The participants voluntarily took part in the experiment in order not only to contribute to the research but also to improve their own skills and assess the effectiveness of modern learning methods.

The experiment lasted three weeks (21 days) and was supervised by the members of the experimental commission: 5 teachers from the English for specific purposes Department, 3 psychologists and 3 teachers of Pedagogy. Every day, except weekends, the groups of participants

gathered in their classrooms and engaged in discussing topics and learning new words for two class periods (90 minutes). In addition, each student had to mark the words they already learned (or add new ones) and the topics that had been discussed and practised in the classroom. Students from group 2 (Tandem) had to make written reports about the time and the topics that they discussed with a native speaker. Participants from group 3 were allowed to study on their own but with the provision of daily reports on the work done. Members of all the three groups were required to record their results in Microsoft Excel (Table 1).

Table 1. A demo example of the data table that the participants in the experiment filled in

Topic	Lesson schedule	Learning method, group No.	Number of words learned	Improvement in pronunciation	Commission assessment
Countries	day 1, 2 class periods	ELSA Speak, No. 1	10	52%	10 out of 10
A dream journey	day 2, 2 class periods	Tandem, No. 2	13	47%	7 out of 10
Different cultures	day 3, 2 class periods	Group classes, No. 3	15	55%	9 out of 10
New friends	day 4, 2 class periods				
Travel arrangements	day 5, 2 class periods				

Source: own development

Thus, every day the teachers and psychologists of the commission collected and analyzed the results of the students, as well as attended the lessons to assess the learning process. At the end of each week, there were general speaking club sessions, dictations to check the vocabulary studied, as well as a percentage assessment of an increase in general knowledge of the topic vocabulary. The most active students presented the reports of the whole group, commented on the learning process, and initiated discussions and discourses. At the end of the experiment, the total number of words that the students learned and used in the discussion of topics was calculated.

Statistical Data Processing

Microsoft Excel and the Statistica 10.0 (StatSoft) were used to analyze and process the statistical data during the research.

Data Analysis

In the course of the experiment based on the results obtained, the mean of successfully completed tests for each group of students, the percentage of total progress, and the total number of lexical units learned using mobile programs were calculated. The results of the surveys and anonymous questionnaires conducted in order to study the descriptive statistics of the ratio of positive and negative feedback from the students and teachers about the use of the mobile learning methods were also analyzed.

Limitations of the Study

The limitations of the study are due to the small sample of participants in the experiment, as the study was conducted on the basis of 3 Russian and 2 Kazakh universities, while educational institutions in other countries did not participate in the experiment.

Results and Discussion

The Scheme of Operation and Algorithms of Standard Educational Mobile Applications for Learning a Foreign Language

It is worth describing the main characteristics of the operation of mobile game applications for learning a foreign language inherent in all services of this type.

- 1) The entry test to determine the level of language proficiency.

Almost every application at the beginning of registration asks the user to take a short test to determine their level of language proficiency. There are applications that allow the user to independently select their level and then change it in the learning process. Some educational mobile applications provide new vocabulary (lists of words or phrases) on different topics according to the level of language proficiency and containing a certain number of words corresponding to it. They offer lists of easy vocabulary for beginners, as well as more complex and specific vocabulary for advanced learners.

The applications that ask their users to take an entry test are *LinguaLeo*, *Simpler*, *Bussu*, *Duolingo*. The applications allowing the user to select their language proficiency level are *Memrise*, *Babbel*, *ELSA*, *Mondly*, *PuzzleEnglish*, *ABAEnglish*, *Beelinguapp*, *Drops*, *PuzzleMovies* and others.

- 2) *Timing and word count.*

Each application first requests a time frame for different purposes:

- ü the number of days a week the user wants to study the language;
- ü the time the user wants to start a lesson;
- ü the number of minutes (less often hours) per day the user is willing to spend on learning the language;
- ü the time when the application will send a notification (reminder) about the upcoming lesson or that the user has missed it;
- ü the number of words per day the user is ready to learn.

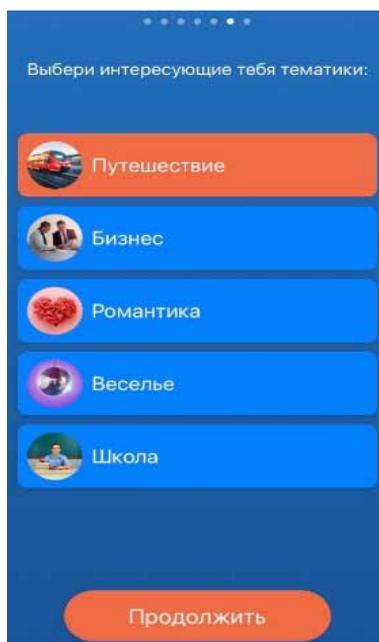
The *Duolingo* app also offers its users to freeze the time and progress if they failed to complete the lesson on the specified day.

- 3) The choice of motivation for learning a foreign language, which determines the vocabulary focus.

The language selection stage is followed by the question determining the user's motivation to learn the language: What's your motivation to learn English? The most common topics are travel, education, career, business, skill improvement, family and friends, school, work, personal interests, animals, and others. The focus of the vocabulary topic to be studied will be determined by the user motivation indicated at the registration stage (Figure 1).

- 4) Personal learning path.

Figure 1. Motivation choices in the Mondly app at the start of the course. Source: Mondly



Although each application has a standard general plan and a list of words, topics, texts, and dialogues for each language proficiency level, the algorithm of the individual selection of topics, the number of words, the time of the study, the nature of errors, and the difficulties of the user adapts learning in accordance with the user needs in all aspects of practice. This is the main advantage of educational mobile applications: while the teacher (person) cannot devote enough time and attention to each student, the application can do a great job in this case.

- 5) Algorithms for the sequence of learning and repetition in the process of mastering the material based on user actions.

The algorithms of applications for memorizing words are to repeatedly give the user the words in which they made mistakes or had difficulties in memorizing. For example, in the *LinguaLeo* app, in the “Vocabulary training” section, there is a subsection “Repetition”, which contains a certain number of words which the user found difficult to learn in order to look at them again. This can be considered the most convenient algorithm of vocabulary applications as the consolidation of the material learned in the context of traditional learning is determined only by the desire of the student; however, the program itself creates review lessons based on and evaluating the previous experience of the user.

