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Research Article

Teaching Multiplication Through the Japanese Multiplication Method: An Action Research Study*

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Abstract –The Japanese multiplication method (JAMED) is defined as drawing diagonal lines from left to right, followed by crossing them with diagonal lines from right to left, and then counting the intersection points to determine the multiplication result. This study aimed to teach multiplication to third-grade students who struggled to learn the operation using traditional methods, by employing the JAMED method, and to evaluate the process. We utilized the technical/scientific/collaborative model, a type of action research, in this study. The research was conducted with four third-grade students who were unable to learn multiplication through traditional methods, in a primary school located in Hani district of Diyarbakir province. We collected data using several tools: the 3rd Grade Multiplication Success Test developed by the researchers, Pre- and Post-Implementation Teacher Interview Forms, Post-Implementation Student Interview Forms, Researcher Diary, Audio Recordings taken during the Teaching Process, Lesson-End Assessment Activity Sheets, and related Rubrics. For the analysis of the qualitative data obtained, we employed content analysis and descriptive analysis. The findings indicated that the JAMED method positively impacted the development of multiplication skills and the transformation of negative affective traits towards multiplication into positive ones. However, students faced difficulties with marking intersection points, counting dots, grouping, adding carry-over numbers, drawing diagonal lines, shifting digits, and transferring results obtained with JAMED to traditional methods. We also identified potential disadvantages of JAMED, such as overshadowing other subjects and time limitations.

Keywords: Multiplication, JAMED, Japanese multiplication method, arithmetic operations, cross-line method.

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Introduction

Mathematics is an abstract tool that solves problems by utilizing concepts of shape, size, and counting. It plays a crucial role in every aspect of life (Niswarni, 2012; Purnama & Afriansyah, 2016; Rohmah & Suriarso, 2018; Ulwiyah & Ragelia, 2020). This discipline is fundamental in developing skills such as analysis, evaluation, and problem-solving. Given its role as a powerful means of communication and its pervasive presence in daily life, it is essential that mathematics be taught from an early age (Lolang, 2019; Simbolon & Sapri, 2022).

In elementary education, mathematics is taught to help individuals acquire various mathematical concepts and to enable them to understand and use arithmetic operations. Among the arithmetic operations introduced at the elementary level, multiplication is particularly significant because it forms the foundation of mathematics and supports other topics (Prahmana et al., 2012; West, 2011).

Multiplication is one of the four basic operations required to solve mathematical problems. Multiplication serves as an essential tool in problem-solving and establishes a solid foundation for reasoning, algebraic thinking, and advanced mathematics. Mastering multiplication is viewed as prerequisite skill that facilitates the learning of other mathematical concepts. Therefore, multiplication is considered a topic that must be taught and reinforced from the early years of elementary education (Adawiyah & Kowiyah, 2021; Firdaus, 2018; Halyadi et al., 2016; Kamini, 2013; West, 2011).

According to the Mathematics Curriculum in Türkiye, the teaching of multiplication begins in the second grade, and as the grade level increases, the topics related to multiplication expand and become more complex. A student who starts the process by learning that multiplication is repeated addition can perform more complex multiplication operations involving multi-digit numbers by the time they graduate from primary school (Ministry of National Education [MNE], 2018; 2024).

Studies have shown that techniques such as magic fingers, dot marking, concrete-semi-concrete-abstract, self-monitoring, read-write-compare, hide-copy-paste, Vedic, and VOFT (Video-Oyun-Flaş Kart-Test [Video-Game-Flash Card-Test]) are effective in teaching multiplication. Additionally, the use of visualization, games, realistic mathematics education, and computer-assisted software has been found to be effective (Albay, 2020; Akgün, 2022; Alıncak, 2019; Aydemir, 2017; bin Syed Ismail & Sivasubramniam, 2010; Chang et al., 2008;

Duyen & Loc, 2021; Hartatik & Rahayu, 2018; Kouhi & Rahmani, 2022; Küçüközyiğit & Özdemir, 2017; Özlü & Yıkmış, 2019; Saygılı & Ergen, 2016; Sertdemir, 2021; Sidekli et al., 2013; Thai & Yasin, 2016). Consequently, the use of different methods and techniques in teaching multiplication is both important and necessary.

