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Classroom Teachers' Perspectives on New Approaches to Teaching Mathematics*

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Abstract

Developments with in mathematics education, alternative and innovative learning approaches have begun to be used, creating appropriate learning environments for students to learn and do mathematics. This study aimed to explore the views of classroom teachers on new approaches to mathematics teaching. A qualitative case study design was used.The study group consisted of 35 classroom teachers. A semi-structured interview form was used to collect data. The data obtained were analyzed by content analysis. It was found that the classroom teachers most frequently used technology-enhanced mathematics teaching and problem-based mathematics teaching, while flipped learning and project-based mathematics teaching were used the least among the new approaches in mathematics teaching. It was concluded that although classroom teachers reported using new approaches to teaching mathematics in all subjects, they used them most in the subject of fractions, and the reasons for using the preferred new approaches were that they provided continuous learning and facilitated learning. According to the classroom teachers, the main difficulty in implementing new approaches is time-consuming. In addition, it was found that classroom teachers stated that the advantages of new approaches in the teaching process are that they provide continuous learning and make lessons interesting and fun and that the disadvantages are that they are time-consuming. In line with the results obtained, it is recommended that classroom teachers make more use of new approaches in mathematics teaching and that seminars be organized to support this.

Keywords: Classroom teacher, mathematics teaching, new approaches, primary school mathematics

1. Introduction

Mathematics education aims to provide individuals with the mathematical concepts and skills they need in everyday life and to develop 21st-century individuals who can use these skills in everyday life. Developments in information and technology have led to changes and innovations in education. These changes and innovations lead to new approaches and learning models that are used instead of traditional methods in the teaching process (Gökcen & Kadıoğlu, 2020). In traditional methods of teaching mathematics, which do not meet the differentiated needs of the age group, operational and computational skills are at the forefront, while skills such as reasoning,

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problem-solving, and prediction have become more important through innovative approaches (Altun, 2016). Particularly in mathematics, where the foundations are laid in primary school, classroom teachers' preference for new approaches that facilitate acquisition learning where students are active, rather than traditional approaches, ensures that students have positive attitudes towards learning mathematics. Classroom teachers should enrich the learning environment by using different methods and approaches in the mathematics teaching process (Tol & Çenberci, 2019).

There are many new approaches and methods that a classroom teacher can use to teach mathematics. Classroom teachers can make a meaningful difference for students and make mathematics more enjoyable by using effective new approaches that are most appropriate for the students and the subject in the mathematics teaching process (Atay, 2023). At this point, classroom teachers should be innovative teachers who follow current approaches and apply these new approaches in their teaching, in short, keeping up with the times. From this point of view, the study aimed to obtain the opinions of classroom teachers about new approaches to teaching mathematics. For these reasons, new approaches that can be used in the teaching of mathematics, according to the purpose of the study, were defined as follows. For these reasons, the following new approaches to mathematics education were identified for the study: Realistic mathematics education, technology-enhanced mathematics education, flipped learning, problem-based mathematics education, cooperative learning, STEM education, arts-based mathematics education, creative drama, project-based mathematics education, professional development model for teachers, learning roadmap-based teaching, inquiry-based mathematics education, differentiated instruction, justification, inclusive education.

Realistic mathematics education is a theory of mathematics education developed by the Freudenthal Institute in the Netherlands in the early 1970^{s} (Çilingir, 2015). Realistic mathematics education is based on Freudenthal's view that mathematics must be related to reality and that mathematics is a human activity (Demirdöğen & Kaçan, 2010). In this approach, the human need to do mathematics is the basis of mathematics education, and mathematics education begins with real-life problem examples. In the realistic approach to mathematics education, the learning process is expressed as the acquisition of formal knowledge as a result of students creating their solutions and generating new models when they encounter contextual problems selected from real life based on their informal knowledge gained from their own life experiences. The process starts with real-life problems and at the end of the process, students arrive at mathematical concepts and theories. This structure is known as mathematisation (Filiz, 2023).

Technology-supported mathematics teaching is the use of instructional technologies to enrich and improve the quality of education during the teaching activities of the mathematics course (Öztürk, 2019). Flipped learning is the process by which students acquire the information to be acquired through videos and similar media previously provided at home, and discuss and evaluate the information acquired in the group to make the time spent in the classroom environment more meaningful and efficient (Karamuk Eskiköy & Liman Kaban, 2023). The flipped learning approach is an approach based on students doing their homework in the classroom and watching the lessons at home (Topbaş Tat, 2023).

Problem-based learning is a learning method that enables critical thinking, presenting original ideas, reasoning, deducing, solving problems, and establishing mathematical relationships by organizing mathematical structures around problem-solving activities (Cantürk Günhan & Başer, 2008). Cooperative learning is a learning approach in which students form small mixed learning groups to achieve a common goal in the classroom environment, helping each other to learn the academic subject and rewarding the group's success in different ways. Cooperative learning aims to maximize learning by students working together with team spirit (Gümüş & Buluç, 2007).

