

## Methodology of application of blended learning technology in mathematics education

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### Abstract

The purpose of this research is to evaluate the application methodology of blended learning technology in mathematics education, with the views of teachers. In this study, the case study method, which is one of the qualitative research methods, was used. A total of 80 mathematics teachers working in various high schools in Nur Sultan city of Kazakhstan participated in the research. Research data were collected with a semi-structured interview form prepared by the researchers. As a result of the research, most of the mathematics teachers stated that the students' attitudes towards the mathematics lesson were negative. The majority of teachers participating in the research stated the combination of the superior features of face-to-face learning environments, diversity in learning and teaching methods, diversity in learning-teaching materials and increase in student success as the advantages of mathematics education in a blended learning environment. The majority of teachers participating in the research stated that the inadequacy of programmes suitable for blended learning, the deficiencies of software and hardware to be used in the course and the inability to use technology efficiently and effectively are the disadvantages of mathematics education in a blended learning environment. In-service training programmes should be organised to develop teachers' self-efficacy regarding blended learning environments and to ensure that they manage assessment and evaluation processes correctly.

Keywords: Psychological and pedagogical foundations, preschool teachers, teacher competencies

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## 1. Introduction

Rapidly developing technology makes a difference in educational opportunities, as well as in all areas of life. It is possible to say that technology, which gives a new perspective to the understanding of education and training, creates an irreversible way in education. In our age, where information and communication technologies are used effectively in all aspects, organising learning activities by making use of the Internet, which has an effect in all areas of life, ensures that the learner is more motivated to the process. In cases where the opportunity to carry out in-class activities is limited due to the limitations of traditional learning-teaching methods, a part of the education process is carried out as distance education in order to provide equality of opportunity. In order to create in-class interaction, the blended learning approach, in which a part of the education process is carried out face-to-face, gains importance (Kerres & Witt, 2003).

### 1.1. Theoretical and conceptual framework

According to Wilson and Smilanich (2005), blended learning generally means using two or more methods for learning needs. So blended learning is the use of the most effective learning styles applied to achieve the desired learning goals in line with certain purposes. Blended learning is actually focusing on learning goals that need to be achieved by using the 'right' personal learning approaches and 'right' learning technologies to transfer the 'right' skills to the 'right' person at the 'right' time (Singh & Reed, 2001).

According to Osguthorpe and Graham (2003), there are similar and different forms of teaching elements in web-assisted learning and face-to-face learning in the design of the blended learning approach. From the teaching elements, the distribution of instructional material, interaction with learning materials, interaction with the teacher, interaction with students and multiple interactions may change. Here, it is emphasised that a good design should be realised according to the basic elements. Blended learning combines the features and possibilities of both to go beyond the individual capacities of face-to-face and online-only learning (Garrison & Vaughan, 2008).

In fact, it is the third generation methods that are meant to be explained by the blended learning we use in our today's education system. In the first generation method, methods that deliver one-way teaching content, such as letters, radio and television, were used for education. In the second generation method, only computer or web-based content was used for education. Third-generation blended learning takes full advantage of the best benefits of face-to-face education, while teaching content is delivered using a variety of technologies. In other words, to put it literally, blended learning is the use of computer technologies at the same or different times as face-to-face education (So and Brush, 2008).

Mathematics education as a part of the education system has taken its share from the developments that the rapid changes in the world have created in the education system, and has added the student-centred education structure, which is the reflection of the total quality understanding and the customer-oriented approach of this understanding in the education system, to its own development process in the changing competitive conditions of the globalising world. Instead of the rote learning and passive structure of traditional education, a participatory, critical, questioning and active structure has been reflected in all lessons in the system (Cekici & Yildirim, 2011). The blended learning method has started to gain importance in mathematics as in other courses. Mathematics lessons are seen as a difficult and incomprehensible lesson for students. With the blended learning method, this perception is desired to be broken. With this method, students have become able to access lectures, course materials and course-related content not only in the

school environment, but wherever and whenever they want to reach (Bath & Bourke, 2010). Students can learn mathematics lessons not only by listening to one person, but by using those methods in the online environment by whichever method they are learning. A student can ask his teacher or friends about the points he does not understand about the mathematics lesson, either online or face-to-face at school (Yildirim & Vural, 2016).