One alternative method for teaching multiplication is the Japanese Multiplication (JAMED) method. The JAMED method is described as a way of calculating the results of numbers to be multiplied. Using this method, students can develop their multiplication skills in a balanced manner without the need for memorization (Hemi et al., 2021; West, 2011). The JAMED method is known as a learning innovation created by Professor Fujisawa Rikitarou from the University of Tokyo. In Indonesia, JAMED is known as the Cross Line Multiplication Method, a geometry-based approach involving two parallel, right diagonal, and left diagonal auxiliary lines. The method involves drawing right diagonal lines over left diagonal lines, counting the points where these lines intersect, and writing the product at the intersection points. As an algorithm, JAMED uses a group of lines to represent numbers, teaching multiplication to children through these patterns. The JAMED method facilitates the understanding and performance of multiplication for primary school students without relying on memorization techniques (Alim et al., 2022; Fuadah et al., 2019; Grain & Kumar, 2018). Figure 1 illustrates how multiplication is performed using the JAMED method.

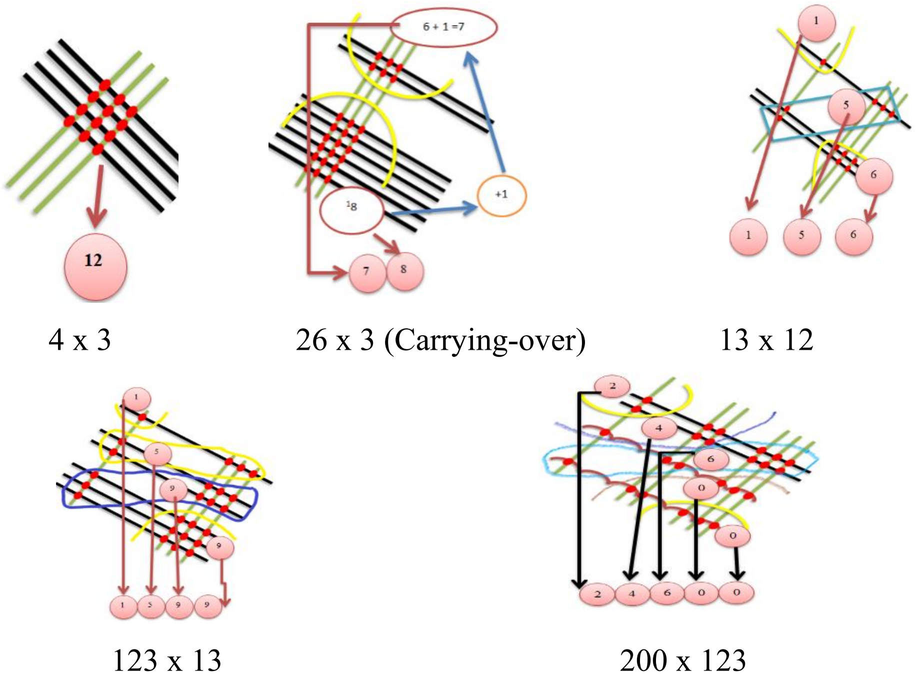

Figure 1 Multiplication Representations with JAMED for Numbers with Different Digit Counts

JAMED is a geometric-based method that enables students to learn multiplication solely through counting skills, without requiring any prior knowledge of addition operations or multiplication tables (Grain & Kumar, 2018). This method frees elementary-level students from the limitations and difficulties of rote learning by allowing them to visualize mathematics (Abari & Tyovenda, 2022; Fuadah et al., 2019). In this method, students can visualize each factor through lines and the product as points, or they can easily comprehend multiplication elements represented in this way. Moreover, by simply changing the orientation of the paper, students can observe the commutative property of multiplication. According to Dumagat et al. (2024), JAMED helps students construct and acquire knowledge through exploration and reflective thinking, facilitating active and hands-on learning. JAMED enables the concretization of highly abstract mathematical concepts by encouraging students to draw lines and create visual representations.