STEM education is an educational approach that includes science, technology, engineering, and mathematics disciplines and aims to produce original solutions to real-life problems by using them in an integrated way and is used at all levels of education (Ültay, Üstüner, Sünbül & Taştan, 2023). In the learning and teaching environment of STEM education, students try to use design skills and create innovative products through applied activities to produce solutions to the problems that arise (Dokumacı Sütçü, Bilgiç Uçak & Toprak, 2023; Şahin, 2021). Arts-based education is mostly considered a process in which the arts are considered as a tool to improve learning in different fields or as an integrated process to improve learning in both the arts and other fields (Kuş, 2023). On this basis, visual arts and mathematics have been linked. Visual arts can be used in mathematics education to encourage and motivate students to learn mathematics (Kuş, 2019).

The lesson study professional development model is a professional development approach adapted from Japan that enables a small group of teachers to plan, observe, analyze, and improve their daily teaching and provides professional development for teachers and teacher candidates. Lesson study allows groups of teachers to work together to research, develop, and implement lessons that have a direct impact on students and improve the quality of teaching (Gökkurt Özdemir, 2023). Teaching based on a learning roadmap is the result of experimental investigations that focus on students' learning and allow them to understand the paths they follow in this process, to construct students' understanding of basic scientific concepts, explanations, and scientific practices with appropriate teaching, and how the ability to use them develops (Yıldırım Bozcuoğlu, 2020).

Inquiry is an approach that requires students to be active in the learning process by investigating information through the process of reasoning, exploring critical and logical thinking to improve understanding of content and solve a problem. Inquiry used in mathematics education includes various mathematical thinking processes such as problem-solving, metacognition, reasoning and making connections, representing, communicating, modeling, discussing, and proving (Şahin, 2019). Differentiated instruction is a new student-centered teaching approach that provides an appropriate educational environment and active participation for all students who have different characteristics in terms of their readiness, interests, abilities, learning styles, needs, and academic achievements (Çam & Acat, 2023). Teachers can create a classroom environment that can meet the different needs of students by differentiating the content, process, product, or learning environment element (Gregory & Chapman, 2022).

Justification is a fundamental aspect of proving the validity of mathematical statements and arguments. Justification involves providing logical reasoning and evidence to support the steps taken in a mathematical proof. This process is necessary to ensure the accuracy and validity of mathematical results. Inclusive education is an approach to education based on providing equal opportunities and fair conditions for all students. Inclusive education is an approach to education that provides appropriate support to meet the diverse learning needs of all individuals in the same learning environment. This approach aims to enable individuals with different abilities, backgrounds, cultures, and characteristics to participate in the education and training process in the best possible way and to support them to benefit from educational services (Oğlakçı & Amaç, 2024).

Köşece and Taşkaya (2015), in their study which aimed to find out the opinions of classroom teachers about the teaching methods they use in mathematics class, found that classroom teachers mostly used problem-solving, lecture, and question-answer methods in mathematics class; computer-assisted instruction could not be used for various reasons, although some teachers wanted to use it; and the methods that were not used in class could not be used due to the limited

physical facilities of the school. As a result of the study, it was suggested that classroom teachers should be trained in teaching methods for mathematics lessons.

In the study conducted by Soylu (2009), which aimed to determine the level of pre-service primary school teacher's ability to use teaching methods and techniques in mathematics education, it was concluded that most of the pre-service teachers felt competent or partially competent in methods and techniques such as lecture, definitions, rules, and question-answer, while they felt inadequate in methods and techniques such as constructivist, invention, cooperative, demonstration, games, case study, problem posing and solving.

In a study conducted by Karasu Avcı and Ketenoğlu Kayabaşı (2019), classroom teachers generally considered themselves competent in the use of methods and techniques. Topan (2013) conducted a meta-analysis study on the effectiveness of student-centered methods in mathematics education on academic achievement and attitudes towards the course and concluded that student-centered methods in mathematics education are positively effective on both academic achievement and attitudes towards the course compared to traditional methods and that this level of effectiveness does not differ according to teaching level, application period, and learning area. As a result of the literature review, the importance of classroom teachers' ability to use approaches, methods, and techniques in mathematics education is understood. To effectively use new approaches in mathematics teaching, classroom teachers should have the necessary knowledge about new approaches.