### *1.2. Related research*

In their study, Kholifah et al. (2020) aimed to reveal how effective the use of the blended learning model is on the learning motivation of vocational education students. The results obtained from the study reveal that the use of blended learning model has a significant effect on vocational education students' motivation. In their study, Attard and Holmes (2020) examined teachers' tendencies to use blended learning approaches. The research was carried out on teachers who taught in secondary school mathematics classes. As a result of the research, it was revealed that the use of technology expands the opportunities for students to engage in mathematics learning by providing multiple ways and access methods, and students can adopt blended learning approaches.

Charlier and Platteaux (2005) investigated the effect of the blended teaching environment on teacher candidates' teaching abilities. As a result of the research, it was observed that the students found this study very useful and the teaching skills of the teacher candidates increased. Larsen (2013), on the other hand, stated in his study on blended learning that teachers' ability to use new technologies in learning environments provides a student-centred learning environment. Acelajado (2011), in his study on university students, compared blended learning methods and face-to-face learning methods. In addition, the effect of blended learning methods on students' success in mathematics teaching and the attitudes of students towards the use of blended learning environment in mathematics education were evaluated in the research. As a result of the research, it was revealed that students who receive mathematics education with the blended learning method are more successful. Moreover, the results such as an increase in motivation, an increase in self-confidence in mathematics and their belief in success were determined for the students who were educated with the blended learning method.

The effect of blended learning on student success (Uluyol & Karadeniz, 2009), students' satisfaction with the types of interaction in blended learning environments (Kuo et al., 2014), the impact of collaborative blended learning environment on pre-service teachers' success (Heba, & Nouby, 2008) are among the researches in the field of learning.

Yushau (2006), on the other hand, investigated the effect of the blended learning environment on the attitudes of students taking mathematics courses at university towards mathematics and computer courses. The findings of the study are that the application of blended learning methods statistically reduced students' computer anxiety and computer self-confidence.

### *1.3. Purpose of the research*

The purpose of this research is to evaluate the application methodology of blended learning technology in mathematics education with the views of teachers. In line with the purpose of the research, answers to the following questions were sought:

1. How do mathematics teachers evaluate students' attitudes towards mathematics lessons?
2. How do mathematics teachers evaluate students' attitudes towards technology use in education?

3. What are the views of mathematics teachers on the advantages of mathematics education in a blended learning environment?

4. What are the views of mathematics teachers on the disadvantages of mathematics education in a blended learning environment?

## **2. Method and Materials**

In this section, the research method, study group, process, data collection and data analysis are explained.

### *2.1. Research method*

The opinions of mathematics teachers on the application methodology of blended learning technology were evaluated with the case study method, which is one of the qualitative research methods. According to Creswell (2016), case study is a qualitative research approach in which the researcher examines one or more limited cases over time with data collection tools (observations, interviews, audiovisuals, documents and reports) that include multiple sources and define situations and themes depending on the situation. Case study is a method in which a single situation or event is examined in depth longitudinally. Data are collected systematically and what is happening in the real environment is looked at. With the results obtained, it reveals why the event occurred in that way and what should be focused on in future studies. In this direction, the case study method was used in this study in order to conduct an in-depth analysis.

### *2.2. Participants*

The working group formed to evaluate the application methodology of blended learning technology with the views of teachers consisted of mathematics teachers who previously applied blended learning technology. A total of 80 mathematics teachers working in various high schools in Nur Sultan city of Kazakhstan participated in the research. The teachers participating in the research were chosen on a voluntary basis and all of them have 10–20 years of professional experience. Of the mathematics teachers participating in the research, 33 are female and 47 are male.

### *2.3. Data collection tools*

Research data were collected with the semi-structured interview form prepared by the researchers. During the creation of the interview form, the opinions of three field experts were taken in order to ensure the content validity of the form. Then, the semi-structured interview form was applied to six mathematics teachers working in the city of Nur Sultan. After the preliminary application, the final form of the form was created and made ready for application. In the semi-structured interview form, there are four open-ended questions about the methodology of mathematics teachers' blended learning technology application. The questions in the semi-structured interview form are given below.

