

The impact of using mobile apps on student engagement and involvement in the learning process

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ABSTRACT

For modern education, mobile applications are actively becoming a key tool. They help increase student engagement and activity by providing access to educational materials, organizing time, completing tasks, and thus stimulating motivation. At the same time, mobile applications can adapt learning methods to the individual needs of each student. Of course, the use of mobile applications is often accompanied by problems: distraction and technical difficulties. The aim of the article is assessing the impact of mobile applications on student engagement in the learning process and analysing the use of mobile applications, their impact on academic achievement, student activity, interaction with materials, and learning effectiveness. Special attention is paid to the context of academic performance. The methodology of the work is a cross-sectional survey. The survey involved 125 students from three universities. The survey results assessed the intensity of students' digital activity, their use of educational platforms, remote interaction, and time spent online for learning. In addition, the results indicate that students do not use mobile applications for in-depth learning but use them only for instrumental purposes. The work implemented a correlation analysis, which showed the absence of a significant impact of digital activity on academic performance. This emphasizes the need for a deeper study of the effectiveness of mobile applications in the learning process.

Keywords: Digital interaction, educational technologies, student motivation, learning platforms, mobile learning.

1. Introduction

For nearly thirty years, since the emergence of computer-assisted learning (CAL) in the 1980s and up to the present day, the relationship between technology and pedagogy has been the subject of much research and debate [3]. The contemporary impact of digital technologies is evident in educational transformations, particularly in remote learning [41]. Educational technologies, including mobile applications, have become tools that have the potential to change approaches to learning by increasing student activity and engagement.

The development of mobile technologies has opened new opportunities for the educational process. Mobile apps provide access to learning materials at any time and promote interactivity through features such as online tests, gamification, and virtual environments [2]. This allows students to participate actively in learning rather than passively consuming information. However, as in the case of other educational technologies, the actual results of the impact of these technologies often show ambiguity.

The most common studies comparing outcomes "with" and "without" mobile apps often show no significant difference, especially if the use of apps is not accompanied by a change in pedagogical approach [17]. As in learning management systems (LMS) studies, mobile applications can only be effective if they are properly

implemented into the learning structure [24]. According to scientists, the reasons for the lack of effectiveness of mobile applications in the educational process are mainly the lack of adaptation of pedagogical methods to the peculiarities of mobile learning, the use of applications without integrating them into the overall learning strategy, and the focus of assessment on basic knowledge rather than the development of higher-level competencies [5], [23].

At the same time, the experience of using mobile applications shows that their potential to stimulate student engagement can only be realized with careful pedagogical design, as the effectiveness of technology depends on the quality of the pedagogy accompanying it.

Thus, mobile apps can increase student engagement and activity when used in conjunction with interactive and stimulating teaching methods [16]. This involves changing the roles of teachers and students, emphasizing the development of social and professional competencies, and creating an environment that encourages continuous learning.

Thus, the modern learning environment has become an integral part of the digital age, where computers, tablets, smartphones, and the internet are used to support learning processes. However, the impact of mobile applications on student engagement and activity remains understudied. The question of improving learning outcomes along with the active use of these technologies also remains open. Therefore, these issues require deeper analysis. Adequate integration of mobile applications into the learning process has the potential to significantly change the learning process.

First, the issue is important because the dynamic digitalization of education and students' digital skills today give them a great advantage in the labor market. Analyzing the impact of mobile applications on student engagement is important in improving learning outcomes, increasing motivation for learning, and developing skills needed in the modern world [7]. The presented article aims to maximize the integration of digital resources to help teachers.

Research indicates that using digital technologies in learning can positively impact student outcomes [1]. Integrating digital technologies facilitates the flexibility of the educational process, enhances opportunities for distance learning, and promotes interactive knowledge acquisition [41], [42]. However, some research indicates that ineffective use of technology can lead to lower performance [22]. The literature review also highlights the importance of teacher training in using digital tools [8], as traditional teaching methods still dominate many educational institutions.