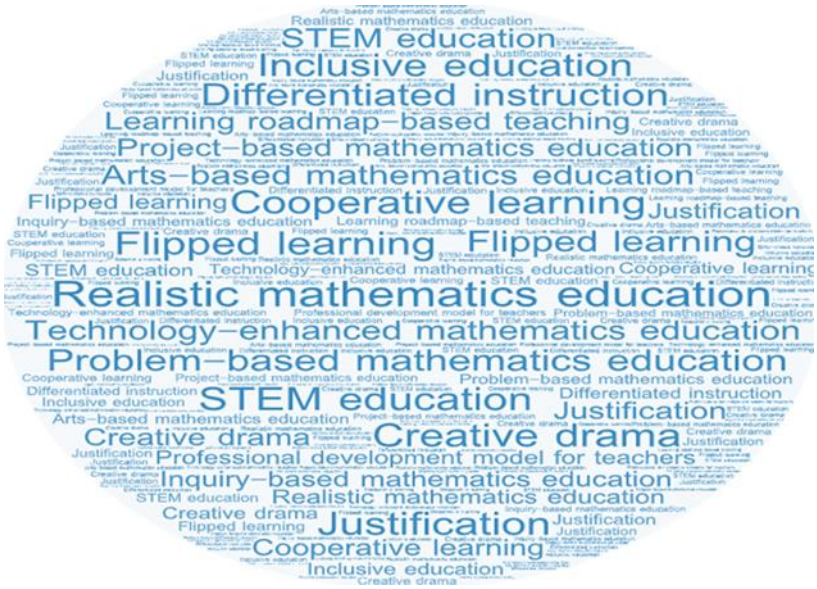

Figure 1. *New Approaches in Mathematics Teaching Discussed in The Study*

The problem statement of this study is that the level of knowledge of classroom teachers about new approaches to teaching mathematics is not known. It is important to reveal the opinions of classroom teachers to reveal their knowledge about this subject. It is important to reveal the opinions of classroom teachers about new approaches to mathematics teaching and to make suggestions in this direction to ensure that mathematics learning is permanent and meaningful in primary schools where students start their educational life (Yorulmaz & Çokçalışkan, 2017). It can be seen that there are some studies in the literature about the approaches, methods, and techniques used in mathematics education, but there is no study in the literature that takes the opinions of classroom teachers about new approaches in mathematics education. For this reason,

there was a need for a study that sought the opinions of classroom teachers on new approaches to teaching mathematics.

Against this background, the study aimed to find out the opinions of classroom teachers about new approaches to teaching mathematics. By the aim of the study, the following questions were put to the participating classroom teachers:

1. Which of the new approaches do you use? Choose 3 approaches that you think you use most.
2. How do the new approaches you use to teach mathematics differ from traditional approaches?
3. How do the new approaches you use to teach mathematics affect students' participation in class and their learning outcomes?
4. How often do you use your preferred new approaches to teaching mathematics and how do you integrate them into the teaching process?
5. In which subjects do you use your preferred new approaches to teaching mathematics?
6. What kind of differentiation techniques do you use with your preferred new approaches to teaching mathematics?
7. What are your reasons for using the new approaches you use in mathematics teaching?
8. What are the difficulties you have encountered in implementing the new approaches you use in mathematics teaching?
9. What are the new approaches that you know about but do not use in mathematics teaching?
10. What do you think about the advantages and disadvantages of the new approaches you use in mathematics teaching?

2. Method

2.1. Research Model

The study was conducted using the case study model, a qualitative research design. Case studies are a research design used in many fields, particularly in evaluation processes, in which the researcher analyses a situation, often a program, an event, an action, a process, or one or more individuals, in-depth (Creswell, 2017). In research, case studies are used to a) identify and examine the details of an event, b) develop possible explanations for an event, and c) evaluate an event (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2022). In this study, this model was used to explore in depth the views of classroom teachers on new approaches to teaching mathematics.

2.2. Study Group

The study group of the research consists of 35 classroom teachers. Purposive sampling was used to select the study group. Purposive sampling enables in-depth research by selecting information-rich situations according to the purpose of the study (Büyüköztürk et al., 20-22). In this study, according to the purpose of the research, classroom teachers were selected through purposive sampling by considering that they had different years of experience, had undergraduate and graduate education, and worked in villages, towns, and city centers. It is assumed that the seniority of the teachers, the place where they work, and the training they have received will influence the teaching methods they use. The demographic characteristics of the classroom teachers in the study group are shown in Table 1.

Table 1

Demographic Characteristics of Participants

Variables		Frequency (f)
Gender	Female	19
	Male	16
Age	22-30	17
	30-35	2
	35-40	9
	40-45	5
	50-55	1
	55+	1
Educational Level	Associate's Degree	1
	Licence	29
	Master's Degree	5
Years of Experience	0-5	16
	5-10	3
	10-15	5
	15-20	7
	20-25	3
	25+	1

An analysis of Table 1 shows that nineteen of the participating classroom teachers were female and sixteen were male. In terms of age, there are seventeen teachers aged 22-30, two teachers aged 30-35, nine teachers aged 35-40, five teachers aged 40-45, one teacher aged 50-55 and one teacher aged 55 and over. One of the classroom teachers who participated in the study has an associate degree, twenty-nine have a bachelor's degree, and five have a master's degree. When analyzing the seniority of the classroom teachers, there are sixteen teachers with 0-5 years, three teachers with 5-10 years, five teachers with 10-15 years, seven teachers with 15-20 years, three teachers with 20-25 years and one teacher with 25 years or more.

2.3. Data Collection Instruments

The interview can be defined as the collection of data from the relevant people within the framework of the questions to be answered in the research (Büyüköztürk et al., 2022). In this study, a semi-structured interview form was used to collect data. While preparing the semi-structured interview form, a literature review on the topic was conducted and a pool of questions on new approaches in mathematics education was created. The forms with the questions used in the study were filled in by the participants and the data were also enriched through interviews. The form consists of three parts. The first part contains general information about the research and whether the participants volunteered to take part in the research, the second part contains questions about the demographic information of the participants, and the third part contains questions about the research topic. The interview form has 10 questions. After the interview form was prepared, the opinion of a faculty member in the field of classroom education was sought to determine its suitability for the study. By the opinions received, necessary corrections were made to the semi-structured interview form and it was made ready for use. The questions for the semi-structured interview form were sent to the participants using Google Form, a web-based application. The interview was then conducted with the participants using the Zoom program and lasted 10-15 minutes.