1. How do you evaluate students' attitudes towards mathematics lesson?

2. How do you evaluate students' attitudes towards technology use in education?

3. What are your views on the advantages of mathematics education in a blended learning environment?

4. What are your views on the disadvantages of mathematics education in a blended learning environment?

#### 2.4. Data collection process

During the data collection phase of the research, appointments were made with the mathematics teachers to be interviewed at a suitable time. Interviews with mathematics teachers were held in the school, in meeting rooms deemed appropriate by the school administration. Permission was requested from the teachers to take audio recordings during the interview. During the interview, the teachers tried not to be influenced by the researcher while answering the questions and the interview lasted an average of 30 minutes. It took approximately 2 months to complete the interviews with all mathematics teachers. After the interview processes were completed, the answers given by the mathematics teachers during the interviews were transferred to the semi-structured interview forms by listening to audio recordings.

#### 2.5. Data collection analysis

The research data were analysed in accordance with the descriptive analysis method. The purpose of descriptive analysis is to bring together the data collected as a result of interviews and observations with the reader in an organised and interpreted way. In most descriptive analyses, the data are classified according to predetermined themes; the findings related to the classified data are summarised; and the summaries are interpreted with the subjective knowledge of the researcher. In addition, the researcher establishes a cause–effect relationship between the findings and, if necessary, makes comparisons between the cases with structural difference analyses (Marshall & Rossman, 2014). Considering these processes, the semi-structured interview forms were analysed. At the stage of explaining, associating and making sense of the organised data and the defined findings, direct quotations were made from the answers of the mathematics teachers.

### 3. Results

In this section, the answers given by the mathematics teachers in the semi-structured interview form were evaluated by creating frequency and percentage tables.

In Table 1, the opinions of the mathematics teachers who participated in the research regarding the attitudes of the students towards the mathematics lesson are evaluated.

Table 1. Teachers' evaluations of students' attitudes towards mathematics

|          | Categories              | Sub-categories                               | F     | %     | Sum |       |
|----------|-------------------------|--|-------|-------|-----|-------|
|          |                         |  |       |       | F   | %     |
| Positive | Approach with love      | Do not love the lesson                       | 11    | 13,75 | 13  | 16,25 |
|          |                         | Enjoying the lesson                          |       |       |     |       |
| Positive | Approach with interest  | Don't be curious about the lesson            | 5     | 6,25  | 13  | 16,25 |
|          |                         | Make time for the lesson                     |       |       |     |       |
| Negative | Approach with prejudice | Prejudice about the difficulty of the lesson | 58    | 72,5  | 67  | 83,75 |
|          |                         | Prejudice for lesson learning                |       |       |     |       |
|          |                         | Prejudice for passing the course             |       |       |     |       |
|          | Approach with anxiety   | 33   | 41,25 |       |     |       |
|          | Lack of motivation      | Lack of motivation to learn                  | 7     | 8,75  |     |       |

In Table 1, the opinions of the mathematics teachers who participated in the research about the attitudes of the students towards the mathematics lesson are given. Teachers evaluated students in terms of developing positive and negative attitudes. 16.25% of the mathematics teachers stated that approaching with love and approaching with interest are positive attitudes developed by students. Approaching with prejudice, approaching with anxiety and lack of motivation were expressed by 83.75% of the teachers as negative attitudes developed by students towards the mathematics lesson. 13.75% of the teachers stated that the students' love for and enjoying the lesson stemmed from their approach to the lesson with love. 6.25% of the teachers stated that the students' curiosity towards the lesson and their attitude of taking time for the lesson stemmed from their approach to the lesson with interest. 72.5% of the mathematics teachers explained the prejudice about the difficulty of the lesson, the prejudice about learning the lesson and the prejudice about passing the lesson as the attitudes of the students to approach the lesson with prejudice. 41.25% of the teachers associated the anxiety about learning the lesson and the anxiety about passing the lesson with the attitudes of the students to approach the lesson with anxiety. Finally, 8.75% of the teachers cited a lack of motivation towards learning among the students' negative attitudes towards the mathematics lesson.

