The Study of Teaching Staff Motivation to Use Mobile Technologies in Teaching Mathematics

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Article Info	Abstract
	The use of distance learning platforms, digital educational resources and mobile devices expand pedagogical arsenal. The subject of the study is teachers' readiness to use mobile technologies in education, for the issue of motivation remains important. The purpose is to identify motivational factors and define mathematics students and teachers' motivation level to use mobile technologies in teaching. The survey involved 74 people, of which 38 were bachelor students of Elabuga Institute of Kazan Federal University in the pedagogical direction (profile "Mathematics and Physics") and 36 mathematics teachers of the Republic of Tatarstan. The author identified motivational factors characterizing mathematics teachers and students' attitude to mobile learning and defined the degree of their relationship with the teaching staff readiness to use mobile technologies in teaching mathematics. The results of the survey confirmed the teachers and students' high motivation to use mobile technologies in teaching mathematics. The calculation of the Spearman correlation coefficient allowed concluding that the level of motivation decreases with age, but the relationship is weak, insignificant. The results can be used to define the level of motivation and assess the motivational factor significance in the teaching staff training, retraining and advanced training in the field of mathematics mobile learning.

Introduction

One of the hallmarks of today's VUCA world is dynamism. The rapid development of events, the problem of choosing from multiple varieties require from people to be mobile and stress resistant. Being a mobile person means possessing an ability to change oneself in the changing reality, and is characterized by purposefulness, self-actualization, and self-organization. Certain methods of organizing work through the network and mobile technologies allow a person to solve life and professional tasks effectively, which directly affects the success of the individual.Getting basic knowledge at school, children need to learn how to use mobile technologies and be ready for adult life, where mobile devices are an integral part of a modern person. Teachers need to understand the relevance of using mobile technologies in their professional activities. Network and mobile technologies

allow the teacher to make the educational process more interactive, expand the educational process boundaries, solve organizational issues, etc.

Sharafeeva (2021) identifies motivational, personal, theoretical, activity and reflexive components of future mathematics teachers' readiness to organize mobile learning for schoolchildren. Motivation and interest in the use of new digital technologies in professional activities play the most important role in teachers' readiness to use mobile technologies in the work. Lessons of mathematics are not held in computer classes, in such conditions the use of mobile devices is practically the only solution in mathematical education. Mobile devices include smartphones, laptops, tablets, e-readers, portable music players and other gadgets. Features of mobile devices are their size, great functionality and easy portability.

The issues of using mobile technologies in teaching mathematics were considered in the works of Raskina and Kurganova (2019), Pozdnyakova and Kolesnikova (2019) and others. Some studies talk about the high motivation of teachers to use mobile technologies (Eom, 2021; Pimmer et al., 2021; Yosiana et al., 2021). There are also works describing the reasons for the teaching staff's negative attitude to new technologies (Maltceva et al., 2019). According to the authors, the main reason for the teachers' negative attitude to the use of mobile devices is psychological in nature: it is fear to lose control over schoolchildren, and a decrease in the teachers' authority. Anisimova and others (Anisimova & Sharafeeva, 2018; Shatunova et al., 2019) talk about the need to introduce additional competencies in the teachers' methodological training.

The need to introduce mobile learning and insufficient knowledge of the issues of teaching staff motivation to use mobile technologies in teaching mathematics determines the relevance of the study. Considering the above, the purpose of the article is to investigate the mathematics students and teachers' motivation to use mobile technologies in their educational activities.

The paper poses the following *research questions*:
  1) Are students and teachers highly motivated to use mobile technologies in teaching mathematics?
  2) Does the age of respondents affect the level of motivation to use mobile technologies in their professional activities?

The scientific novelty of this study lies in the identification of a number of motivational factors characterizing the mathematics teachers and students' attitude to mobile learning, and the assessment of the degree of their relationship with the teaching staff readiness to use mobile technologies in teaching mathematics that are based on the Likert scale and Spearman's rank correlation coefficient method.

Literature Review

Learning through mobile technologies is called mobile learning (m-learning). There are different definitions of this notion. Kuklev (2017) defines mobile learning as "e-learning using mobile devices, independent of time and place, using special software on a pedagogical basis of interdisciplinary and modular approaches" (p. 7).