2.4. Data Collection

After finalizing the data collection tool to be used in the research, the interview form was sent to each classroom teacher via the WhatsApp messaging application by creating a Google Forms link to request answers to the questions in the semi-structured interview form. During the data collection process, interviews were conducted with the classroom teachers who volunteered to complete the interview form. After the classroom teachers completed the demographic information sections of the semi-structured interview forms sent to them, data were collected by conducting in-depth interviews with those who agreed to be interviewed via the Zoom program.

2.5. Data Analysis

The content analysis method was used to analyze the data obtained from the research. Content analysis is based on bringing together similar data within the framework of certain concepts and themes, and organizing and interpreting them in a way that readers can understand (Yıldırım & Şimşek, 2018). Content analysis is a technique in which inferences are made to identify certain features of a message objectively and systematically (Büyüköztürk et al., 2022). The reason why the content analysis was preferred in the study is that the responses of the participating classroom teachers should be analyzed in depth and systematically (Devecioğlu, Zorluoğlu & Doğru, 2022).

In the data analysis, the interview forms were named (T1, T2, T3, ...T35). The data obtained from the forms were carefully read and analyzed. Subcategories were formed by bringing together the related codes from the collected data. An attempt was made to create categories from these subcategories. As a result of the content analysis, categories, subcategories, and codes were formed from the opinions of the participating classroom teachers. To ensure comprehensibility, the opinions of the classroom teachers were transformed into tables and presented with their frequencies in the findings section. After interpreting the tables, direct quotations of the participants' opinions were given.

2.6. Validity and Reliability

To ensure the validity and reliability of the study, the credibility, transferability, consistency, and confirmability strategies specified by Lincoln and Guba (1985) were used. The credibility of the study was increased by providing detailed information about the characteristics of the participants, obtaining an expert's opinion while preparing the research questions, and making the necessary arrangements according to the expert's opinion. To ensure transferability, the demographic characteristics of the classroom teachers and the findings from the data are presented in detail with their frequencies. Direct quotations were made from the classroom teachers' responses. To ensure the consistency of the research findings, the researchers explained in detail the method of the study, the process of preparing the data collection instruments and data collection, and how the data were analyzed. The raw data, coding, semi-structured interview forms, and analysis processes obtained by the researchers were retained to ensure verifiability.

To ensure consistency of coding during data analysis in the study, the researchers coded separately and were unaware of each other. Agreement between the two coders was calculated using Miles and Huberman's (1994, p. 64) formula (reliability = agreement/agreement + disagreement x 100), and the agreement rate between the coders was calculated as .84. In cases where the value calculated using the Miles-Huberman reliability formula is higher than .70, it can be said that the coding is reliable (Akay & Ültanır, 2010, p. 80). In cases where there was a different coding idea, the reason was analyzed and the code was decided by discussing it together (Silverman, 2005). New codes and themes were easily integrated into the scheme, inappropriate codes were removed

and necessary adjustments were made. The final stage was to organize the data with figures and to quote from the teachers' opinions during the presentation.

2.7. Ethics Committee Approval

In this study, all the rules stated in the Directive of Scientific Research and Publication Ethics of Higher Education Institutions were followed. Approval was obtained from Kahramanmaraş Sütçü İmam University Social and Human Sciences Ethics Committee on 17.07.2024, dated and numbered E-72321963-050.04-327794.

3. Results

This part of the study presents the results of the analysis of the answers given by the participants to the questions in the semi-structured interview form.

The answers to the first question of the research "Which of the new approaches (which ones) do you use in mathematics teaching? Choose the 3 approaches that you think you use most." are shown in Table 2.

Table 2

The First Three Approaches Preferred by Classroom Teachers When Teaching Mathematics

Category	Codes	Frequency (f)
New Approaches to Mathematics Education	Technology-supported mathematics education	28
	Problem-based mathematics teaching	23
	Cooperative learning	12
	Realistic mathematics teaching	12
	Creative drama	9
	Inquiry-based mathematics education	9
	STEM education	3
	Flipped learning	2
	Project-based mathematics education	2

An analysis of Table 2 shows that the new approaches to teaching mathematics used by the classroom teachers who participated in the study are technology-enhanced mathematics teaching (28), problem-based mathematics teaching (23), cooperative learning (12), realistic mathematics teaching (12), creative drama (9), inquiry-based mathematics teaching (9), STEM education (3), flipped learning (2) and project-based mathematics teaching (2). According to the table, classroom teachers most preferred 'technology enhanced mathematics teaching' and 'problem-based mathematics teaching' approaches to teaching mathematics. According to Table 2, classroom teachers reported having used 'flipped learning' and 'project-based mathematics teaching' at least once in mathematics class. In addition to the approaches mentioned in the table in the first question, arts-based mathematics teaching, the professional development model of lesson study, teaching based on a learning roadmap, differentiated teaching, justification, and inclusive education approaches were also presented to classroom teachers as options. However, it was observed that most of the participating classroom teachers did not prefer these approaches to mathematics teaching. Only the 'professional development model' and the 'justification' approaches were marked by one class teacher.

The responses to the second research question, "How do the new approaches you use to teach mathematics differ from traditional approaches?" are presented in Table 3.