- 6) Intervals in vocabulary review: the memory consolidation principle (from short-term to long-term memory)

Applications operate at optimal intervals for the average person to memorize words. Reminders are sent according to the same principle when the user has not attended lessons for a long time. Most often, applications work according to the spaced repetition technique, for example the *MnemonicWords* application, where each user has an opportunity to create their own vocabulary trainer, which takes into account their individual requirements.

The use of flashcards in many mobile applications for learning English vocabulary should be noted here. The method of the use of flashcards was developed by Leitner back in the 1970s and was actively introduced in various computer software aimed at learning English. Today this method is still the most popular with foreign language learners, and the concept of the method is the basis of operation of most up-to-date game-based applications along with the spaced repetition technique (Eremeeva & Baranova, 2016). *Quizlet*, one of the most popular services, and other common apps, such as *Anki*, *TinycardsbyDuolingo*, *Flashcards+* and *Lingualeo* also rely on this principle. A good example of visual memory development is not just flashcards with the original word and its translation but also with vivid drawings, and in some applications, these can be short videos to listen to the correct pronunciation of the word (*Memrise*).

7) Selection of topics according to the user interests.

This feature can be compared with the choice of motivation; however, the application also offers other sets of words (short thematic vocabulary) and often provides a selection of dialogues on various topics to complete listening and reading exercises where important words and phrases of the topic are highlighted. In *Duolingo*, in the course of listening to the dialogue, the program prompts the user to perform simple tasks to determine whether they can understand what they have heard and whether they are memorizing the new vocabulary. Standard conversation topics are everyday situations that anyone can find themselves in. For example, “Good morning”, “Good evening”, “At the store”, “On a date”, “At the museum”, “In the cinema”, “At the exam”, “At the airport”, “At the passport control”, “Family Dinner”, “At the Station”, “At the disco”, etc.

8) Practice of grammar rules using the words and phrases learned

Each application that aimed not only at improving vocabulary or speaking skills but also grammar practice offers a grammar section containing examples. Moreover, this involves not only grammar explanation (not in all applications) but also examples of the use of these grammatical structures in the sentences made with the words that the user has already learned. In *Duolingo*, each section contains both exercises to master vocabulary and grammar exercises. The application asks the user to translate sentences from Russian into English and vice versa using thematic vocabulary and specific grammar. The mistakes made are immediately shown along with the correct answer, and the playback algorithms and test sequences remember the mistake and offer to perform this task again in several other tests.

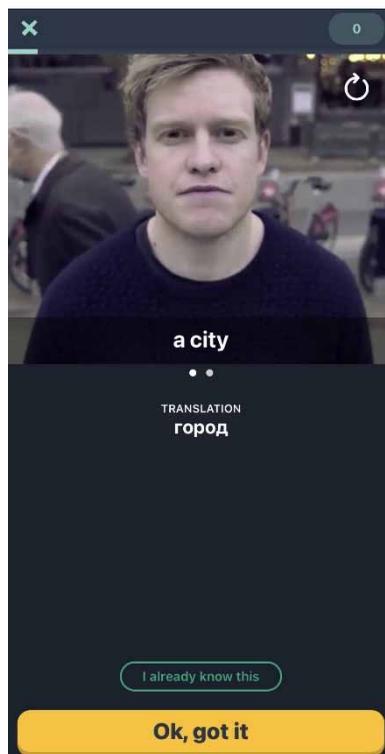
9) New vocabulary accompanied by audio recording of phonetically correct pronunciation by native speakers.

In almost every app, new vocabulary that the user learns is accompanied by an audio recording of phonetically correct pronunciation by a native speaker. Applications with specific content and focus offer short videos with a native speaker pronouncing a phrase or a word, for example the *Memrise* app. This can be defined as a kind of an interactive flashcard (Figure 2).

10) Reading or listening to the text.

Some applications include exercises to develop reading and listening comprehension skills. The most striking example can be the *LinguaLeo* application, which provides various exercises to develop reading skills: easy reading of the text; time-constrained reading (the lines on the top gradually disappear); putting certain words or phrases of the same text in the correct order within the time given; putting sentences of the text in the correct order (to understand cause-and-effect relationships). In

Figure 2. Exercise to memorize English vocabulary in the Memrise application accompanied by a short video. Source: Memrise



addition, the user can listen to the text, and thereby train their reading and listening skills at the same time. The texts offered by the app are most often excerpts from famous fiction books.

11) Speaking exercises (only in applications with a specific focus).

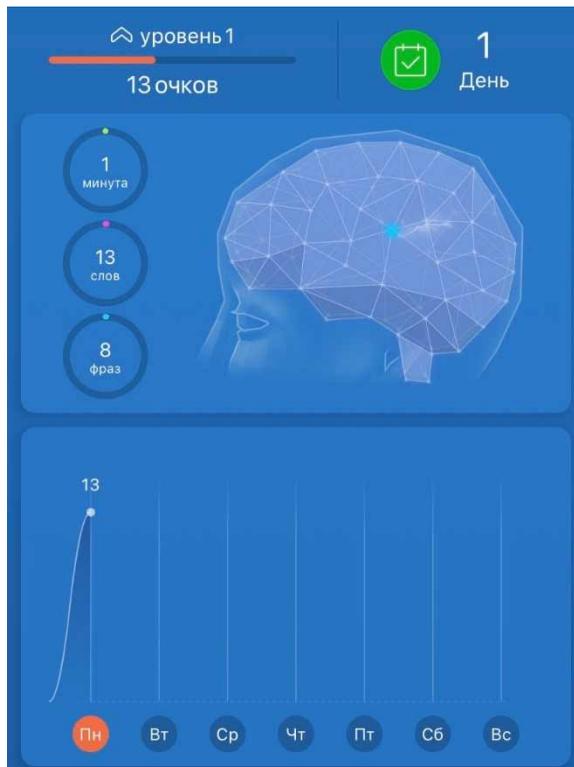
There are applications that are focused on the development of correct articulation and speech. A good example is the *ELSA Speak (English Language Speech Assistant) application*; the app content and algorithms are aimed at assessing the quality of the user speech and its correction: the student listens to the word and repeats it while recording themselves. There are also conversation games, intonation games and evaluation games. Moreover, this is combined with the vocabulary replenishment as the application contains separate sections with thematic dictionaries, where each word is accompanied by an audio recording of its correct pronunciation and the user can also record themselves to assess their performance.