Rodionov and Gubanova (2020) define mobile learning as "a type of learning in which communication between a teacher and a student occurs through a mobile device" (p. 157), thereby focusing on the technological component.

According to Grant (2019), there are four definitions of mobile learning categories:

      1) connection with distance learning and e-learning,

      2) use of devices and technologies,

      3) interaction with the help of technologies, and

      4) mobility of both the student and the learning process.

These categories complement and are closely related to each other. The use of mobile devices and technologies in education will lead directly to the interaction of the participants in the educational process at any time and in any place.

Mobile technologies in mathematics education allow students to create a personal media library of digital educational resources, receive information of an organizational nature, test and assess the acquired knowledge, skills and abilities (testing), participate in a survey, develop skills in solving mathematical problems (interactive simulators), solve more complex and volumetric problems using computer mathematics systems (Erbilgin & Şahin, 2021).

The analysis of the notion of "mobile learning" and the study of the possibilities of mobile technologies in mathematics education allowed formulating the author's definition of the notion of "mobile learning in mathematics". Thus, *mobile learning in mathematics is a form of organizing the learning and control process through mobile technologies, in which students can get continuous access to educational resources anywhere and at any time, expand theoretical knowledge in mathematics, form and improve problem-solving skills, develop mathematical, information and speech culture, as well as interact with each other and with the teacher.*

The effectiveness of the use of mobile technologies in the teacher's work depends on the understanding of the value and necessity to introduce these technologies into the professional activities, as well as on the teacher's motivation (Kalimullina et al., 2021). Vikhansky and Naumov (2020) give a more accurate and complete definition of motivation and define it as "a set of internal and external driving forces that encourage a person to activity, set its boundaries and forms, and direction focusing on achieving certain goals" (p. 201). Dukhnovsky (2021) gives several interpretations of the term "motivation": a set of factors that support and guide, i.e. determine human behavior; a set of motives; a set of processes responsible for behavior and activity, etc. However, within the framework of this study, we will consider motivation as an incentive to action. After all, if a teacher is aware of the need to introduce mobile learning, but does not study and does not use mobile technologies in teaching, it indicates a lack of motivation.

The problems of the teaching staff motivation to professional activity are considered in the works of Gorbushina and Korchagina (2020), Kozhevina and Dubrovina (2018), Skudaryova (2014) and others (Balganova, 2021; Evans-Amalu & Claravall, 2021; Isaikina et al., 2021; Volkova et al., 2020). Alexandrova (2019) proposes a

methodology for the formation of the motivational component of the teacher's readiness to use ICT. The author identifies groups of cognitive and professional motives in the content and structure of the teacher's motivational readiness to use ICT.

There is a sufficient number of studies on the students' motivation to use mobile devices in the educational process. Koroleva's (2016) study shows that almost all schoolchildren have smartphones with Internet access, but even being at home and having a desktop computer, they prefer to use mobile devices. Eom (2021) developed a learning model that involves three interrelated processes: the cognitive learning process, self-regulating learning processes, and communication between participants in the educational process. The results of the study show that the use of mobile devices has a positive effect on the students' internal and external motivation to learn, which, in turn, improves communication between participants in the educational process and metacognitive self-regulating learning processes. The results of this study showed a high level of students' achievements in mobile learning.

Such scientists as Pimmer et al. (2021) conducted a study on the impact of WhatsApp on the level of students' knowledge and their resistance to stress. The study participants were graduates of medical schools. WhatsApp moderators shared knowledge and facilitated professional discussions with pilot group members. The results show that WhatsApp group members had markedly higher levels of knowledge, greater resilience, and lower levels of professional isolation as compared with the control group. They also reported about less stress when looking for a new job. The results of Yosiana, Djuandi and Hasanah's (2021) studies show the effectiveness of mathematics mobile teaching to high school students. The scientists consider the following criteria of effectiveness: 1) the students' attitude to mobile learning, 2) their interest in learning using mobile technologies, and 3) mobile devices and applications availability.