A review of the literature highlights numerous studies on the use of the JAMED method in mathematics education. Abari and Tyovenda (2022) demonstrated that JAMED is more effective than traditional methods in improving mathematics achievement and retention among elementary school students in Benue State, Nigeria, regardless of gender. Similarly, research conducted in Indonesia with elementary school students indicates that JAMED significantly enhances multiplication skills (Mustafa et al., 2021; Pertiwi et al., 2023), positively impacts learning outcomes (Cahyani & Lestari, 2024), and effectively teaches mathematical representation skills compared to rote learning methods (Fuadah et al., 2019). Furthermore, studies have shown that JAMED has a large effect size on conceptual understanding of multiplication (Hidayah, 2016), promotes active participation and easier comprehension of multiplication concepts (Nitasari, 2020), and simplifies students' understanding of the "concept of multiplication" (Fasya et al., 2023). In the context of the Philippines, Dumagat et al. (2024) similarly revealed that JAMED is more effective than traditional methods in improving the multiplication skills of elementary school students. In addition to its effectiveness in general settings, JAMED has been found to assist elementary school students with learning disabilities in Malaysia in developing fundamental multiplication skills (Mun & Abdullah, 2023).

Despite its proven benefits, JAMED is not included in the current Mathematics Curriculum in Türkiye (MoNE, 2024), and no studies on its implementation have been conducted in this context. Instead, the curriculum relies on the conventional long multiplication method. However, research has identified significant challenges with this approach. Students often make errors such as incorrect carrying, multiplying only digits in the ones place, calculation errors, using addition instead of multiplication, and misunderstanding the effects of "0" and "1." Additional issues include misapplying operation sequences, writing results incorrectly, and lacking knowledge of shortcut multiplication techniques (Attisha & Yazdani, 1984; Doğan, 2002; Gürsel, 2000; Kilian et al., 1980; Kubanç & Varol, 2017; Üçüncü, 2010). On the one hand, studies reporting positive findings on the teaching of multiplication through methods such as JAMED, and on the other hand, the challenges faced in traditional multiplication methods, raise the question of whether JAMED could serve as an alternative solution. Therefore, this study aims to explore the potential of the JAMED method in teaching multiplication to students who have struggled to learn through traditional approaches. To this end, the study seeks to address the following research questions:

1. What are the teacher's perspectives on the process of teaching multiplication using traditional methods?
2. What are the views of the teacher, students, and researcher regarding the process of teaching multiplication using the JAMED method?
3. How effectively do students apply the steps of the JAMED method for multiplication?
4. What changes are observed in the multiplication success test scores of students after learning multiplication with the JAMED method?

Method

Research Model

In this study, we employed the technical/scientific/collaborative model, one of the types of action research. Action research is recognized as a research method that involves systematically and scientifically collecting data to understand the current situation and developing practices based on that data. In action research, the researcher actively participates in the research process. Although action research falls within the category of qualitative research, it utilizes both qualitative and quantitative research methods and techniques (Büyüköztürk et al, 2021; Kuzu, 2009).

Study Group

We conducted the research in a primary school located in the Hani district of Diyarbakir, Türkiye. The study began by identifying a teacher who had students in her classroom experiencing difficulties with multiplication and who was willing to voluntarily participate in the research to address this issue. The teacher, who is 30 years old, has completed her fifth year in the teaching profession. At the time the study was conducted, she was teaching students whom they had been educating since the first grade.We used criterion sampling, one of the purposive sampling methods to determine the students. The criteria for selecting students in this study included being in the third grade and struggling to learn multiplication using traditional methods. To identify the students, we administered an achievement test developed by the researcher and research advisor and conducted interviews with classroom teachers. Based on the analyses of the test results and interviews, students who met the criterion of obtaining the lowest scores on the achievement test were selected for the study. The selected students and their parents were informed about the research processes, and informed consent was obtained from them, confirming their voluntary participation in the study. We assigned pseudonyms—Ada, Songül, Ferit, and Seyran—to the students included in the study. The teacher provided the following descriptions of the students, as presented in Table 1.