The views of some of the teachers who participated in the research on the attitudes of students towards the mathematics lesson are as follows:

*'Students are often biased towards math class. They have no belief that they can learn the lesson. This causes them to be unmotivated'.*

*'Students think they can't pass the course. In fact, this is entirely due to their prejudice against the course. Also, students have anxiety. They worry about both understanding the lesson and passing the lesson successfully'.*

*'I think that stereotyped ideas about the lesson mostly have a negative effect on their learning. They think the course is difficult. They think about how they will learn, how they will succeed'.*

*'My students approach mathematics with love. They are also interested. They are curious about the lesson and take the time to learn'.*

*'Students enjoy math class. They are also successful when they take the necessary time to learn. I think that students approach the lesson with love'.*

In Table 2, the views of the mathematics teachers participating in the research on the students' attitudes towards technology use in education are evaluated.

Table 2. Opinions of teachers on students' attitudes towards technology use in education

|                                | Categories                        | Sub-categories                        | F  | %     | Sum |       |
|--------------------------------|-----------------------------------|---------------------------------------|----|-------|-----|-------|
|                                |                                   |                                       |    |       | F   | %     |
| Positive                       | Effective learning                | Providing diversity in learning       | 65 | 81,25 | 71  | 88,75 |
|                                |                                   | Increasing the permanence of learning |    |       |     |       |
|                                |                                   | Reinforcing learning                  |    |       |     |       |
|                                | Fast learning                     | Saving on time                        | 21 | 26,25 |     |       |
| Practical learning opportunity |                                   |                                       |    |       |     |       |
| Negative                       | Insufficient technology knowledge | Limited technological tools           | 6  | 7,5   | 9   | 11,25 |
|                                |                                   | Limited technology knowledge          |    |       |     |       |
|                                |                                   | Technical issues                      |    |       |     |       |
|                                | Lack of motivation                | Lack of motivation to learn           | 4  | 5     |     |       |

In Table 2, the opinions of the mathematics teachers participating in the research about the students' attitudes towards technology use in education are given. Teachers evaluated students' attitudes towards technology use in education in terms of students with positive and negative attitudes. While 88.75% of the teachers stated that they found the students' attitudes to use technology in education positive, 11.25% of the teachers stated that they found it negative. 81.25% of the teachers defined providing diversity in learning, increasing the permanence of learning and reinforcing learning as positive attitudes in terms of effective learning of students. 26.25% of the teachers expressed the time-saving and practical learning opportunity as the positive attitude of the students in terms of fast learning. 7.5% of the teachers stated that limited technological tools, limited technology knowledge and technical problems are a negative attitude caused by insufficient technology knowledge. Finally, 5% of the teachers stated that their lack of motivation towards learning was one of the negative attitudes of the students towards the use of technology in education.

The views of some of the teachers who participated in the research on the attitudes of students towards the mathematics lesson are as follows:

*'Students use technology in every aspect of their lives. They also view the use of technology in education positively. Different learning environments reinforce their learning. Both learning is reinforced and learning becomes more permanent. It also provides a faster learning activity. It is a great advantage for students in terms of time saving'.*

*'Students find the opportunities to use technology in education positive. Because it provides practice and learning in a shorter time. It also offers students an alternative and offers diversity'.*

*'My students approached mathematics education very positively in the blended learning environment. They learned faster. They realised a more permanent learning. I think this is the effect of versatile learning environments'.*

*'Students are disturbed by the problems experienced in the technology dimension of blended learning environments. The limitation of technological tools is a negative factor. I think it is another problem that they do not know exactly how to use technology in education'.*

*'I think that in blended learning, students are confused about realising face-to-face and online learning and cannot fully adapt. I think it negatively affects the motivation of the students'.*

In Table 3, the opinions of the mathematics teachers participating in the research on the advantages of mathematics education in a blended learning environment are evaluated.

Table 3. Opinions of teachers on the advantages of mathematics education in a blended learning environment

| Categories   | F  | %     |
|--|----|-------|
| <b>Combination of superior features of face-to-face and online learning environments</b> | 63 | 78,75 |
| <b>Diversity in learning and teaching methods</b>  | 41 | 51,25 |
| <b>Diversity in learning and teaching materials</b>                                      | 32 | 40    |
| <b>Increase in student achievement</b>   | 30 | 37,5  |
| <b>Flexibility in learning environments</b>  | 28 | 35    |
| <b>Providing pedagogical enrichment</b>  | 25 | 31,25 |
| <b>Ensuring the integration of technology into education</b>                             | 17 | 21,25 |
| <b>Active learning environment</b>   | 11 | 13,75 |
| <b>Provide students with the opportunity to control their own learning</b>               | 6  | 7,5   |
| <b>Increase in motivation for the lesson</b>   | 3  | 3,75  |