A pedagogical experiment conducted by Soboleva and Perevozchikova (2019), allows concluding that "the use of a mobile application with educational content in learning activities contributes to an increase in the teacher training level in the sphere of gamification elements while organizing the younger students' education" (p. 436). The authors argue that mobile educational games, due to their interactivity and increased feedback, have influenced the cognitive activity of future teachers and improved the cognition quality. Deng et al. (2019) offer a mobile math learning game based on augmented reality for students. The educational game is created on one of the most popular 3D design platforms Unity AR Foundation. According to the authors, the use of educational gamification in the classroom contributes to an increase in interest in mathematics; playing this game at any time and in any place, students develop skills in solving mathematical problems.

However, there are studies whose results show a negative impact of smartphones on the learning process. Mikova (2019) conducted a psychological study on the impact of gadgets on the students' cognitive abilities. The students of the experimental group, who deliberately did not use smartphones in the classroom, showed greater activity and better assimilation of the material. The author says that "the use of smartphones in the classroom work leads to interference in student-teacher communication, although it turns out to be a convenient tool in a situation of independent work" (p. 58). The analysis of scientific and methodological literature on the

subject of the study showed that the purposeful use of mobile technologies in the educational process using new learning formats (gamification, augmented reality, flipped classroom, etc.) allows effective organization of the learning process, thereby improving the quality of knowledge and students' academic performance.

Method

Study Design

The methodological basis of the study is the personal approach, which recognizes the personality as the goal, subject, result and main criterion for the pedagogical process effectiveness, and the system-activity approach, which allows considering the process of mathematics teachers' training as a system of structured and interrelated activities. The study used the following methods: theoretical – analysis and generalization of the works of domestic and foreign researchers on the research problem; empirical – observation, questioning; mathematical – statistical processing of research results. The analysis and generalization of the works of domestic and foreign scientists on the research problem allowed us to 1) formulate a definition of the notion of "mobile learning in mathematics"; 2) determine the motivational factors for the use of mobile technologies in teaching mathematics; 3) be confirmed in the study relevance and necessity. A survey was conducted to investigate the level of motivation of bachelor students in mathematics and mathematics teachers to use mobile technologies in teaching activities. When creating questionnaire questions, we used the Likert scale consisting of five positions. The sum of the received data of one respondent made it possible to assess the level of his motivation. To assess the significance of each motivational factor and the dependence of the motivation level on the age of respondents to use mobile technologies in their professional activities, we applied Spearman's correlation analysis.

Participants

Total 74 people participated in the survey, of which 38 were bachelor students of Elabuga Institute of Kazan Federal University in the pedagogical direction (profile "Mathematics and Physics") and 36 mathematics teachers of the Republic of Tatarstan. The survey was conducted among fourth- and fifth-year students who have experience in teaching mathematics at secondary schools. Mathematics teachers who responded the survey were of different age categories, both beginners in their teaching careers and those with many years of experience.

Research Instruments

To study the students and teachers' motivation to use mobile technologies in mathematics, we conducted a survey using the Likert scale (summary assessment method). Respondents were asked to indicate the degree of their agreement or disagreement with a certain statement on a scale from 1 to 5, where 1 is "disagree completely", 2 – "disagree", 3 – "difficult to answer", 4 – "agree", 5 – "agree fully".

The study and analysis of the existing research on the teaching staff motivation to use mobile technologies made

it possible to formulate the following statements:

1. The use of mobile technologies helps to increase students' interest in mathematics; the learning process becomes exciting and interesting.

2. Today, there is a large market for digital educational resources for teaching mathematics by means of mobile technologies, and the teacher can choose from the existing ones or create one himself.

3. A mathematics teacher needs to navigate the variety of modern mobile technologies, monitor the emergence of new aspects in the field of mobile learning, and study other teachers' experience.

4. The use of mobile technologies in teaching mathematics allows the teacher to organize the educational process effectively.

5. I need to improve my knowledge, skills and abilities in the field of using mobile technologies in teaching mathematics.

6. Joining the teachers' community on the use of mobile technologies in teaching mathematics in social networks or messengers will allow me to exchange experiences and explore new opportunities for mobile learning.

In this study, we used the methods described in the work of Kvon, Vaks, and Pozdeeva (2018). The authors use the Likert scale and Spearman's correlation analysis to identify the motivational factors of students to use innovative technologies in the educational process (Kvon et al., 2018). We used Google Forms to conduct the survey; statistical processing of the research results was carried out in Excel.