Applications that are used for the development of speaking and pronunciation skills include *Tandem, HelloTalk and Pimsleur*; they allow learners to make friends with native speakers or find tutors to improve their speaking skills.

12) Keeping records of daily progress.

Almost every educational mobile app keeps record of daily progress and reflects an increase in skills and the level of mastery. For example, the *Mondly* application has a very bright and user-friendly interface visualizing the words and phrases the user has learned in a moving sphere or in human brain points as formations of neural connections (Figure 3).

Figure 3. User progress record in the Mondly app. Source: Mondly



This system is a universal means of storing and compiling static data on the quantitative and qualitative success of the user (student), which is physically impossible for a teacher who pays attention to a large number of students. This is a big advantage of the application as it provides an assessment and a visual diagram of progress.

13) Rewards and points for completed tasks.

Educational mobile applications have a reward and motivation system rewarding users for completing tasks and expanding vocabulary. In applications where there are online competitions or user rankings, this motivation is of special importance. For example, *LinguaLeo* and *Duolingo* have competitions and leaderboards with the names of the strongest participants. In *Quizlet*, where educators can create their own courses and modules, users can also view Leaderboards with the nicknames of the most successful students.

Traditional teaching methods should be complemented by innovative methods of mobile pedagogy as a mobile game offers the user standard knowledge and a presentation of success only in this application, and the teacher relies on human factors, psychological characteristics of the student, and can also explain linguistic issues in the context of human culture, society, mentality and relationships, which cannot be done by any artificial intelligence system.

Application Groups, Their Characteristics and Content Features

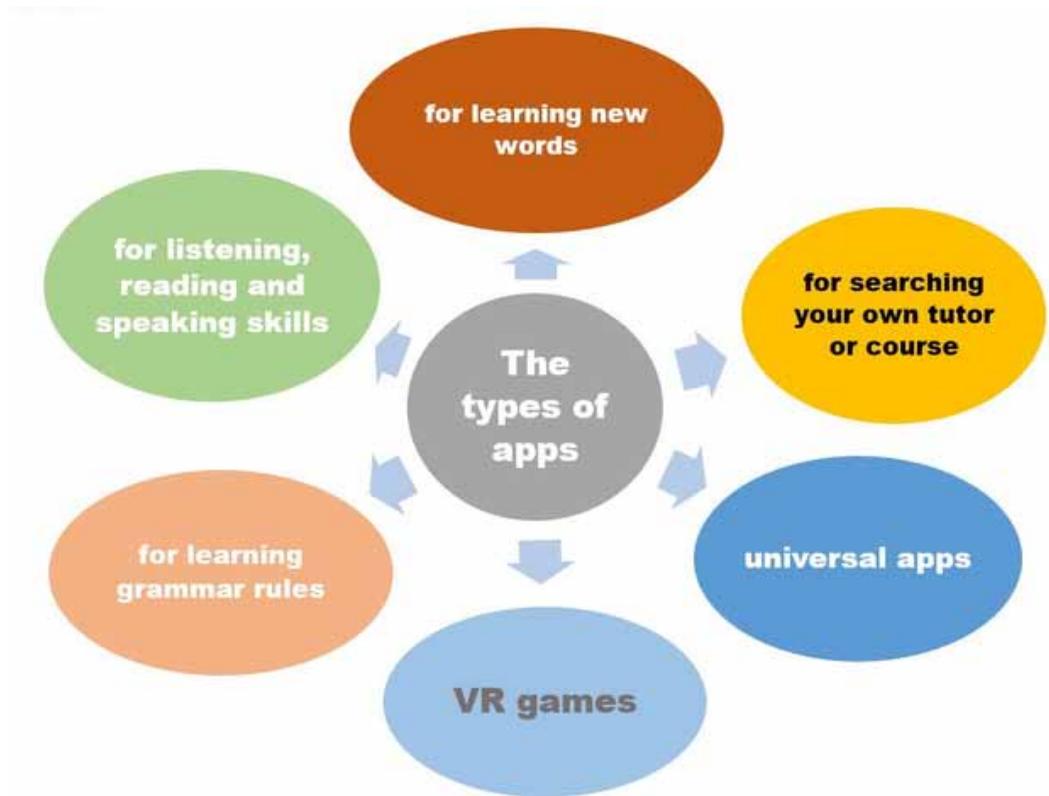
There are applications that are aimed at improving certain foreign language skills characterized by special and characteristic content. All mobile game applications created for learning a foreign

language help the user develop different types of skills, but the most popular ones are games aimed at replenishing vocabulary. This focus is key to starting learning any language, which means that applications of this type are the most important and effective in the list of mobile programs for learning a foreign language.

This study identifies 6 main groups of educational mobile applications (Figure 4):

- 1) applications for learning new words;
- 2) applications aimed at the development of listening, reading and speaking skills;
- 3) applications aimed at mastering and learning grammar rules;
- 4) applications for finding a teacher or a foreign friend for communication;
- 5) universal apps;
- 6) VRgames.

Figure 4. Types of mobile game applications for learning foreign languages. Source: own development



Some applications can be attributed to several categories at the same time, but not all game-based applications are universal in all aspects as they have a certain focus in addition to secondary functions. However, in every application for learning a foreign language, the key function is the assimilation of new vocabulary.

For Learning New Words

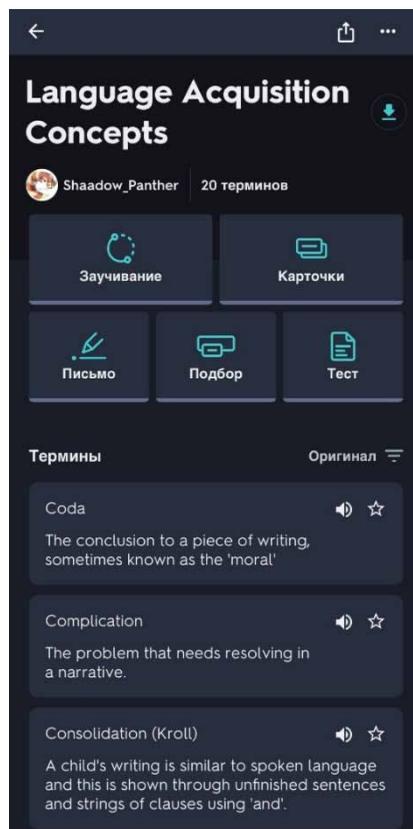
This category of mobile game applications includes *Quizlet*, *PuzzleEnglish*, *EasyTen*, *Words*, *RosettaStone*, *15,000 UsefulPhrases*, *WordBook*, *Babbel*, *Bussu*, *Mondly*, *Duolingo*, *Memrise*, *LinguaLeo*, *FluentU* (the last six applications are included in each category as they are universal). Let's take a closer look at their functions and content.