Table 3

The Difference of New Approaches Used in Teaching Mathematics from Traditional Approaches

Category	Category	Codes	Frequency (f)
Features Distinguishing New Approaches from Traditional Approaches	Student-Centred	Effective participation in the classroom	17
		Putting the student at the centre	9
	Teaching Processes	Continuous learning	7
		Facilitating understanding	7
		Enabling discovery	6
		Developing the ability to question	4
		Embodiment	2
	Motivation	Being interesting	9
		Use in daily life	7
		Enjoying the lesson	2

Looking at Table 3, we can see that the category of characteristics that distinguish new approaches from traditional approaches consists of three subcategories: student-centered, teaching processes, and motivation. In the student-centered subcategory, the responses were effective in-class participation (17) and student-centered (9). In the subcategory of teaching processes, the responses were continuous learning (7), facilitating understanding (7), enabling discovery (6), developing questioning skills (4), and concretization (2). In the subcategory of motivation, the responses were interesting (9), applicable to everyday life (7), and enjoyed the lesson (2). It was found that the classroom teachers who participated in the research stated that the difference between the new approaches they used in teaching mathematics and the traditional approaches was mostly effective in terms of student's participation in the lesson. Below is the interview transcript of the teacher-coded T3.

R (Researcher): *How do the new approaches you use to teach mathematics differ from the traditional approaches?*

T3: *The difference between the new approaches I use in teaching mathematics and the traditional approaches is mainly that I teach by involving the students more actively in the lesson. Apart from that, the new approaches we use are more fun for the students. As an example, I can give the mathematics lessons I teach with the support of technology.*

The answers to the third question of the research "What are the effects of the new approaches you use in teaching mathematics on students' participation in the lesson and on their learning outcomes?" are presented in Table 4.

Table 4

Effects of New Approaches ot Mathematics Teaching on Teaching Processes

Category	Subcategory	Codes	Frequency (f)
Contribution to Teaching Processes	Impact on Learning the Gains	Facilitate learning	19
		Make learning fun	13
		Use in daily life	5
		Process-oriented learning	5
		Becoming successful	2
		Effects on class participation	2
	Providing Ongoing Learning	Increased class participation	16
		Increased interest and motivation	14
		Increased confidence in participation in class	2

An analysis of Table 4 shows that the category of contribution to learning processes consists of two subcategories: effects on learning outcomes and effects on participation in learning. In the subcategory of effects on learning outcomes, it can be seen that the answers given were providing lasting learning (19), facilitating learning (13), enjoying learning (5), being able to use in everyday life (5), process-oriented learning (2) and being successful (2). In the sub-category of effects on participation in class, it can be seen that the responses were increased participation in class (16), increased interest and motivation (14), and increased confidence in participating in class (2). Below is the interview transcript of the teacher-coded T23.

R: *What are the effects of the new approaches you use in mathematics teaching on pupils' participation in class?*

T23: *Because the new approaches I use appeal to the students, their motivation towards the lesson increases. This allows them to actively participate in the lesson and learn the results.*

The answers to the question "How often do you use the new approaches you prefer in mathematics teaching and how do you integrate them into the teaching process?" are given in Table 5.

Table 5

Integration of New Approaches to Mathematics Teaching into The Teaching Process and Frequency of Use

Category	Subcategory	Codes	Frequency (f)
Integration Types and Usage Frequencies	How to Integrate	Those who do not provide information about the way of integration	13
		Integrating into the narrative	9
		Reinforcement and evaluation process	8
		Content and materials in the approach	5
		Using real-life problem situations	2
		Using ntegrating with smart board	2
	Frequency of Use	Always	14
		According to eligibility for earnings	7
		Very stylish	6
		1-2 times a week	4
		3 times a week	3

An analysis of Table 5 shows that the category of integration methods and frequency of use consists of two subcategories: integration methods and frequency of use. In the subcategory of integration methods, it can be seen that the answers of those who did not give any information about the integration methods were as follows: integration into the subject expression (13), integration into the reinforcement and evaluation process (9), integration into the approach of activities, content, and materials (5), use of real-life problem situations (2), use through integration with the Smart Board (2). In the subcategory of frequency of use, the participants gave the following answers: always (14), depending on the appropriateness of the result (7), very often (6), 1-2 times a week (4), 3 times a week (3). In the subcategory of integration method, it was found that most of the classroom teachers did not give any information about the integration method and most of the participants answered 'always' to the frequency of using new approaches. Below is the interview recording of the teacher-coded T3.

R: *How often do you use the new approaches you prefer in mathematics teaching and how do you integrate them into the teaching process?*

T3: *I try to use new approaches in my teaching as much as possible, if I have to say one lesson hour, I use 3 hours of my 5-hour weekly mathematics lesson by integrating new approaches in my teaching. I do this by preparing my activities and materials according to the approach I have chosen when preparing my lesson plan.*

The answers to the fifth question of the research, "In which subjects do you use the new approaches you prefer in mathematics teaching?" are presented in Table 6.