Data Collection

The study comprised three stages. The first stage included carrying an analysis of literature on the research problem and developing the necessary materials for the survey (questionnaires, analytical tables for further processing). The second stage included conducting a survey. We e-mailed a link to the questionnaire developed in Google Forms to the students and teachers, or sent it via messengers. The survey included information about the respondent's name, but we informed the respondents that it was optional. Respondents were notified about the possibility of taking the survey anonymously, as well as about the confidentiality of the data received by the organizers. Participation in the survey was voluntary. The survey term was two months. At the third stage, all data were inserted into Excel tables, and then they were analyzed and mathematically processed.

Data Analysis

To identify the level of the teaching staff motivation to use mobile technologies in their professional activities, the Likert scale was used. The sum of all marks of one participant allowed us to determine the level of motivation to use mobile technologies in teaching mathematics. When determining the levels of motivation, we relied on the point-rating system for assessing students' knowledge, which is used in universities, where the grading system is "excellent, good, satisfactory and unsatisfactory". Table 1 presents the level of motivation and the corresponding number of points in the analysis of the results of each subject based on the method of total assessments.

Table 1. Research Levels and Metrics

Levels	Metrics
High	26-30 points
Advanced	21-25 points
Average	15-20 points
Low	Less than 15 points

The calculation of the obtained data allowed us to determine the level of motivation and thereby answer the first research question. To identify the significance of the motivational factor and the dependence of the level of motivation on the age of the respondents, Spearman's correlation analysis was used. Correlation analysis is a statistical method that uses correlation coefficients to find out whether there is a relationship between variables and how strong it is. To identify the closeness of relationships between variables, a scale with three gradations was used: strong relationship (coefficient values of 0.7 or more), medium relationship (from 0.4 to 0.699), and weak relationship (from 0 to 0.399).

Results

To the question "While studying/working remotely, what device do you mostly use?", 55% answered that it was a laptop, 35% – a smartphone, 8% – a desktop computer, 2% – a tablet, which suggests that respondents prefer mobile devices. It is worth noting that more students use smartphones than schoolteachers do. This is because if the device is used to listen to lectures, pass tests, communicate with participants in the educational process, it is more convenient to use a smartphone. Preparation for lessons, development of teaching materials, and organization of the educational process using distance technologies requires work on a laptop or computer.

The survey showed the following results: 27 respondents' motivation is advanced, 32 respondents' motivation is high, 13 respondents' motivation is average, and only 2 survey participants showed a low level of motivation. The high motivation to use mobile technologies in teaching activities is due to the fact that with the transition to distance learning during the pandemic in the world and in Russia, people's perception of the need to use digital technologies, mobile devices and online learning tools has changed. Table 2 is a summary of the survey results of several respondents.

Table 2. Survey Results

Res-pon-dent	Status	Age	Judg-ment 1	Judg-ment 2	Judg-ment 3	Judg-ment 4	Judg-ment 5	Judg-ment 6	Total Score	Motivation Level
1.	Math teacher	50	1	2	1	1	1	1	7	low
2.	Math teacher	33	4	3	5	3	5	4	24	advanced

Res-pon-dent	Status	Age	Judg-ment 1	Judg-ment 2	Judg-ment 3	Judg-ment 4	Judg-ment 5	Judg-ment 6	Total Score	Motivation Level
3.	Bachelor student	24	2	4	2	3	5	3	19	average
4.	Bachelor student	22	3	5	5	4	4	4	25	advanced
5.	Bachelor student	22	2	3	5	4	5	4	23	advanced
…										
…										
72.	Math teacher	34	4	5	4	4	4	4	25	advanced
73.	Math teacher	34	3	4	4	4	4	4	23	advanced
74.	Math teacher	50	5	5	5	5	5	5	30	high
Total			270	312	302	283	304	288	1759	

The next stage was the statistical processing of the results and the calculation of the Spearman correlation coefficient for each judgment. Table 3 presents the results of the calculation according to Judgment 1 – "The use of mobile technologies increases the students' interest in mathematics; the learning process becomes exciting and interesting." The indicators of conjugate tables according to Judgments 2–6 are calculated in a similar way.