This group is the largest one among the varieties and types of foreign language learning applications. The focus and content of these applications are aimed at replenishing user vocabulary.

Modern educational mobile applications provide not only lists of new words with their translation but also audio recordings of their correct pronunciation by native speakers; in addition, there are also examples of their use.

Different applications offer various game-based tests to consolidate the material learned. The most common games are “define the word”, “fill in the gaps” or “put the words in the correct order to make a sentence”; thus, the user must arrange the words in the correct order while maintaining the sequence structure and semantics of the sentence in order to learn to identify cause-and-effect relationships between the words. These applications also offer a “listen and write” task; in this case, the user must listen to a new word and write it down. This task acts as a prototype of dictation, but the text is voiced by a native speaker and played back; the answers can be recorded either manually using the keyboard of a mobile device or using the puzzle letters that make up the word. Based on the same principle, the user performs tasks to create sentences: listens and writes down the sentence or its translation using the keyboard / puzzle letters; reads the definitions or the original words in

Figure 5. Quizlet interface in a user-generated course. Source: Quizlet



the language that is being studied, and then writes down the sentence or arranges word puzzles in accordance with the task given. These are more convenient and versatile tasks compared to dictations in the context of the traditional learning process guided by the teacher. In the mobile learning system, the tasks are immediately and automatically checked and the difficulties arising in the process of their completion are analyzed by the user action algorithms. Therefore, the user either comes across difficult lexical units until they can remember them, or these are sent to the Review folder.

Quizlet has become a versatile tool for educators in the context of distance learning as it allows them to create their own course with double-sided flashcards and exercises to master the material learned based on these cards (Figure 5).

Thematic vocabulary flashcards can also be created in *FluentU*, *Memrise*, *TinycardsbyDuolingo*, *WordPowerLite*, *Flashcards +*, *Vocabulary.com*, *EnglishDomWords*, *MnemonicWords*, *Anki* and others.

For the Development of Listening, Reading and Speaking Skills

The list of mobile game applications for improving speaking, reading and listening skills includes the following apps: *ELSA Speak*, *FluentU*, *Extra English Conversation*, *Puzzle Movies*, *Listening, Tandem*, *LearnEnglish Videos*, *LyricsTraining*, *SpeakingPal*, *Voscreen - Learn English*, *Idiom*, *Daily Dictation*, *Supiki*, *Pimsleur*, *Bussu*, *LinguaLeo*, *Duolingo*, *Memrise*.

This category of applications should be separately highlighted as certain exercises for replenishing vocabulary cannot be considered completely effective in learning a foreign language due to the fact that the ability to use new vocabulary at different levels of communication is the main indicator of vocabulary mastery.

The main focus of these applications is placed on exercises to develop reading, listening, and speaking skills. These goals are accomplished by completing different assignments which are somewhat different from traditional classroom teaching methods.

For example, *ELSA Speak* is based on speech recognition and correction algorithms. The user reads a word, phrase or a paragraph of text, which are analyzed by the system that identifies and highlights sounds to be practised or the degree of the speaker's accent. At the sign-in stage, the user can take a verbal test in order for the program to identify and create an individual training course based on the user's pronunciation difficulties. In addition, tasks are performed on the basis of certain topics and complexity levels to which thematic dictionaries are added. Another important feature of the dictionaries in *ELSA* is the ability to add new words or phrases, listen to them, and check one's own pronunciation. Each user recording is assessed as a percentage of its closeness to the pronunciation of a native speaker.

Other interesting apps of this type are those allowing the user to watch videos, excerpts from films, interesting scientific and public lectures or music videos, etc. in order to develop listening skills. Such applications also provide subtitles in both languages and after watching the video, users have an opportunity to complete various tasks, tests, and exercises in order to master the words and phrases they have heard. These are the most effective listening practices involving spoken language to help the learner adapt themselves to everyday communication patterns. This can be considered much more productive than listening to textbook recordings in the traditional classroom. In addition, watching videos, listening to native speakers, and reading subtitles are a combination of tools for the development of key skills to acquire language proficiency. These skills can be trained in *FluentU*, *SpeakingPal*, *VOA learning English*, *LyricsTraining*, *Puzzle Movies*, *Voscreen - Learn English*, *Extra English Conversation*.

A striking example of a mobile game application that combines exercises to improve the three most important skills (reading, listening, vocabulary skills) is the *Idiom* app allowing the user to listen to the words or phrases spoken by celebrities, as well as read many excerpts from different novels or news. Moreover, the learner can use vocabulary cards and the application establishes time intervals for the student to review the material.

Another rather unusual game for developing foreign language speaking skills is *Supiki*. This is an application providing the user with a list of discussion topics; the learner can choose any topic and discuss it with the application at any time. Smart algorithms of the app can listen to the user and ask them different questions on the topic. In addition, the app has videos with stories of characters whose adventures provide the user with a list of new words to learn.

For Mastering and Learning Grammar Rules

This group of game applications includes *English Grammar in Use*, *English Grammar Test*, *English Grammar Book*, *English Grammar Book by TalkEnglish*, *LearnEnglish Grammar by the British Council*, *English Tenses Practice by MagikHub*, *Duolingo*, *Memrise*, *Mondly*, *LinguaLeo*, *FluentU*, etc.

Most often, these programs offer the division of grammar topics into sections as in textbooks. Each grammatical section is divided into large and small topics accompanied by detailed explanations of the use of grammatical structures with examples in sentences, as well as various exercises, tests, and quizzes to practise the use of the rules studied (*EnglishGrammarinUse*).