Table 1 Descriptions of the Students

Student	Teacher's description
Ada:	"*Her reading skills are the weakest among her peers. She struggles the most with reading in the class. She exhibits learned helplessness. Although her parents are supportive, she lacks motivation and effort, which prevents her from progressing. She struggles not only in mathematics but in all subjects. However, she is social and enjoys talking. I believe her academic performance will improve if she advances her reading skills. I think her struggles in all subjects stem from her reading difficulties.*"
Ferit:	"*He is interested in everything except the lessons. He loves to talk and share his experiences. He shows no interest in any subject and often forgets his books and notebooks. He doesn't make any effort. Although his reading skills are good, he struggles to regulate his breathing. Even after discussing this with his family, no progress was made. His parents believe that he doesn't study enough.*"
Songül	"*She shows more interest in art than in other subjects. She enjoys colors and drawing and is aware of color harmony. However, she is not engaged in her lessons. Her reading and writing skills are at a low level, and she doesn't make an effort to improve. This lack of effort is reflected in all subjects, not just mathematics. She exhibits learned helplessness and doesn't practice reading and writing at home. As a result, she is failing in all subjects. Although she performs better in addition and subtraction, she is still behind her peers. Her family is uninvolved and insufficiently supportive.*"
Seyran	"*Seyran is a curious and talkative child but often misses classes and does not participate regularly. She can perform addition and subtraction but has weak reading skills, although her reading has improved recently. She now reads books and asks me if her reading has improved. I believe Seyran has the potential to progress and that, with time, she will learn multiplication. She enjoys extracurricular activities such as playing games, jumping rope, and physical education*."

In the study, in addition to teacher and student data, researcher data were also utilized. The researcher graduated from the department of primary school teaching in 2018 and has completed their fourth year in the teaching profession. At the time the study was conducted, the researcher was serving as an assistant principal and was pursuing a master's degree program in primary education.

Action Committee Meetings

To ensure the effective implementation of the study, we formed an action committee before beginning the implementation process. The committee, comprising the advisor, researcher, and classroom teacher, met at the start of the process, after each action plan was implemented, and at the conclusion of the study to assess progress and address emerging issues.

Initially, the committee gathered to discuss the research process and decided that the JAMED method was appropriate for addressing the research problem, recommending that data be collected in this direction. The committee also concluded that it would be beneficial to interview the teacher about the students before starting the implementation. The interview provided insights into the teacher's previous experience with traditional multiplication teaching methods. However, the committee found the interview data insufficient and decided to conduct a second interview. After reviewing the pre-implementation achievement test results, the committee selected the students to be included in the study.

Before starting the research, we conducted a pilot implementation. We found that students had difficulty drawing diagonal lines. To address this issue, we decided to use grid paper to make drawing diagonal lines easier in our first action committee meeting. Following the first action plan, the committee met to evaluate the week. It was reported that grid paper had been distributed to the students, and the issue of not being able to draw diagonal lines was resolved. However, a new issue emerged the following week. The committee observed that the complexity of grid paper increased when the number of steps and numerical values increased, leading to the decision to discontinue the use of grid paper. After the second action plan, the committee convened to review the week's activities. It was decided that, for a student who experienced difficulties with carrying, remedial instruction in addition was to be provided until the next action plan date. After the third action plan, the researcher reported that the remedial instruction was insufficient, as the student continued to struggle with carrying. The researcher suggested that the student should add dots to the lines representing the carried number, which successfully resolved the issue. However, the researcher also noted that students had difficulty grouping by place value, and the committee recommended marking each group with different colored pencils. After the fourth action plan, the researcher reported no problems, and the meeting was adjourned. However, after the fifth action plan, the teacher raised a concern, stating that reverting to the traditional method after using JAMED might negatively impact the students. As a result, the committee decided to extend the action research by one more week. The committee suggested combining the JAMED method with traditional multiplication for the sixth action plan, creating a lesson plan where each multiplication step is performed using the JAMED method and recorded in the corresponding place in the traditional method.