The following hypotheses were put forward in the proposed study:

1. Hypothesis 1: Students who actively use mobile apps for learning show higher exam results compared to those who do not use these apps.
2. Hypothesis 2: High student engagement in the learning process is positively correlated with the use of mobile applications.
3. Hypothesis 3: Socio-demographic characteristics (age, gender, level of education) influence the use of mobile applications in education.

A cross-sectional study was conducted among 125 students from different disciplines to test these hypotheses. The data was collected through a questionnaire that included the use of mobile applications, the level of engagement in the learning process, and academic performance. Thus, the present study will address how mobile applications can increase students' activity and engagement in learning and identify the factors that influence this use.

In the modern world, mobile technologies play an important role in learning, especially among students [36]. The impact of mobile applications on students' activity and engagement in the learning process can be viewed through the prism of the basic mobile learning concepts defined by cognitive science [13]. Such statements emphasize the importance of attention, active participation, feedback, and retention in mobile learning.

Cognitive science identifies four key pillars of learning: attention, active participation, feedback, and retention [34]. Attention is a critical element, as it shapes students' motivation and affects the duration of learning. Active participation of students in the learning process contributes to deeper learning. According to [7], feedback, which can be obtained through self-assessment or feedback from teachers, is important for correcting learning processes. Retention of knowledge, in turn, ensures the sustainability of acquired knowledge and skills.

In the context of mobile learning, teacher support can be implemented through mobile applications that provide access to learning materials anytime and anywhere [4]. This allows students to revise material and consolidate knowledge. Self-assessment, an important element of feedback, allows students to evaluate their achievements and difficulties, which contributes to developing their autonomy and responsibility for their learning [11].

Mobile learning has evolved from the simple use of mobile devices in the learning process to a more comprehensive approach that considers the mobility of students [14]. Learning through mobile applications is focused on the active participation of students in the process, which allows them to integrate the learning process into everyday life [12].

In this context, mobile technologies can be integrated into different learning theories, such as behaviorist, constructivist, and socio-constructivist [18]. Each of these theories suggests different approaches to using mobile apps to increase student engagement, from stimulating active participation to facilitating collaborative learning [40]. Learning using mobile applications is implemented in various formats. It can be formal, informal, and additional learning. Integrating mobile applications into formal learning enables their use in the learning process. This gives students access to resources and support during classes. Informal learning can also be stimulated using mobile technologies [32]. Therefore, combining formal and informal learning creates additional opportunities for student engagement. Such a mix increases motivation and activity in the learning process. Thus, mobile applications and their impact on learning are extremely productive. An in-depth analysis of the topic demonstrates their potential to increase student activity and engagement. This has a positive impact on their learning outcomes.

2. Method

The article uses a cross-sectional design, allowing for simultaneous data collection on student mobile app usage. The aim is to assess the impact of mobile apps on student engagement in the learning process.

The focus group comprised 125 students, including 90 women and 35 men. The participants represented 3 educational institutions.

The selected students who participated in the study had to meet certain criteria:

- The age range is 18 to 30 years;
- By gender - representatives of both sexes (90 women, 35 men);
- To study at the specified higher education institutions.

To collect the data, the focus group was offered a semi-structured interview questionnaire, which included questions about the frequency of using mobile applications for learning and the impact of mobile applications on student engagement in the learning process. Students were also asked to indicate the advantages and disadvantages of using these applications.

- Thus, the research questions were as follows:
- How often do students use mobile apps for learning?
- Do apps increase student engagement in learning?
- What are the advantages and disadvantages of using mobile applications from the student's point of view?

To determine the required sample size in a cross-sectional study, formulas were used to calculate test power, taking into account the expected effect size and significance level. Since the study involved 125 students, it provided sufficient statistical power to identify correlations between the use of mobile applications and academic performance.

The study involved a variety of data collection measures, including a self-report questionnaire on the frequency of mobile app use and an assessment of student engagement and activity through questions about study habits and socio-demographic characteristics such as age, gender, and level of study.

The proposed study had a cross-sectional design, which allowed data on different aspects of students' use of mobile applications to be collected simultaneously. The main goal was to assess the impact of mobile applications on student engagement and activity in the learning process.

The study tested the research hypotheses. The chosen design allowed for a comprehensive assessment of how mobile apps contribute to student engagement and academic performance and which demographic variables influence the way apps are used.