The *English Grammar Test app* is an auxiliary tool of the *EnglishGrammarinUse* app which contains a collection of 60 tests with 20 tasks for each grammar topic. This application is not an electronic textbook with the explanations of grammar rules but a collection of exercises to master the material previously assimilated by the user. Thus, students have an opportunity to practise the use of certain grammatical structures anytime and anywhere. Moreover, at the end of each test, the application provides a detailed description of the answers with explanations of the mistakes made and generates progress statistics in the results section.

EnglishGrammarBookbyTalkEnglish is a kind of electronic grammar textbook that contains more than 138 grammar topics. As in every standard grammar application, lessons are divided by topic and complexity level, and they are accompanied by a number of games, tests and exercises to assimilate the material. The app rewards the user with medals and points for good results.

Another popular application for learning English is *LearnEnglishGrammarbytheBritishCouncil*; the app consists of 25 large topics that include 600 exercises and a large number of tests. Each grammar topic is accompanied by illustrations and detailed descriptions of grammatical structures.

For the assimilation, improvement and general study of 12 English tenses, the *English Tenses Practice by Magik Hub* application was created. It includes a detailed description of each tense with examples of use. Exercises and tests in this application can also be taken offline.

Applications, such as *Duolingo*, *Memrise*, *Mondly*, *LinguaLeo*, and *FluentU*, are universal tools for learning a foreign language as they contain all types of exercises to develop important language skills. It should be noted that grammar exercises and tests in these apps are based not only on the grammar rules and standard structures presented in textbooks but also on the new vocabulary that the user is studying or has already learned. This selection is universal as it follows the algorithm for compiling a personalized training program according to user mistakes and difficulties.

Applications for Finding a Teacher or a Foreign Friend for Communication

This group includes *HelloTalk*, *English Talk*, *Speaklar*, *Speak Peak*, *Tandem*, *Bussu*, and *Coursera*.

The applications of this type could be attributed to a specific subcategory of applications for improving speaking and listening skills that has its own characteristics that give reason to define it as a separate category.

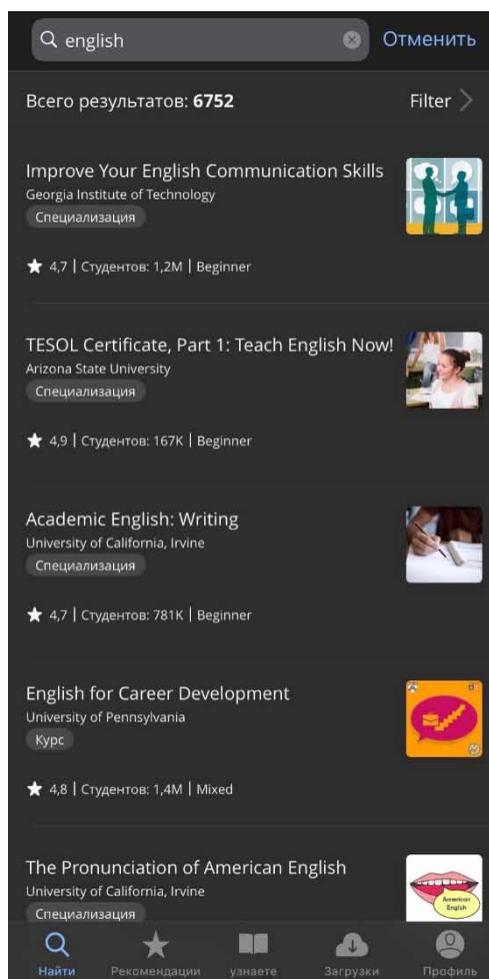
HelloTalk, *English Talk*, *Speaklar*, *SpeakPeak* and *Tandem* are specific platforms or chat rooms where users can find foreign friends or teachers to learn the language with. For example, in the *Tandem* application, at the sign-in stage, the user must indicate the language they are learning, as well as the purpose. Thus, the algorithms match users with similar interests (thematically) and opposing languages (for example, for a Russian speaker who is studying English for travel the application finds a British man who is studying Russian and is interested in a similar topic). These applications are effective tools for learning a spoken language with its native speaker.

In such applications, users have an opportunity to communicate, exchange audio messages, or make audio calls, as, for example, in the *Speaklar* app, which also has ready-made recordings for listening practice.

An interesting feature of the *Bussu* application due to which it has been included in this category is a function allowing the user to complete exercises and get them checked by native speakers who analyze the work and can give useful advice.

Coursera is an application that allows the user to enroll for any course that is taught by different higher educational institutions in different countries (Figure 6). There are also language courses with different thematic focus and specificity, and courses in other disciplines. These courses can be taken for a fee and for free depending on the nature of the course; but after completing the paid course, a certificate can be provided. *Coursera* is a convenient app that can be used as an auxiliary tool in distance learning or as one of the sources of the mobile pedagogy concept as teachers record video lessons for their university courses, which can be taken by students around the world.

Figure 6. Search for English courses in Coursera. Source: Coursera



Universal Apps

Universal applications, which have been repeatedly noted in the above groups, are mobile game applications such as *Duolingo*, *Memrise*, *Mondly*, *LinguaLeo*, *FluentU*, *Bussu*.

These are applications that include materials, tests, exercises and quizzes for the development of all foreign language skills (learning new words, reading, listening, speaking, learning grammar rules).

The main function or tool for the development of a key skill is an algorithm for the step-by-step study of different thematic vocabulary, which acts as the main foundation for further improvement of other skills.

Grammar learning in these applications is implemented through creating and processing of grammatical structures based on the vocabulary studied, which involves the comparison of sentences, exercises and tests.

This category includes the *Memrise* application, which is a kind of gaming platform or type of video game, which contains a large number of videos with native speakers, as well as games aimed at effective and active assimilation of different types of learning material.

Duolingo and *LinguaLeo* offer the study of thematic groups of words in combination with exercises for reading, listening comprehension, and mastering new lexical units, as well as dictations, user competitions with different types of tasks, etc.

An interesting example of unusual tasks is one of the tests provided by the *LinguaLeo* application in the reading section. After reading a short excerpt from a famous fiction novel, the game offers to arrange paragraphs or complex sentences in the correct order to develop the user's ability to identify and establish cause-and-effect relationships in integral syntactic structures.