Table 6

Subjects in which New Approaches to Teaching Mathematics are Used, according to Classroom Teachers

Category	Codes	Frequency (f)
Preferred Mathematics Subjects	All subjects	14
	Fractions	13
	Operations with natural numbers	12
	Problem-solving	12
	Geometric objects and shapes	10
	Measurement	8
	Geometric patterns	3

An analysis of Table 6 shows that the classroom teachers' responses to the subjects in which new approaches are used in mathematics teaching are as follows: all subjects (14), fractions (13), operations with natural numbers (12), problem-solving (12), geometric objects and shapes (10), measurement (8) and geometric patterns (3). Although the participating classroom teachers stated that they used new approaches to teaching mathematics in all subjects, it can be seen that they used them mainly in fractions. Table 6 shows that the subject in which the participating classroom teachers used new approaches to teaching mathematics the least was geometric patterns. Below is the interview recording of the teachercoded T8.

R: *In which subjects do you use the new approaches you prefer in mathematics teaching?*

T8: *In addition, subtraction, division, multiplication with natural numbers and related problems, geometric shapes, patterns*

The answers to the sixth question of the research "What kind of differentiation techniques do you use with the new approaches you prefer in mathematics teaching?" are given in Table 7.

Table 7

Differentiation Techniques Used in Preferred New Approaches

Category	Subcategory	Codes	Frequency (f)
Situations of Using Differentiation Techniques	Use Differentiation Techniques	Not mentioning the name of differentiation techniques	13
		Station technique	6
		Group research	6
		Role-playing technique	4
		Layered teaching method	3
		complex teaching	2
	Don't Use Differentiation Techniques	Who do not prefer differentiation techniques	8

Looking at Table 7, we can see that the category of using differentiation techniques consists of 2 subcategories: those who use differentiation techniques and those who do not use differentiation techniques. In the subcategory of those who use differentiation techniques; not specifying the name of the differentiation techniques (13), station technique (6), group research (6), role play technique (4), layered teaching method (3), and complex teaching method (2), responses were given. In the sub-category of those who do not use differentiation techniques; it can be seen that 8 participating classroom teachers do not prefer to use differentiation techniques. Below is the interview transcript of the teacher-coded T27.

R: *What kind of differentiation techniques do you use with the new approaches you prefer in mathematics teaching?*

S27: *I use a multi-level teaching method, group research, and station technique. Sometimes I give group research and use a flipped learning strategy.*

The answers to the seventh question of the research "What are your reasons for using new approaches in teaching mathematics?"' are presented in Table 8.

Table 8

Reasons for Using Preferred New Approaches

Category	Subcategory	Codes	Frequency (f)
Reasons for Preference	Reasons for the Learning Process	Provides permanent learning	14
		Making learning easier	12
		Ensuring participation in class	11
		Creating a fun learning environment	8
		Increasing interest	6
		Provide concretization	2
	Reasons for Skill Development	Gaining critical and versatile thinking skills	6
	Reasons for the Student	Suitable for student-level	2
		Being student-centered	2
	Reasons for the Age We Live in	Being in line with the times	3
	Real Life Reasons	Ability to use in daily life	2

An analysis of Table 8 shows that the category of reasons for preference consists of 5 subcategories: reasons for the learning process, reasons for skill development, reasons for the student, reasons for the current era, and reasons for real life. In the sub-category of reasons for the learning process, it can be seen that the reasons for using new approaches are that they provide continuous learning (14), facilitate learning (12), provide participation in the lesson (11), create a fun learning environment (8), increase interest (6) and provide concretization (2). In the sub-category of skill development reasons, the responses are that it provides critical and versatile thinking skills (6); in the sub-category of student reasons, it is appropriate to the student level (2) and it is student-centered (2); in the sub-category of age reasons, it is appropriate to the age (3); in the sub-category of real life reasons, the responses are that it can be used in everyday life (2). According to the participating classroom teachers, the table shows that the most common reasons for using the preferred new approaches are that they provide continuous learning and facilitate learning. Below is the interview recording of the teacher-coded T24.

R: *What are your reasons for using the new approaches you use in mathematics teaching?*

T24: *It enables the students to understand more easily the subjects that they find difficult to perceive in the abstract. It keeps students active in the lesson. It keeps students focused on the lesson. It minimizes student boredom.*

The answers to the eighth question of the research "What are the difficulties you have experienced in implementing the new approaches you use in mathematics teaching?" are given in Table 9.

Table 9

Difficulties Encountered in İmplementing New Approaches

Category	Subcategory	Codes	Frequency (f)
Difficulties Encountered	Sourced from the Student	Loss of class dominance	10
		High number of students	9
		Differences in students' learning levels	6
		Students' perspective	3
	Due to Time	be time consuming	14
	Sourced from the Teacher	Lack of technical knowledge	3
		Not having enough information about new approaches	2
	Sourced from Material	Lack of equipment	4
	Sourced from the Curriculum	The topics are intense	3
	Caused by the Environment	Unsuitable classroom environment	2

An analysis of Table 9 shows that the category of difficulties encountered consists of 5 subcategories: student-related, time-related, teacher-related, material-related, curriculum-related, and environment-related. In the student-related subcategory, loss of classroom dominance (10), large number of students (9), different learning levels of students (6), students' point of view (3); in the time-related subcategory, time-consuming (14); in the teacher-related subcategory, insufficient technical knowledge (3) and insufficient knowledge of new approaches (2); in the material-related subcategory, lack of tools and equipment (4); in the curriculum-related subcategory, intensive subjects (3); and in the environment-related subcategory, inappropriate classroom environment (2). According to the participating classroom teachers, the main difficulty in implementing new approaches is that new approaches are time-consuming. Below is the interview recording of the teacher-coded T4.