In Table 3, the opinions of the teachers participating in the research on the advantages of mathematics education in a blended learning environment are given. 78.75% of the teachers defined the combination of superior features of face-to-face and online learning environments as an advantage. 51.25% of the teachers stated diversity in learning and teaching methods and 40% stated diversity in learning and teaching materials as an advantage. The advantages of education in the learning environment show that 37.5% of the teachers stated that they want to increase student success; 35% of them provide flexibility in learning environments; 31.25% of them provide pedagogical richness; 21.25% of them ensure the integration of technology into education; and 13.75% of them use a blended active learning environment. In addition, 7.5% of the teachers defined the opportunity for students to control their own learning and 3.75% of the teachers defined the increase in motivation for the lesson as an advantage.

The views of some of the teachers who participated in the research on the attitudes of students towards the mathematics lesson are as follows:

*'I think it has very important advantages. Most importantly, I think it has a positive effect on student achievement. The use of different methods provides an active learning environment for students. I think that adds to the success'.*

*'Blended learning has a great advantage in that it combines the positive aspects of both face-to-face learning and online learning. It provides significant flexibility in terms of learning environments. It also positively affects students' motivation. It also offers a variety of learning materials'.*

*'The best part is that it combines technology and education. It also creates a rich learning environment in terms of pedagogy. It also positively affects the active participation of students and their motivation to learn on their own'.*

*'It provides both method and material diversity. Combining technology with education is an important advantage. Blended learning has a significant impact on student achievement and motivation'.*

*'The positive aspects of face-to-face learning are combined with the positive aspects of online learning. The integration of technology into education is a great advantage. It allows different methods to be used'.*

In Table 4, the opinions of the mathematics teachers participating in the research on the disadvantages of mathematics education in the blended learning environment are evaluated.

Table 4. Teachers' views on the disadvantages of mathematics education in a blended learning environment

| Categories  | F  | %     |
|---|----|-------|
| Lack of programmes suitable for blended learning            | 58 | 72,5  |
| Software and hardware deficiencies to be used in the course | 42 | 25,5  |
| Inefficient and effective use of technology                 | 36 | 45    |
| Teachers' low self-efficacy                                 | 23 | 28,75 |
| Low self-efficacy of students                               | 16 | 20    |
| Difficulties in assessment                                  | 9  | 11,25 |
| Failure to resolve technical problems quickly               | 4  | 5     |



In Table 4, the opinions of the teachers participating in the research on the disadvantages of mathematics education in the blended learning environment are given. 72.5% of the teachers stated the inadequacy of the programmes suitable for blended learning and 25.5% of the teachers stated the software and hardware deficiencies to be used in the course as a disadvantage. 45% of the teachers stated that technology cannot be used efficiently and effectively, 28.25% of the teachers stated that the teachers' self-efficacy is low and 20% of the teachers stated that the students' self-efficacy is low as a disadvantage. 11.25% of the teachers stated the difficulties experienced in assessment and evaluation and 5% of the teachers stated that technical problems cannot be solved quickly as the disadvantages of mathematics education in a blended learning environment.

The views of some of the teachers who participated in the research on the attitudes of students towards the mathematics lesson are as follows:

*'Special programmes need to be created for blended learning. I think that the appropriate programmes are not fully created. In addition, software inadequacies and hardware inadequacies are important disadvantages.'*

*'The inadequacies in the use of technology and the low self-efficacy of the students are very important disadvantages. There are problems due to technical glitches, and the inability to resolve them quickly creates a negative view of blended learning.'*

*'I think that this learning style has the most inadequacies in terms of the programme. The inadequacies experienced in the dimension of the programme also bring along the difficulties experienced especially in the field of measurement and evaluation.'*

*'Technology usage knowledge affects the efficiency of blended learning applications. In my opinion, both the programmes used and the competence of teachers to use these programmes are the weak points of blended learning.'*

*'To be able to learn effectively enough in blended learning, teachers need to have high self-efficacy. I do not think that every teacher has the competence to teach in this new learning environment.'*

#### **4. Discussion**

The majority of mathematics teachers participating in the research stated that students' attitudes towards mathematics lesson were negative. The reasons for students' negative attitudes towards the mathematics lesson were defined by the teachers as approaching with prejudice, approaching with anxiety and lack of motivation. Senol et al. (2015) stated in their research that the majority of teachers stated that students have a prejudice and fear of mathematics. When the literature is examined, there are studies examining the effects of students' math anxiety on learning (Tapia & Marsh, 2004; Puteh, 2002; Sloan et al., 2002; Cates & Rhymer, 2003).