Data Collection

We collected the data for this study using several instruments, including the 3rd Grade Multiplication Achievement Test developed by us, pre- and post-implementation teacher interview forms, post-implementation student interview forms, a researcher's diary, audio recordings from the teaching process, lesson-end assessment activity sheets, and rubrics related to these activity sheets.

The content of the 3rd Grade Multiplication Achievement Test includes learning objectives of multiplication from the 2nd and 3rd grades. We reviewed these learning objectives and selected those suitable for teaching using the JAMED method. Based on this selection, we created a draft achievement test form consisting of 25 items. To determine the content validity of the test, we used Lawshe's (1975) technique. We formed an expert group consisting of eight members—five from elementary education and three from mathematics education. These experts evaluated the items using three criteria: essential, useful but not essential, and not necessary for performance. After gathering the experts' feedback, we calculated the content validity ratios (CVR) and content validity indices (CVI) for each item. We calculated the content validity ratios by subtracting "1" from the value obtained by dividing the number of experts who labeled the item as 'essential' by half the total number of experts. Items with a CVR of 0 or lower were removed from the test, which led to the exclusion of items 5 (CVR = -0.25), 7 (CVR = 0), 9 (CVR = 0), and 10 (CVR = 0). The average CVI value for the remaining items in the test was found to be 0.93, which is above the critical CVR value of 0.75 for eight experts. Therefore, we concluded that all remaining items had sufficient content validity.

After establishing content validity, we administered the 21-item version of the test to 504 third-grade students in Diyarbakir to calculate item difficulty and discrimination indices and to conduct an Exploratory Factor Analysis (EFA) for construct validity. The item discrimination indices ranged from 0.11 to 0.85, while the difficulty indices varied between 0.55 and 0.95. We removed item 1, which had a discrimination index below 0.30 (0.11). The average difficulty level of the test was calculated as 0.72, indicating that the test is relatively easy (Büyüköztürk, 2020). This ease was expected since the pilot study was conducted with students who had previously learned these skills. Given that this study is an action research project and the test's purpose is to identify students who struggle even with easier questions, we decided to use the test within this research.

As a result of EFA, the Kaiser-Meyer-Olkin (KMO) value was 0.93, and Bartlett's test was significant ($p < 0.05$). The EFA results indicated that the achievement test could be grouped under a single factor. The total variance explained by the 20-item test was 42%, which is sufficient for a single-factor structure (Bayram, 2015). All items in the test had factor loadings above 0.30 (ranging from 0.44 to 0.77), suggesting that none of the items needed to be removed (Pallant, 2007). These findings indicate that the data were appropriate for factor analysis and that the sample size was adequate (Seçer, 2013).

We assessed the reliability of the measurements conducted for the EFA using Cronbach's α coefficient, given that the test items had more than two response options (three-choice items) (Uyanah & Nsikhe, 2023). The reliability coefficient for the achievement test was calculated as 0.92, indicating that the measurements were reliable (Sipahi et al., 2010).

We designed the Pre-Action Teacher Interview Form to gather insights into the multiplication teaching process using traditional methods. We aimed to understand the challenges faced, the reasons behind these challenges, students' attitudes and perceptions toward multiplication, and the errors students made while solving multiplication problems.

After each action plan, we used the Post-Action Teacher Interview Form to collect the teacher's reflections on the JAMED method. Similarly, we employed the Post-Action Student Interview Form to capture students' thoughts on the JAMED method following each action plan.