As the study was cross-sectional, it did not include experimental manipulations or interventions. However, the data was analysed using statistical methods - correlation analysis. It allowed us to identify the links between the use of mobile applications and students' academic performance. The questionnaires were sent online. All participants agreed to be interviewed.

3. Results

According to the study results, mobile applications play an important role in shaping students' activity and involvement in the learning process in the modern educational environment. The nine-part questionnaire provided a deeper understanding of how students interact with digital technologies and what factors influence their academic success (Table 1).

Table 1. Correlation analysis data on the use of mobile applications and student engagement

Frequency of use	Number of students	Engagement increased (Yes)	Engagement has not increased (No/Don't know)	Involvement (Yes, %)	Involvement (No/Don't know, %)
Daily	50	40	10	80	20.00
Several times a week	37	30	7	81.08	18.92
Once a week	19	15	4	78.95	21.05
Less frequently	13	6	7	46.15	53.85
Never	6	3	3	50.00	50.00

The correlation results showed a correlation coefficient of 0.85 and a significance level (P-value) of 0.065. Accordingly, it can be stated that there is a strong positive correlation (coefficient of 0.85) between the frequency of use of mobile applications and increased student engagement in the learning process. However, the significance level of $P = 0.065$ is slightly higher than the standard threshold (0.05), which indicates the need for further analysis or an increase in the sample for more reliable results.

The results of the study show the socio-demographic characteristics and peculiarities of students' use of digital devices for learning. The main age group was 18-22 years old (70%, or 88 people), while the share of younger students under 18 was 10% (13 people), and the older groups (23-27 years old and 28+) were 15% (19 people) and 5% (5 people), respectively. The majority of students have access to digital devices: 90% (113 people) use a smartphone, 75% (94 people) use a laptop, 30% (38 people) use a tablet, and 20% (25 people) use a desktop computer. Permanent access to the Internet is available to 85% (106 students), partial access to 10% (13 students), and 5% (6 students) do not have it.

Regarding the level of proficiency in applications, the majority have an intermediate level - of 60% (75 people), a high level of proficiency in 25% (31 people), and a beginner level - of 15% (19 students). The frequency of using mobile applications shows that 40% (50 people) use them daily, 30% (37 people) several times a week, 15% (19 people) once a week, 10% (13 people) less often, and only 5% (6 students) never use them. The effectiveness of mobile applications was noted by 75% (94 students), who believe that mobile applications increase engagement in learning. The main benefits of apps include easier access to learning materials (80% or 100 people), increased motivation (50% or 62 people), and interactive learning (40% or 50 people). The main advantages are convenience (60%, or 75 people), access to a large amount of information (50%, or 62 people), interactivity (40%, or 50 people), and time-saving (30%, or 38 people). At the same time, the main disadvantages are distraction (50% or 62 people), technical problems (30% or 38 people), limited functionality (20% or 25 people) and the cost of applications (10% or 13 people).

Socio-demographic factors, such as age, gender, or level of education, influence the use of apps: 65% (81 people) recognize their influence, 20% (25 people) believe that there is no such influence, and 15% (19 people) are not sure. Younger students are more likely to use apps (85% in the 18-22 group), and women are more likely to emphasize interactivity as an advantage (45% vs. 30% among men). Overall, the results indicate a significant

role for digital technologies in the learning process but also point to the need to overcome certain technical and organizational limitations.

The first four parts of the questionnaire focused on the conditions in which students' study. It included questions about the availability of digital devices, the level of proficiency in various applications and the frequency of their use in academic and extracurricular activities. This is important, as the effectiveness of mobile applications directly depends on how often students use them and what capabilities they have.

These findings suggest that mobile apps have a significant impact on the learning process by promoting student engagement and providing access to materials. However, there are also barriers, such as distractions and technical difficulties.

The survey results show that most students have access to modern digital devices such as laptops and smartphones. In particular, 90.6% of respondents have a laptop with an Internet connection, which allows them to use mobile applications for studying, taking notes, researching information, and completing assignments. These devices have become not only a means of communication but also an integral part of the learning process.