Table 3. Calculation Results of the Conjugated Table on Judgment 1

Respon-dent	Total Score S_0	Judgment Score S_1	Score difference S_0-S_1	Rank S_1	Rank of difference, S_0-S_1	Difference of ranks, d	Rank difference squared, d^2
1.	7	1	6	2	1	1	1
2.	24	4	20	43.5	34.5	9	81
3.	19	2	17	7.5	14	-6.5	42.25
4.	25	3	22	20	49	-29	841
5.	23	2	21	7.5	43	-35.5	1260.25
…							
…							
72.	25	4	21	43.5	43	0,5	0.25
73.	23	3	20	20	34.5	-14.5	210.25
74.	30	5	25	66.5	70	-3.5	12.25
Total	1759	270				0	23865.5

Table 4 shows the resulting Spearman correlation coefficients for each Judgment.

Table 4. Spearman's Correlation Coefficients for Selected Judgments

Judgment	Coefficient
1. The use of mobile technologies helps to increase students' interest in mathematics; the learning process becomes exciting and interesting.	0.65
2. Today, there is a large market of digital educational resources for education through mobile technologies, and the teacher can choose from the existing ones or create one himself.	0.61
3. A mathematics teacher needs to navigate the variety of modern mobile technologies, monitor the emergence of new aspects in the field of mobile learning, study the experience of other teachers	0.67
4. The use of mobile technologies in teaching mathematics allows the teacher to organize the educational process effectively.	0.78
5. I need to improve my knowledge, skills and abilities in the field of using mobile technologies in teaching mathematics.	0.57
6. Joining the teachers' community on the use of mobile technologies in teaching mathematics in social networks or messengers will allow me to exchange experiences and explore new opportunities for mobile learning.	0.72

In their work, Kvon et al. (2018) contingently define the following boundaries of indicators that allow assessing the closeness of relationships between features:

- the connection is strong – the value of the coefficient r_s is 0.7 and more;

- medium connection – from 0.4 to 0.699;

- the connection is weak – from 0 to 0.399.

Thus, the results of the study indicate a strong connection for Judgments 4 and 6; the remaining judgments have an average relationship between motivational factors. The high coefficient ($r_s=0.78$) of Judgment 4 indicates that the pedagogical staff understands the effectiveness of the educational process organization using mobile technologies. Mathematics students and teachers believe that the use of mobile technologies increases students' interest in mathematics, the learning process becomes exciting and interesting (the value of the coefficient of Judgment 1 – $r_s = 0.65$). The results of these two judgments allow us to conclude that it is necessary and effective to use mobile technologies in the educational process both by students and by teachers.

Judgment 3 showed a close relationship between the motivational factors identified by the author and the teaching staff readiness to use mobile technologies in teaching mathematics ($r_s=0.67$). This suggests that mathematics teachers understand the value and necessity of self-education, self-actualization. Also, mathematics students and teachers believe that there is a sufficient number of digital educational resources for organizing mathematics teaching using mobile technologies and it is possible to select or create one themselves (the value of the Judgment coefficient 2 – $r_s = 0.61$).

Judgment 6 – "Joining the teachers' community on the use of mobile technologies in teaching mathematics in social networks or messengers will allow me to exchange experiences and explore new opportunities for mobile learning" – has a coefficient of 0.72, which indicates the students and teachers' readiness for network interaction. Judgment 5 does not have a strong connection (r_s=0.57). Comparing Judgments 5 and 6, we can conclude that teachers are ready to increase their competence in the field of mobile learning of mathematics, but preference is given to online communities. Participation in an online community allows mathematics teachers to communicate with each other at any time, share experience in using new technologies, solve complex mathematical problems, realize themselves and improve their professional level.

Respondents were to indicate their age for us to study the question whether age affects the motivation to use mobile technologies in professional activities. The age of the respondents and the total score on Judgments made it possible to calculate the Spearman coefficient, which was equal to -0.07. A negative relationship between the studied features suggests that an increase in one feature leads to a decrease in the other. Thus, with age, the level of motivation to use mobile technologies in professional activities decreases. However, a low correlation coefficient indicates a weak relationship between the level of motivation and age. All of the above allows us to conclude that there is little relationship between the respondent's age and the level of motivation to use mobile technologies in teaching mathematics.