The majority of teachers participating in the research stated that the students' attitudes towards the use of technology in education were positive. It has been stated by the teachers that effective and fast learning plays a decisive role in students' positive attitudes towards the use of technology in education. In studies where students' attitude is important in the integration of technology into education and students' attitudes towards technology and mathematics lessons are examined, it has been stated that students who have a positive attitude towards technology have a high level of success in blended learning (Barkatsas et al., 2009; Fogarty et al., 2001; Reed et al. et al., 2010).

The majority of teachers participating in the research stated the combination of superior features of face-to-face learning environments, diversity in learning and teaching methods, diversity in learning-teaching materials and increase in student success as the advantages of mathematics education in a blended learning environment. In addition to this, the teachers consider the advantages of mathematics education in a blended learning environment. They listed them as flexibility in learning environments, providing pedagogical richness, integration of technology into education, active learning environment, enabling students to control their own learning and increasing motivation for the lesson. When the studies in the literature are examined, it is seen that there are studies that identify similar advantages of education given in a blended learning environment (Carman, 2002; Lilje and Peat, 2012; Cavalli et al., 2007). Osguthorpe and Graham (2003) categorised the advantages of blended learning as facilitating access to information, enabling social interaction and providing pedagogical enrichment.

The majority of teachers participating in the research stated that the inadequacy of programmes suitable for blended learning, the deficiencies of software and hardware to be used in the course and the inability to use technology efficiently and effectively are the disadvantages of mathematics education in a blended learning environment. Teachers stated low self-efficacy of teachers, low self-efficacy of students, difficulties in assessment and evaluation and inability to solve technical problems quickly as disadvantages. Graham (2006) stated in his study that the effectiveness of blended learning environments depends on the development of students' self-efficacy. Oh and Park (2009) stated in their research that one of the most important disadvantages of blended learning environments is the lack of evaluation criteria. On the other hand, Kim and Baylor (2008) stated that the use of the Internet in the blended learning environment causes limitations in the use of teaching methods. On the other hand, teachers stated that students' attitudes towards the use of technology in education were positive.

## **5. Conclusion**

As in all areas of life, the effects of technology are also seen in the field of education, and the use of technology in education has become almost a necessity in our age. Blended learning, which arises from the support of face-to-face education and online education, offers students new opportunities in education. However, this new learning environment also brought about some disadvantages. Therefore, in this study, the application methodology of blended learning technology in school mathematics was evaluated with the views of teachers. As a result of the research, most of the mathematics teachers stated that the students' attitudes towards the mathematics lesson were negative. The majority of teachers participating in the research stated the combination of the superior features of face-to-face learning environments, diversity in learning and teaching methods, diversity in learning-teaching materials and increase in student success as the advantages of mathematics education in a blended learning environment. The majority of the teachers participating in the research stated that the inadequacy of programmes suitable for blended learning, the deficiencies of software and hardware to be used in the course and the inability to use technology efficiently and effectively are the disadvantages of mathematics education in a blended learning environment.

## **6. Recommendations**

In the research, the views of mathematics teachers on the application methodology of blended learning technology in school mathematics revealed the problems experienced in blended learning environments. In this direction, the following recommendations have been developed:

1. Courses should be given to improve pre-service teachers' self-efficacy regarding blended learning environments.
2. In-service training programmes should be organised to develop teachers' self-efficacy regarding blended learning environments and to ensure that they manage assessment and evaluation processes correctly.
3. Institutions should ensure that the software and hardware deficiencies and technical disruptions needed for blended learning are eliminated.
4. Various seminars should be organised to increase students' motivation regarding mathematics education in a blended learning environment.

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