The next parts of the questionnaire explored students' learning strategies, including the use of digital tools. It was important to determine how mobile applications affect the way students learn, whether they help with time management, completing tasks, or increasing motivation to learn. Assessment of student's achievements based on exam results allowed us to conduct a correlation analysis between the activity of using digital technologies and academic success (Table 2):

Table 2. Relationship between the use of mobile applications and students' academic performance

Category	Number of students	Increased motivation (%)	Easier time management (%)	Improved task performance (%)	Average exam score (out of 100)
Women (90 people)					
Frequently used applications	60	85	78	83	86
Rarely or not used	30	30	25	28	72
Men (35 people)					
Frequently used applications	20	75	70	80	84
Rarely used	15	40	35	45	74

According to Table 2, students who use mobile apps frequently demonstrate higher average exam scores and improvements in aspects such as motivation, time management, and task completion. In particular, women showed greater engagement and efficiency in using digital tools compared to men. This points to the need to promote mobile apps among all categories of students to improve their academic success.

Students highly appreciate the opportunity to access digital services provided by the university. Online platforms, digital libraries, and the Internet contribute to improving the learning process by providing students with convenient access to the necessary materials. For example, 93% of students consider the online platform useful for their studies, and 55% visit it daily. However, it is worth noting that the activity of using these resources varies depending on the specialty, which indicates different needs and approaches to learning in different academic areas.

The last parts of the questionnaire focus on the socio-demographic characteristics of students. Understanding such parameters as gender, age, occupation and parental education level allows us not only to track trends in the use of mobile applications, but also to assess their impact on students' academic performance.

Therefore, the use of mobile applications and digital technologies in the educational process is an important factor that affects student activity and engagement. Studies show that students who actively use digital tools are more motivated and have better academic results. Further research can help develop new strategies for implementing mobile technologies in education, which will optimize the learning process and increase its effectiveness.

In the modern learning environment, mobile apps and digital technologies are becoming integral to the educational process. According to our research, 24.3% of students surveyed use computers or tablets to take notes in class. Interestingly, students of humanitarian specialties are more likely to use these technologies than their natural sciences and healthcare counterparts. This can be explained by the peculiarities of the curricula, as writing down formulas or diagrams on the keyboard is more difficult than simply taking notes with a pen.

However, mobile device use is not limited to studying. According to the survey, 47.9% of students actively use them to communicate via text messages during classes, while 15% browse the Internet without any connection to the learning process. This suggests that digital technologies can distract from learning, reducing student activity and engagement.

It was found that 23.52% of students spend less than 30 minutes a day studying online. The average time spent on Internet resources does not exceed one-third of the total working time. It is quite clear that students with academic difficulties are more likely to use the Internet to complete assignments, while successful students who have a large amount of study material are less likely to use the Internet for learning.

It is worth noting that students are actively creating their digital workgroups, such as Facebook groups, to share information and interact with learning content. According to the study, 84% of students have such groups. However, students with low academic performance are the least involved in this process, which can be explained by their high level of competition. As practice shows, cooperation between students indicates their greater involvement in the learning process.

Many students are still unaware of massive open online courses (MOOCs). Only 5.1% of respondents have already registered for such courses, which indicates an insufficient integration of digital technologies into the educational process. The majority of students still prefer traditional teaching methods.

The study showed that digital technologies moderately impact students' academic performance. Students' grades were not strongly influenced by digital technologies, with the coefficient of determination ranging from 3.6% to 6.1%. This suggests that while digital tools can enhance the learning process, their use is not decisive for student performance.

Thus, despite mobile applications' powerful potential, their implementation in the educational process remains at an early stage. To increase student engagement and involvement, it is necessary to focus on the deeper integration of digital technologies into teaching strategies.

4. Discussion

The study put forward three hypotheses to prove the impact of mobile applications on students' learning process.

According to Hypothesis 1, which predicted that active use of mobile applications for learning would improve academic performance, the results of the study confirm the existence of a positive impact, although this effect was less pronounced than expected. For example, students who use apps on a daily basis demonstrated increased engagement in learning in 80% of cases, but their academic achievements, according to the correlation analysis, had only a moderate relationship with the frequency of use (correlation coefficient of 0.85, but P-Value = 0.065). Thus, confirmation of the hypothesis requires a larger sample and further research.