Virtual Reality Games

This group includes *TheHouseofLanguages*, *VirtualSpeech*, *AltSpaceVR*, *ClassVR*, *ImmersiveVREducation* (4 best virtual reality apps for learning English).

This is a modern and still unusual method of learning foreign languages that is an excellent alternative to live communication with a native speaker or travel to the target country. The student becomes a direct participant in the communication process as virtual reality games are based on the simulation of immersion in a certain environment, in this case, in a foreign language environment and communication.

There is a VR application (collection of mini-games), *The House of Languages*, developed by an Estonian game company. The game offers immersion in virtual reality as a tool for learning and mastering foreign language vocabulary for high school students. The game consists of mini-games (puzzles, guess the word tests, etc.) that combine different points of perception of virtual reality with a high level of immersion (Oculus, 2021; Unimersiv, 2021).

Virtual Speech is a game that simulates communication situations at work and in the office. Thus, this course can be defined as a thematic collection of words and situations in Business English. This application uses voice analysis algorithms that correct speech, pronunciation, and awkward pauses and make comments about the use of phrases or words to better suit business communication.

AltSpaceVR makes it possible to create one's own avatar in the virtual world and communicate with other real users in different thematic situations (games, walks, chatting with stars, parties, etc.) that the game offers. There are more than 150 countries, whose residents can use the game and communicate with each other.

ClassVR is a learning platform that was originally designed for educators. It contains a number of communication topics devoted to routine daily situations and allows users to watch various interactive videos. It also relies on the concept of blended learning (augmented or mixed type of reality) and the user can use notebooks and textbooks.

Immersive VR Education is a very convenient platform for finding a tutor or gathering study groups with the help of virtual reality and the ability to conduct individual or group lessons. This

game differs from others by the availability of unusual themes or virtual places (walk on the moon, sunken ships, treasures on the island, etc.) to immerse oneself and practice language skills.

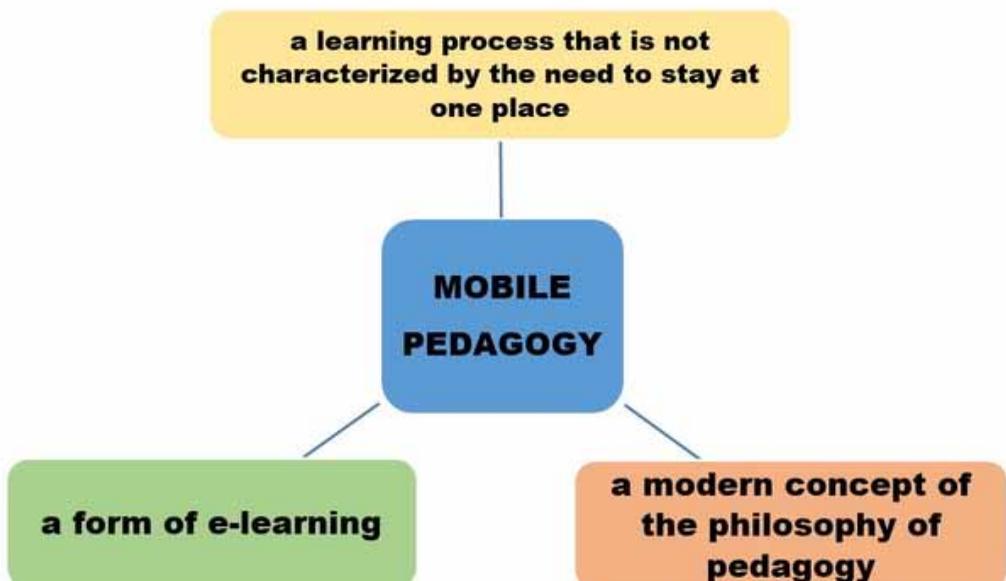
Mobile Learning to Expand Vocabulary

In the context of the introduction of *mobile pedagogy* into ELT (English Language Teaching), most students and teachers agree that the educational process, which is based exclusively on textbooks or classroom lectures, has already become obsolete, especially when it comes to paper dictionaries and written assignments in the study of foreign language vocabulary (Dias & Victor, 2017; Dumford & Miller, 2018; Kärki et al., 2018). Students demand the introduction of more socially mobile (technical) innovations into the learning process. Such innovations mean the use of digital media, mobile devices, network communication or the active introduction of up-to-date educational mobile applications based on games.

The best way out of this situation seems to be the implementation of various mobile programs in the learning process. Thus, the concepts of *mobile learning* and *mobile pedagogy* are being more broadly defined. There are three most common identifications (Figure 7):

- 1) a learning process that is not characterized by the need to stay at one place (classroom, school, university) combined with the use of technology;
- 2) a form of e-learning with the use of mobile technologies (games, applications, e-books, programs, courses, etc.); unlimited space, portability, accessibility, the social connection of students and teachers with the help of technology; an individual approach to training; all-round orientation (towards each student separately and towards the teacher, in particular);
- 3) the emergence of a new direction in the philosophy of pedagogy, which is most characteristic of the 21st century: the role of the teacher fades into insignificance (focus on self-learning) or is reinforced with the help of various mobile applications (when the teacher creates their own interactive learning material in special educational applications).

Figure 7. Three concepts of mobile pedagogy. Source: own development



It is worth studying in detail the concept of the *philosophy of mobile pedagogy*, which should become the way of thinking of the 21st-century teachers. This refers to the establishment of certain strategies aimed at the development of the learning process within or outside the classroom involving a system of active interaction between the three parties of the educational discourse: students, teachers, and mobile devices (applications, games, programs, learning platforms). This thinking is based on the understanding of the most important factor: students' interest in learning English should be manifested both in the classroom and outside the classroom if the main goal of the teacher is to obtain qualitative and quantitative improvements in student achievements. This effect can be achieved with the help of mobile games, which are based on entertainment content but with a focus on learning.

There is no doubt that the main idea of the concept of *mobile learning* or *mobile pedagogy* is the teacher's ability to combine all three areas, that is, to create a favorable environment for students with no reference to the audience, to encourage the active use of mobile devices as auxiliary tools in the classroom, and also to maintain motivation for learning a language by creating an interest in an independent study after the main lessons with the teacher.