R: *What are the difficulties you have encountered in implementing the new approaches you use in mathematics teaching?*

T4: *The number of pupils is high, there are differences in level between pupils. It is tiring and time-consuming for teachers to prepare, implement and evaluate.*

The answers to the ninth question of the research "What are the new approaches that you know about but do not use in teaching mathematics?"" are given in Table 10.

Table 10

New Approaches Known But Not Used by Classroom Teachers

Category	Codes	Frequency (f)
Non-Preferred Approaches	STEM education	11
	Flipped learning	9
	Project-based mathematics teaching	5
	Art-based mathematics education	3
	Differentiated instruction	2
	Creative drama	2
	Technology-supported mathematics teaching	2
	Collaborative learning	2

An analysis of Table 10 shows that the classroom teachers gave examples of STEM education (11), flipped learning (9), project-based mathematics teaching (5), arts-based mathematics teaching (3), differentiated teaching (2), creative drama (2), technology-enhanced mathematics teaching (2) and collaborative learning (2) as new approaches that they knew about but did not use. From the table, it can be seen that the most common new approaches that the participating classroom teachers were aware of but did not prefer to use were 'STEM education' and 'flipped learning'. Below is the interview recording of the teacher-coded T7.

R: *What are the new approaches that you know about but do not use in mathematics teaching?*

T7: *I know many of them such as flipped learning, STEM education, and collaborative teaching, but I can't always use them, either there is not enough time or they are not suitable for every student in my class.*

The answers to the question "What do you think about the advantages and disadvantages of the new approaches you use in mathematics teaching in the teaching process?" are presented in Table 11.

Table 11

Classroom Teachers' Opinions on The Advantages and Disadvantages of The New Approaches in The Teaching Process

Category	Subcategory	Codes	Frequency (f)
Opinions on the Teaching Process	Advantages	Provides permanent learning	18
		Making lessons interesting and fun	15
		Ensuring participation in class	10
		Providing convenience in the teaching process	6
		Providing effective teaching	5
		Relating to daily life	4
		Contributing to versatile development	3
		Providing diversity in teaching	3
	Disadvantages	Takes time	21
		Difficulties encountered in the application process due to the large number of students	7
		Lack of opportunities	5
		Makes classroom management difficult	4

When analyzing Table 11, the category of opinions about the teaching process was divided into two subcategories: advantages and disadvantages. In the subcategory of advantages, the participating classroom teachers used the expressions providing continuous learning (18), making

lessons interesting and fun (15), providing participation in lessons (10), providing convenience in the teaching process (6), providing effective teaching (5), associating with everyday life (4), contributing to multidimensional development (3) and providing diversity in teaching (3). In the sub-category of disadvantages, it can be seen that they included the statements that it takes time (21), difficulties in the implementation process due to the high number of pupils (7), lack of facilities (5), and makes classroom management difficult (4). Below is the interview transcript of the teacher-coded T8.

R: *What do you think about the advantages and disadvantages of the new approaches you use in teaching mathematics?*

T8: *The advantage of teaching with new approaches is that the students are more active and the knowledge is more permanent. The disadvantage is that it takes a lot of time and not every student is suitable for every approach in every subject. There is a curriculum that we have to implement. Time is short and sometimes we have to leave activities unfinished. Homework does not contribute enough to the teaching process.*

According to the participating classroom teachers, it is clear from the table that the main advantage of the new approaches used in mathematics teaching is that they provide continuous learning and the disadvantage is that they take time. Some of the participants' answers to this question are given below.

4. Discussion and Conclusion

In this part of the study, the results of the research are summarised, compared with the relevant literature, and discussed. In the first question of the study, classroom teachers indicated that the new approaches they used most in mathematics teaching were technology-enhanced mathematics teaching and problem-based mathematics teaching. These approaches were followed by cooperative learning and realistic mathematics teaching approaches, respectively. Köysüren and Üzel (2018) concluded that the use of technology in mathematics teaching increased the mathematical literacy self-efficacy of 6th-grade students. In their study, Boz and Özerbaş (2020) concluded that classroom teachers' perceptions of the use of technology in mathematics education were positive. The reason why the participants mostly used technology-supported mathematics lessons in mathematics teaching may be that instructional technologies serve the purpose of mathematics teaching and facilitate the teaching process. Taşkaya and Kösece (2015), in their study, stated that the problem-solving method is one of the most used methods by classroom teachers in mathematics education. It was understood that the participants used flipped learning and project-based mathematics teaching approaches, at least in mathematics classes.

When analyzing the results of the category of characteristics that distinguish new approaches from traditional approaches for the second research question, according to the opinions of the participating classroom teachers, the difference between the new approaches they use in mathematics teaching from traditional approaches is most evident in terms of the effectiveness of class participation. In his study, Yağan (2021) concluded that student-centered methods, techniques, and strategies have a moderate effect on positively improving students' attitudes. In their study, Demirdöğen and Kaçan (2010) concluded that the course taught according to realistic mathematics education was significantly more effective than the traditional teaching approach between the success of the experimental and control groups in teaching the fractions concept.