We kept a research diary to record our observations after each action plan. We maintained the diary in an unstructured format, making occasional notes during the action plan implementation and reflecting on the assessment after the lesson ended. We also documented any observations shared by teachers and students regarding the effects of the JAMED method both inside and outside the classroom between the conclusion of one action plan and the implementation of the next.

We administered lesson-end assessment activities to students after each action plan. We designed these activities to align with the day's action plan outcomes. We shared the activities with the teacher before each action plan and made necessary revisions. For instance, we prepared a three-question activity sheet for the first action plan and presented it to the teacher, who suggested adding a question to assess the representation of the number "0" in JAMED. Consequently, we replaced the "6x3" question with "6x0". After the lesson, we asked students to complete the activities and collected the completed activity sheets.

We assessed the collected activity sheets using an analytic rubric, which allowed for detailed evaluation of each step in the process or skill being measured (Haladyna, 1997). We developed separate rubrics for each assessment activity in the action plans to gather detailed information about students' performance in the multiplication process using the JAMED method.

To ensure the validity and reliability of the rubrics, we followed several steps. We referred to Kutlu et al. (2010) for guidelines on creating reliable rubrics. According to their recommendations, criteria should be clear and unambiguous, non-overlapping, descriptively defined, accurately reflect grading, and have enough levels to distinguish performance differences. After preparing the rubrics with these features, we increased their validity by seeking expert opinions. We consulted seven experts, including three in mathematics education and four in elementary education. We asked the experts to evaluate the rubric based on the criteria, descriptive definitions, and grading accuracy. Based on their feedback, we made several changes. For example, we revised the description for the "0" score from "inability to draw lines as many as the factor" to "inability to draw lines." Similarly, we split the original criterion "*Left a small space between lines and drew diagonal lines as many as the units digit on the right*" into two separate criteria: "*Did not leave a space where necessary*" and "*Drew as many diagonal lines as the units digit on the right*."

After each action plan, both the teacher and researcher individually scored each student using the rubric. To facilitate scoring, each rubric included the criteria, their descriptive definitions, and the corresponding scores. Table 2 provides an example of the rubric and descriptive definitions used for scoring the multiplication of two single-digit numbers using the JAMED method.

Table 2 Rubric for the Multiplication of Two Single-Digit Numbers Using the JAMED

	0 (Inadequate)	1 (Partially adequate)	2 (Adequate)
1. Drew diagonal lines from the right for the first factor.	Did not draw lines	Drew lines unevenly, too many or too few, or did not draw the correct number of lines	Drew lines correctly and as many as the factors
2. Drew diagonal lines from the left intersecting with the diagonal lines from the right for the other factor.	Did not draw lines	Drew lines unevenly, too many or too few, or did not draw the correct number of lines	Drew lines correctly and as many as the factors
3. Drew curved lines for the factor with a zero value.	Did not draw curved lines for the zero value	Drew curved lines incorrectly for the zero value	Drew curved lines correctly for the zero value.
4. Marked the intersection points of the lines.	Did not mark intersection points	Marked intersection points incorrectly	Marked intersection points correctly
5. Counted the marked intersection points.	Did not count intersection points	Counted intersection points incorrectly	Counted points correctly
6. Wrote the multiplication result.	Did not write the multiplication result	Wrote the multiplication result incorrectly	Wrote the multiplication result correctly.

Data Analysis

We employed content analysis and descriptive analysis to analyze the qualitative data obtained from the research. Content analysis is a qualitative research method that involves examining documents, texts, and records to obtain objective and reliable information (Metin & Ünal, 2022). Descriptive analysis involves the in-depth examination and organization of qualitative and quantitative research on a specific topic (Ültay et al., 2021). We analyzed interviews, diaries, and dialogues using content analysis, while documents were analyzed through descriptive analysis. We used MS Office Excel software to calculate data from the success test, summing the points given for each correct answer (5 points).