Thus, it follows that the key to the concept of *mobile learning* is, first of all, the competent application of the *self-learning/self-studying* method. This involves not only the process of learning at home or outside the educational institution using a mobile device but also the establishment of attitudes and awareness of the need for learning, practice and improvement of language skills.

Mobile learning completely transforms the learning process as mobile devices combine traditional forms of presenting and accessing information with the help of mobile technologies; therefore, this type of learning is getting personalized or individualized. It should be noted that most applications for learning foreign languages work exactly according to this principle. This principle can also be referred to as *self-study facilities* or *just-for-me installations*, which are very convenient for each individual student. It relies on a task selection algorithm based on previous mistakes and difficulties of the user. The teacher does not have enough time to pay attention to the problems of each student but this can be done by a mobile game application.

An Experiment in the Form of a Survey

At the first stage of the experiment, the comments of some students and members of the commission were analyzed, which made a certain contribution to the final results of the study.

“Generally, mobile learning develops motivation in students learning languages as today the old assessment system is not a big incentive for the younger generation, and the points and rankings in the educational game encourage them to get the best results among their fellow students or users of the application.” (One of the teachers of Moscow State Psychological and Pedagogical University, member of the commission in the Pedagogy Department).

This opinion can be considered correct and objective as in fact educational game applications provide rankings or points for the completion of vocabulary tasks as separate encouragement and motivation systems. Moreover, points can be deducted for mistakes made.

It is also worth highlighting the comments of some students.

“When you turn over the pages of a thick textbook and try to memorize Latin terms, you have to write them out separately or highlight them with a marker and memorize the page number – this is very inconvenient. However, when you can open a mobile application at any time and in any place and study with the help of an exciting game, the desire to learn grows every day, and you do not feel tired in the process of learning. In addition, the teacher can control whether the students are engaged in the course or not.” (First-year student of Sechenov Moscow State Medical University about Quizlet and Memrise, as well as the differences in learning).

“In learning English, the most important thing is a constant desire to learn it and daily practice. This is very easily achieved with the help of interesting games that not only help to increase the level of language proficiency and improve the quality and quantity of vocabulary but also make it possible to visually monitor progress and maintain motivation.” (First-year student of the State Academic University for the Humanities at the Russian Academy of Sciences).

The research results showed that over the period of the experiment, students from groups 2 and 3 increased their vocabulary by 80-90% (100-112 words), and students from group 1 by 56% (70 words), where 100% is 125 new words and terms in 25 days.

The greatest progress in the study of foreign vocabulary was observed in group 2; the students used the Quizlet application and memorized 90% of the new vocabulary (112 words). The psychologists from the commission noted an overall increase in motivation and team spirit among the students, as well as a visual memory improvement as the participants memorized the flashcard pictures or the word placement in game tests. The completion of timed tasks (puzzle tasks to combine the word with its Russian translation or definition) contributed to the improvement of students' motor skills.

Students in Group 3, who learned new vocabulary in the Memrise app, memorized 82% of new words (103 words). The members of the commission noted an improvement in the visual memory of the participants and active use of imagination in the process of memorizing and recreating images in memory as symbols of new words; this was due to the fact that the vocabulary study in the application was accompanied by short videos with native speakers.

In both groups, there was an improvement in the auditory perception of foreign language words as the applications contained audio recordings of words and phrases that accompanied every task.

Group 1 that relied on traditional learning methods showed the worst result. Thus, the students memorized 56% of the new vocabulary (70 words out of 125); moreover, no significant improvements in the approaches to memorizing foreign language words were noticed.

The students of the medical university who studied the terms of Latin origin should be separately considered. In this category of students, there was a large gap between the results of the groups studying based on traditional learning methods and the use of the Quizlet and Memrise apps. Students who studied the terminology in the textbook memorized only 40% of the words, and those who used game applications learned 85%, which is almost twice as many.

The overall results of this experiment showed that mobile learning with the use of game applications, namely Quizlet and Memrise, is more effective and efficient in the educational process compared to traditional learning methods. The anonymous survey, which was based on determining the level of satisfaction with applications and mobile learning methods showed the following results: 86% of positive reviews and 14% of negative ones; 89% of negative reviews were due to costly use of the educational apps.

It has been concluded that mobile learning and mobile pedagogy are the most effective and relevant in the educational process of the 21st century as they affect an increase in student motivation and contribute to the ways of information memorization and perception.

In the course of the second stage of the experiment, the following results were revealed. These were supported by the comments of some participants.

“The main advantage of studying English with a Russian-speaking teacher is the possibility of getting a detailed description of the differences between the languages while a native speaker cannot see them and, accordingly, cannot explain them.” (Second-year student of the Eurasian Humanitarian Institute (experimental group 1 studying based on traditional learning methods).

“Communication with a native speaker develops the skills of extreme learning of new vocabulary and listening comprehension of spoken language or the phenomenon of phonetic “swallowing” of sounds while learning a language in the classroom with a teacher makes students become participants in a slow learning process in a specific comfort zone, thereby making this method less effective.”

(Third-year student of the Eurasian Humanitarian Institute (experimental group 2) about the service provided by the Tandem application).

“The concept of individual learning via mobile apps has its pros and cons. For example, students can schedule their classes themselves, that is, they have freedom of choice. Moreover, in such an environment there is no pressure from the teacher or fellow students. But at the same time, a person adapts to the environment that excludes an active communication process and interaction, which is a big disadvantage of this method.” (Teacher of the methods of pedagogical practices of the Eurasian Humanitarian Institute about the use of ELSASpeak and Tandem).

The final result of the experiment showed that the differences between the results of group 1 and group 2 are small, more precisely, almost equally high, but the results of the third group are slightly different from the rest.

Group 1 that studied words and discussed topics with the teacher showed the following results: general knowledge of each topic ~ 80%; the number of new words that were used in discussions ~ 220 out of 250.

Group 2 that studied topics and words using the Tandem application showed the following results: general knowledge of each topic ~ 76%; the number of new words that were used in discussions ~ 210-230 out of 250, including new slang units that were added to the list.

Group 3 that practised speaking skills and replenished vocabulary using the ELSASpeak application, showed the following results: general knowledge of each topic ~ 65%; the number of new words that were used in discussions ~ 180-200 words out of 250, but with significant improvements in the quality of pronunciation.