Related research shows the significant potential of mobile applications to optimize the learning process [21]. However, according to the authors, further research is needed to draw more reliable conclusions to overcome technical and organizational limitations. Deepening the integration of digital technologies can provide better outcomes, increasing both student engagement and performance [15].

According to [37], in today's educational environment, mobile apps are becoming increasingly important tools to support learning. Interviews from related work have provided valuable insights into what types of apps can be useful for students [10]. According to the authors, on the one hand, the importance of self-assessment and self-regulation of learning has been emphasized as a key component of a successful learning process. On the other hand, the question of the availability of these resources arises, as paid courses may limit the opportunities of some students [39].

The results of the work confirm hypothesis 2. The second hypothesis is that the active use of mobile applications correlates with the activity of students. Thus, students who use mobile applications daily or several times a week have better motivation and access to educational materials. It is shown that 75% of students confirmed that

mobile applications increase their engagement. 80% of the advantages mentioned easy access to materials. Among the disadvantages are distraction (50%) and technical problems (30%).

Reference [38], in a related study, proves that teachers express interest in applications. They help them consolidate knowledge outside the classroom. The results appeal to the need to create tools that complement traditional learning. An approach based on behaviorism becomes the basis for integrating digital resources into the learning process [40]. Therefore, educational institutions must review their learning strategies and include mobile technologies as an integral part of education. Reference [6], in an empirical study, proves the impact of mobile learning on second-year college students. The study showed positive results in implementing the PC2AC program. Therefore, educational programs are effective tools for knowledge retention. However, in this respect [33] points out that the social aspects of technology accessibility should also be considered to overcome barriers arising from the price of some courses. The authors also describe strategies that can be applied to ensure the democratization of access to quality resources for all students [20]. Addressing these issues opens the door for further research and development in the field of mobile learning, as it is important not only to introduce new technologies but also to create favorable conditions for their use so that every student can get the most out of the learning process.

In the proposed study, hypothesis 3 investigated the influence of socio-demographic characteristics on the use of mobile applications in education. The survey results confirmed this hypothesis. For example, in the 18-22 age group, 85% of students use mobile applications, while among older groups, this figure is much lower. Women were more likely to emphasize the benefits of interactivity (45% vs. 30% of men). In general, 65% of students admitted that factors such as age and level of training influence the use of digital tools.

In today's world, digital technologies, including mobile applications, are becoming an integral part of the learning process. However, as numerous studies show, including the results of a survey by [29], the impact of these technologies on the academic performance of students of both genders is ambiguous. Gender and participation in digital workgroups have not been shown to have a significant impact on exam results.

According to [25], one of the key aspects of using mobile applications for educational purposes is that the use of digital technologies in the context of gamification, which is not learning-oriented, can negatively affect student performance. This emphasizes the importance of conscious and purposeful use of mobile applications that can stimulate learning rather than distracting from it [26]. Research by [31] also indicates that students who actively use mobile apps for learning find it easier to maintain high motivation and engagement in the learning process, which in turn can have a positive impact on their academic performance. Reference [28] notes that students' prior education and personal characteristics remain determinants of their success at university. Successful undergraduate students tend to use digital resources and mobile applications more effectively [27]. There is a need to adapt curricula and resources to the needs of different categories of students. This can ensure equal access to digital technologies and maximize their potential in the learning process. Of course, the use of mobile applications alone does not guarantee success. While the correct and purposeful use significantly increases student engagement in the learning process. They make learning more informative and interactive. There is a need for further research in this area to better understand the aspects of mobile technologies that can contribute to student success.

5. Conclusions

With the development of digital technologies, mobile applications are becoming important tools in the learning process. They have the potential to affect student engagement significantly. The proposed study aimed to analyze how digital technologies can be integrated into teaching practices and their impact on student's academic performance. The results demonstrated that the impact of digital technologies on learning outcomes is not unambiguous. First, the simple use of digital technologies does not guarantee a significant improvement in academic performance. Second, numerous studies demonstrate a positive relationship between the use of mobile applications and student performance. The context in which these technologies are used is critical. Teaching methods also play a crucial role in shaping the results. The survey results showed that the recreational use of mobile applications can hurt student performance. This may be because students use digital technologies not for active learning but for entertainment. The decrease in the impact of digital technologies on academic performance may also be because students do not know how to integrate these tools into their learning process.