Validity and Reliability

To ensure internal validity and reliability in the study, we also addressed and attempted to block the researcher's biases related to the phenomena under investigation (Merriam, 2015). The researcher's bias was their belief in the JAMED method's effectiveness for teaching multiplication and their role as an assistant principal at the school where the research was conducted. To account for the potential influence of the researcher's beliefs on the diaries, we utilized semi-structured interviews and document data to obtain diverse perspectives. We informed both students and teachers at the beginning of the interviews that they could express their thoughts impartially and without hesitation, emphasizing the value of negative feedback for the study. One indicator of the effectiveness of this strategy was the identification of themes related to both the advantages and disadvantages of the JAMED method in the research findings.

We ensured the internal validity of the data through data source triangulation and the internal validity and reliability through analyst triangulation (Patton, 2014). In this context, we conducted interviews with teachers and students, maintained diaries, collected documents related to student activities, evaluated these documents using scoring rubrics, and recorded researcher-student dialogues during action implementations. In other words, we enriched the data obtained from the research through interviews with various individuals and documents from the process. We supported findings in the presentation by corroborating the same category with different data sources. For instance, the "willingness" category under the affective theme in the process findings of the second action plan is an example. The researcher's statement, "*Students constantly raised their hands to come to the board and solve multiplication problems,*" and the dialogue, "***Researcher****: Yes, children, the multiplication of a two-digit number by a single-digit number is done like this in the Japanese multiplication method. Now, let's do another example.* ***Seyran****: Teacher, let's do it too*," demonstrate data collection from two different sources for the same category. Additionally, we used other data sources to uncover themes and categories not apparent from a single source. For example, the theme of cognitive features, which did not emerge from interviews or diaries, along with the categories of guidance and process explanation, were obtained through recording classroom dialogues. Interviews and diaries were coded by the researcher and the advisor, while activity documents were coded and analyzed by the researcher and teacher using scoring rubrics. We calculated the reliability of these codes using Miles and Huberman's (1994) reliability formula [Reliability = Agreement/(Agreement + Disagreement)]. The reliability for teacher interview data was 85%, for student interview data was 92%, and for researcher diary data was 83%. Inter-coder reliability for the assessments conducted with scoring rubrics was 98.3% (728/740). Since these percentages exceed 70%, we can assert that the inter-coder reliability ratio is sufficient and that the coding meets the minimum reliability criteria.

In qualitative research, the use of the audit trail technique is also essential for ensuring research reliability. This involves explaining how data were collected, how categories were created, and how decisions were made (Merriam, 2015). In this study, we collected qualitative data between March 14, 2023, and May 9, 2023. We conducted semi-structured interviews with the teacher before the implementation. After selecting students based on success test data, we communicated the process to them and explained the actions to be taken during the implementation. Weekly, we conducted semi-structured interviews using teacher and student interview forms at the end of each action plan. Additionally, throughout the process, the researcher maintained their diary. Weekly interviews were recorded and transcribed. We analyzed and coded the transcribed interviews and the researcher's diary data.

Initially, two coders separately coded the data. We then compared these codes to identify agreements and disagreements. In cases where the two coders disagreed, we followed the researcher's decisions due to their greater familiarity with the research processes; however, all such cases were recorded as disagreements. For example, while scoring the rubric for the first activity of the first action plan, the researcher awarded a "1" point for Ada under the criterion "Marked the intersection points of the lines" by noting that the points were not distinct, while the teacher awarded a "0" point, believing that the marking was incomplete.