This experiment made it possible to conclude that mastering vocabulary and speaking skills with a teacher in groups, as well as with the help of native speakers in the Tandem application, are the most efficient and effective learning methods.

The psychologists from the survey assessment commission noted that such a result can be achieved not only through innovative learning methods or high-quality teaching but also through the general synchronization of student communication, the traditional educational process, and the use of mobile applications. This can explain the lag of Group 3 as individual learning involves personal preferences and directions in the study. It is also worth noting that pronunciation improved significantly only in group 2 and group 3 as group 2 communicated with native speakers and group 3 studied vocabulary using the ELSA application that assesses the quality of user speech and corrects it. The psychologists also noted that the success of group 1 and group 2 lies in the fact that the students were exposed to the general influence of interests and questions during classes so they had an opportunity to discuss more points and topics than those who studied individually and strictly according to the program.

The teachers from the expert group made a general conclusion on the experiment. They believe that each method separately has its pros and cons, but in their totality, they form the basis of the concept of *mobile pedagogy* or *mobile learning of the 21st century*, which is the most effective and efficient combination of different learning methods. Every mobile game application is of an entertaining nature, which contributes to better memorization and perception of information by the brain. When a student is in the classroom, many other factors can affect him/her, and these are not always positive. For example, the perseverance and severity of the teacher; conversations of fellow students that are distracting; unsound competition or fear of public speaking; fear of any social contact; lack of time to complete tasks; shyness. There are many psychological and physical barriers and factors, and when talking about new concepts of the mobile pedagogy philosophy, the teacher should always keep in mind that students have their own individual characteristics. This is what is worth remembering in this context as mobile game applications focus on personal experience and preferences as key in the educational process.

The results of studies on the effectiveness of the general implementation of mobile learning show student satisfaction with the quality of services (quality of information and systems) of mobile

learning. In addition, on the basis of such studies, it can be concluded that e-learning technologies are the best way to achieve increased efficiency of the educational process as the experiments and surveys revealed that the education system in some developing countries requires redesign and further development. There is a shortage of capable teachers in schools and universities and this problem can only be solved by the introduction of e-learning (Rajasekaran et al., 2022).

Bimasheva et al. (2021) conducted their experiments based on smartphone functions such as SMS, MMS, e-books, etc. in combination with traditional learning methods (paper sheets, classroom learning). These techniques were applied to English language learners seeking to improve their vocabulary. However, in our study, we relied on the methods of mobile learning of a foreign language with the help of game applications but not the functions of mobile devices themselves. Nevertheless, both experiments were conducted in order to identify the effectiveness of the use of mobile devices in learning English. Despite this, the results of the experiments have some differences: the study by Bimasheva et al. (2021) showed that the differences between the results of the effectiveness of traditional and mobile learning methods are minor or there aren't any at all. Our data demonstrate the opposite results, namely the high efficiency of using mobile devices in the educational process.

Van et al. (2020) also conducted an experiment to determine the effectiveness and efficiency of the Quizlet app in learning English, specifically in vocabulary replenishment. The researchers concluded that students who used the app both in the classroom and outside the classroom had much better average results and improved their general performance compared to those learning foreign language vocabulary exclusively with the help of traditional methods. These results are similar to our findings, which indicates the effectiveness of the implementation of this method in the context of modern mobile pedagogy.

The number of mobile applications for learning English is growing every year, and the level of popularity and relevance is constantly changing. However, a number of identical educational applications, which are the most popular, can be distinguished. Such applications can be divided into main groups according to their content and focus. For example, applications aimed at replenishing vocabulary, developing speaking, reading and listening skills, and reproducing communication situations, or universal applications (Busel, 2020; Cruz & Orange, 2016; Elmurodov, 2020; Kibireva, 2019; Kuimova et al., 2018; Shakhova & Tapilin, 2017). Nevertheless, in our study, we provide not only a detailed description of the applications from generally accepted groups but also highlight two more innovative categories – virtual reality games and platform applications for finding tutors or courses.

Conclusion

This study is focused on the analysis of the effectiveness of using educational mobile applications in the process of learning a foreign language in the context of mobile pedagogy. The effectiveness of the implementation of mobile games for vocabulary replenishment was assessed based on the comparative analysis of the features of applications. The work describes the schemes of operation of the most common mobile applications and highlights 13 fundamental algorithms with examples of their functioning in the most popular programs of this type (55 applications). It was found that the key algorithm of any mobile application of this type is based on the principle of developing an individual training program for the user as the application adapts to the actions and level of knowledge of the student analyzing their mistakes and difficulties in the process of completing assignments. The same principle is embedded in the concept or philosophy of mobile pedagogy of the 21st century. This study also describes and highlights 6 main and most relevant groups of mobile game applications: 1) applications for learning new words; 2) applications aimed at the development of listening, reading and speaking skills; 3) applications aimed at mastering and learning grammar rules; 4) applications for finding a teacher or a foreign friend for communication; 5) universal applications; 6) virtual reality games. In order to objectively assess the effectiveness of the implementation of mobile applications in the process of learning English, an experiment was conducted. An objective assessment of learning outcomes and a survey based on the Technology Acceptance Model (1989) were carried out. Using

Quizlet and Memrise, students memorized 80-90% of the vocabulary given while students who studied words based on the traditional approach learned only 56%; 86% of students were satisfied with the learning app and 14% of users gave negative feedback. ELSASpeak and Tandem were also tested to identify their effectiveness in the improvement of speaking and vocabulary skills. Significant increases in the number of new words used in discussions were seen among the students using the Tandem app (~ 210-230 out of 250). The group that used ELSASpeak demonstrated a great improvement in the quality of pronunciation. It was concluded that a combination of traditional learning methods with mobile game applications, which is the key concept of mobile pedagogy of the 21st century, is the most effective and efficient in the modern educational process. The practical significance and prospects for further research are based on the possibility of using the proposed method of analysis of mobile applications in the process of learning English. It is also promising to study the possibilities of using the proposed applications in the study of not only English but also other languages, as well as the analysis of the use of mobile applications in the process of teaching other subjects. The practical, social, theoretical, and managerial implications of the study explanation of the use of mobile applications in the educational process in general, to address various issues related to management issues in society, and the results can be a theoretical basis for further study of mobile applications in various social fields, including education. In addition, the results of the study can be used in the development of applications for management purposes and communication in society.

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