Despite fully disclosing the issues raised, the work has limitations. They are based on a specific sample of students and may not reflect the overall picture. In the future, further research should consider the diversity of

courses and levels of study. The use of more detailed methods for assessing digital activity is desirable. Given the limitations, future research should analyze approaches to integrating mobile applications into the educational process. Since students use digital technologies more for entertainment than for deeper learning, there is a need for changes in teaching. Strategies should be adapted to the current needs of students. This will encourage them to actively use technology for learning. Thus, the study of mobile applications' impact on student engagement in learning emphasizes the importance of integrating digital tools into teaching methods and the need to change students' attitudes toward using technology in learning. As distance learning becomes increasingly popular, finding a balance between traditional teaching methods and new digital approaches that can improve learning efficiency is important.

This study undoubtedly provided valuable information about the impact of digital technologies, particularly mobile apps, on student engagement and academic performance, but there are some limitations. This study had a specific sample of students. Their number somewhat limits the generalization of the results to other student groups or educational institutions. Demographic and academic homogeneity does not fully reflect the diversity of experiences or outcomes across different student groups. Because the study used surveys, the focus group may have overestimated or underestimated their interactions with mobile apps. All of this can lead to potential inaccuracies in the data.

Given the limitations described, future research could focus on the diversity of the sample population. There is also a need for longitudinal research to analyze the long-term impact of mobile apps on academic performance. Thus, this study highlights the significant potential of mobile apps in shaping student engagement and academic performance. However, it also highlights the need for further research to understand the contextual factors influencing their effectiveness.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

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Appendix A

Questionnaire to study the impact of mobile applications on students' academic success.

Part 1: General information about the student

1. Your age:
 - Under 18 years of age
 - 18-22 years old
 - 23-27 years old
 - 28 years and older
2. Your gender:
 - Male
 - Female
3. Name of the educational institution:

4. Field of study (specialty):

Part 2: Availability of digital devices

5. What digital devices do you use for studying? (You can choose several options.)
 - Smartphone
 - Tablet
 - Laptop
 - Desktop computer
 - Others: _____
6. How do you assess access to the Internet for learning?
 - Permanent, without restrictions
 - Partial (unstable connection, time limitations)
 - None

Part 3: The level of proficiency with the programmes

7. How would you rate your level of proficiency with mobile learning applications?
 - Initial
 - Medium
 - High
8. What mobile apps do you use most often for learning? (List up to three):
 0. _____
 1. _____
 2. _____

Part 4: Frequency of mobile app usage

9. How often do you use mobile apps for learning?
- Daily
 - Several times a week
 - Once a week
 - Less frequently
 - Never

Part 5: The effectiveness of mobile apps

10. Do you think mobile apps help increase your engagement in learning?
- Yes
 - No.
 - Not sure
11. If 'Yes', how do mobile applications affect your learning? (Please select all that apply):
- Facilitate access to learning materials
 - Increase motivation to learn
 - Make learning more interactive
 - Other: _____

Part 6: The benefits of using mobile apps

12. What, in your opinion, are the main advantages of using mobile applications for learning? (Please select all that apply.)
- Convenience.
 - Saving time
 - Access to a large amount of information
 - Interactivity
 - Other: _____

Part 7: Disadvantages of using mobile apps

13. What do you see as the main disadvantages of using mobile apps for learning? (Please select all that apply.)
- Distraction
 - Technical problems
 - Limited functionality
 - Cost of applications
 - Other: _____

Part 8: The impact of socio-demographic characteristics

14. Do you think that factors such as age, gender, or level of experience affect the use of mobile apps?

- Yes
- No.
- Not sure

15. If yes, please describe how:

Part 9: Additional comments

16. Share any other thoughts or suggestions you have on using mobile apps in education:

Thank you for your participation in the study!