When analyzing the results of the category of contribution to teaching processes for the third research question, it was concluded that two subcategories emerged. In the subcategory of effects on class participation, it was concluded that there was an increase in-class participation, an

increase in interest and motivation, and an increase in confidence in class participation. In his study, Topan (2013) concluded that student-centered methods in mathematics education have a positive effect on both academic achievement and attitudes toward the course compared to the traditional method.

Looking at the results of the category types of integration and frequency of use for the fourth research question, it can be seen that it is divided into two subcategories. In the subcategory of type of integration, it was observed that most of the classroom teachers did not give any information about the type of integration. In the subcategory of frequency of use, there are opinions of class teachers who used the expressions always, according to the appropriateness of the acquisition, very often, 1-2 times a week, 3 times a week. Erduran and Tataroğlu Taşdan (2018) examined the process of integrating technology into the classroom and concluded that pre-service mathematics teachers had difficulties in integrating technology into mathematics education.

Examining the results of the category of preferred mathematics subjects for the fifth question of the research, it can be seen that the participating classroom teachers stated that they used new approaches in teaching mathematics in all subjects, but mostly in fractions. Altındal (2019) concluded that there was a significant difference in favor of the experimental group between the mean scores of achievement, retention test, and attitude scale of the students in the experimental group using the creative drama method in the sub learning area of addition with natural numbers and the students in the control group using the activities in the curriculum. Çilingir Altıner and Artut (2017) conducted a study in which the subject "geometric shapes and measurement" at the fourth-grade level of primary school was taught as a requirement of realistic mathematics education in the experimental group and as a normal course in the control group. In line with the results of the study in the related field, it can be said that the use of new approaches in the teaching process of mathematics subjects has a positive effect on students' achievement.

When analyzing the results of the sixth research question, the use of differentiation techniques, two subcategories emerged. In the subcategory of those who use differentiation techniques, it was seen that 13 classroom teachers did not specify the name of the differentiation technique they used. The reason for this may be that the classroom teachers do not have the necessary knowledge and experience of differentiation techniques, or that they did not think of them at that moment. Demirkaya (2018) found that classroom teachers need theoretical and practical training in differentiated instruction. Ekinci and Bal (2019) concluded that the differentiated instruction approach increased students' mathematics achievement.

When analyzing the results of the category of reasons for preference for the seventh research question, it can be seen that five sub-categories emerged. In the sub-category of reasons for the learning process, the reasons for using new approaches, according to the classroom teachers, are mainly the effects of providing continuous learning, facilitating learning, and ensuring participation in the lesson. In addition, according to Atay (2023), teachers' use of more effective methods in mathematics education can be effective in increasing students' interest and participation and in making mathematics education more meaningful and enjoyable. Kösece and Taşkaya (2015), in their study, also concluded that classroom teachers seek the characteristic of facilitating learning in the selection of methods used in mathematics teaching. These studies in the literature support the findings of this study.

When analyzing the results of the category of difficulties encountered for the eighth question of the research, it was concluded that six subcategories emerged. In the sub-category arising from the pupils, the difficulties experienced were mainly the loss of classroom dominance and the large number of pupils. In the sub-category arising from the teacher, the difficulties experienced,

according to the participating classroom teachers, were mainly the lack of technical knowledge. In their study, Yılmaz, Korkmaz, and Kurt (2023) concluded that classroom teachers may experience some negative situations such as experiencing problems related to time, difficulties in applying in crowded classes, and difficulties in classroom management while applying creative drama from new approaches.

Regarding the ninth question of the study, it is understood that the new approaches that classroom teachers are aware of but do not use are mostly STEM education and flipped learning approaches. Köse and Ataş (2020) evaluated the opinions of classroom teachers on STEM education and found that teachers had difficulties in terms of material supply and course duration during STEM education practices and that teachers should be supported by the Ministry of National Education with training to effectively implement STEM education in classrooms. In their study, Alagöz and Sözen (2021) found that classroom teachers considered STEM education necessary but faced difficulties in implementation and integration problems due to reasons such as curriculum intensity, lack of knowledge and experience.

When the results of the category of opinions about the teaching process for the tenth research question were analyzed, it was found that they were grouped into two subcategories. According to the opinions of the classroom teachers in the advantages subcategory, the greatest advantages of the new approaches used in the teaching process are that they provide continuous learning and make the lessons interesting and enjoyable. Çırak and Uygun (2023) stated in their study that teachers should use technological tools to increase students' interest in mathematics and to facilitate their understanding of mathematical knowledge. In their study, Güneş and Buluç (2017) stated that the advantage of technology in terms of time, labor, and speed is one of the biggest reasons for preferring technology and that technology is important for the last lesson in terms of motivating students for the lesson and increasing teacher effectiveness. In this study, technology-supported mathematics teaching was the most frequently used approach in mathematics teaching according to the classroom teachers' opinions.

Based on these findings, it is recommended that classroom teachers should use more new approaches in mathematics education and that classroom teachers should be trained on new approaches to use new approaches in mathematics education correctly and effectively.

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