Discussion

The use of mobile technologies in pedagogical activity changes the structure of the educational process, requires the use of gaming technologies (gamification), augmented reality technologies, the flipped classroom methodology, etc. Technologies are developing very quickly, while the methods of their application in education are moving at a slow pace. Therefore, the readiness of the teaching staff to use mobile technologies in teaching is important. The UNESCO Recommendations (2013) state the need to prepare teachers and lecturers for the use of mobile learning in pedagogical practice.

Based on the works (Alexandrova, 2019; Eom, 2021; Raskina & Kurganova, 2019), the motivational factors of the teaching staff to use mobile technologies were identified. In learning mathematics, the main students' activity is problem solving. Therefore, the use of network and mobile technologies in education has its own characteristics: the use of formulas, theorem proving, problem solving, the development of mathematical and logical thinking, etc. In this study, the participants are undergraduate students and teachers of mathematics; therefore, the subject area was taken into account when compiling the research materials. This methodology can be adapted to other disciplines, taking into account their specificities.

There are different methods for identifying the level of motivation for various types of activities in the work of the teaching staff. Kuzmina and Rean (2002) developed a methodology for studying the factors of the profession attractiveness that shows the level of satisfaction with the profession in the form of a quantitative index. Respondents are offered to choose one of two judgments a) and b) in accordance with the scale: I agree with a), I doubt, I agree with b). Here a) and b) are radically opposite judgments, given in an unambiguous way. These

methods are based on an interval scale. The difference between this technique and the Likert scale is, firstly, in the type of question (the choice of radically opposite judgments and agreement or disagreement with the judgment) and, secondly, the gradations of choice (the Likert scale has five gradations). The simplicity and convenience of the Likert scale for both the respondents when answering and the organizers when processing the obtained results explains the choice of this technique for this study.

The study results showed a high level of the students and teachers' motivation to use mobile technologies in teaching mathematics. Correlation analysis made it possible to reveal the degree of significance of the motivational factor in the teaching staff readiness for this type of activity. The high correlation coefficient of Judgment 4 indicates that the main motivational factor is the effectiveness of the educational process organization using mobile technologies. Professional support for teachers in the field of using mobile and network technologies in teaching mathematics is important, and it is advisable to organize network interaction for these purposes, which allows you to discuss the issues that have arisen with colleagues and methodologists, get acquainted with the experience of other teachers, share achievements, etc. Mentoring methodologists and experienced teachers allows students to adapt to teaching activities quickly and successfully. The value of this study lies in the fact that the described methodology allows not only to determine the level of the teaching staff motivation, but also to analyze the degree of relationship between the motivational factor and the teaching staff readiness to use mobile technologies in teaching mathematics. The results of the study are recommended to be used both to determine the level of motivation and to assess the significance of the motivational factor in teacher training, retraining and advanced training in the field of mobile learning of mathematics.

Conclusion

Motivation is the most important component of the teaching staff readiness to use mobile technologies in their professional activities. Determining the level of the teacher's motivation is a rather a difficult task and requires a comprehensive study, for motivation is a psychophysiological process. The analysis of the available research allowed formulating such motivational factors for teachers to use mobile technologies in their professional activities as an increase in students' interest in mathematics, educational process effective organization, and teaching staff readiness to master new knowledge and skills in the field of mobile learning. We do not exclude a possibility of identifying other motivational factors. The use of mobile technologies in teaching mathematics should be conscious, associated with teachers' self-organization, self-education, and self-reflection. This research can be continued in the direction of studying other motivational factors and formulating new statements. Conducting a study with a large number of respondents and analyzing according to the described methodology allows determining the significance coefficient of these statements in the teaching staff preparation for the use of mobile technologies in teaching mathematics. Knowledge of the level of teaching staff motivation to use mobile technologies in teaching mathematics and the motivational factor coefficient of significance allows teachers of higher educational institutions to define the content and structure of training courses in different ways, thereby satisfying the teachers' didactic, methodological, and organizational needs in the field of mathematics mobile learning.

Acknowledgement

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