From the codes obtained by the coders, we derived categories, and from the categories, we developed themes. For instance, in the pre-action interview with the teacher, we found statements such as:

"*Children generally have a failure mindset. They realize they cannot perform addition and subtraction, and then they think, 'If I can't do addition and subtraction, I can't do multiplication either' (**cannot-do prejudice**). As a result, they develop prejudices such as 'I cannot grasp multiplication' (**cannot-grasp prejudice**) and 'I can't do it' (**cannot-do prejudice**). ... Since children cannot perform rhythmic counting and do not understand the concept of multiples in multiplication, they develop a prejudice against multiplication (**prejudice due to lack of knowledge**).*"

From these statements, we obtained three codes: "cannot-grasp prejudice," "cannot-do prejudice," and "prejudice due to lack of knowledge." These codes were categorized under the "prejudice" category, which was then combined with themes of fear and anxiety, lack of self-confidence, and learned helplessness under the "affective characteristics" theme.

To ensure the external validity of the study, we employed sample diversity and rich, thick descriptions (Creswell, 2007; Merriam, 2015). To achieve sample diversity, we included one student with the lowest score among boys, despite the fact that all four students with the lowest scores from the success test were girls. In terms of rich, thick descriptions, the findings were supported by direct quotations from teachers, students, and the researcher, as well as visuals of activities solved by the children. Additionally, after providing pseudonyms for each participant in the study group section, we presented detailed information based on the teachers' views.

Role of the Researcher

Akgün (2008) has stated that action research can be conducted not only by teachers but also by academics and researchers. Based on this, in this study, the implementation process was directly managed by one of the researchers. Her role as both the assistant principal of the school where the study was conducted and a graduate student created a sense of responsibility for resolving the issues students faced with multiplication. As a result, all action plans in the study were implemented by us in collaboration with and under the observation of the teacher.

A review of the literature reveals similar studies where action plans were managed by researchers (Anagün, 2008; Türkkan, 2008; Şekerci, 2018). Therefore, the researcher's position, qualifications, personal values, and experience with the research topic were considered influential factors at each stage of the process. We conducted detailed research on the problems related to multiplication and its teaching, as communicated by the teacher, and concluded that the JAMED method could address these issues. Consequently, we decided to use action research as qualitative research method for this study.

As the assistant principal of her own school, the researcher was able to maintain continuous communication with students. She worked to earn their trust by interacting with them during breaks and informed them that they could visit her with any concerns related to the action process.

Findings

Findings on the Process of Teaching Multiplication Using the Traditional Method and JAMED

The themes and categories derived from opinions on the multiplication process conducted with the traditional method before the action research, the multiplication teaching process carried out using JAMED during the intervention (1st-5th weeks), and the process where these two methods were combined (6th week) are presented in Table 3.

Table 3 Perspectives on Teaching Multiplication Using the Traditional Method and JAMED

		Traditional	JAMED					
		multiplication	1	2	3	4	5	6
Perspectives	Difficult	✓						
	Necessary	✓						
Issues	Carrying Over	✓		✓				
	Shifting digits	✓						✓
	Failing to Complete the Multiplication Process	✓						
	Inability to Solve Problems	✓						
	Marking Intersection Points		✓	✓				
	Speed		✓	✓				
	Counting Dots		✓	✓		✓		✓
	Grouping				✓		✓	
	Transferring JAMED Results to the Traditional Method							✓
Causes of Issues	Lack of Prerequisite Knowledge	✓						
	Unfamiliarity with Rhythmic Counting	✓						
	Lack of Understanding of Multiples	✓						
	Unfamiliarity with the Multiplication Table	✓						
	Inability to Grasp the Logic of Multiplication	✓						
	Aesthetic Concerns		✓	✓				
	Line (Spacing, Size, and Shape)		✓		✓	✓	✓	✓
	Hastiness		✓	✓	✓	✓		
	Lack of Knowledge of Addition			✓				
	Inability to Express Data Numerically						✓	
	Confusion							✓
	Sequential steps							✓
Affective Traits	Prejudice	✓						
	Fear and Anxiety	✓						
	Lack of Confidence	✓						
	Learned Helplessness	✓						
	Low Motivation	✓				✓		
	Perseverance		✓	✓	✓			
	Enjoyment		✓	✓				
	Affection		✓	✓	✓	✓	✓	✓
	Interest		✓					
	Confidence		✓	✓	✓	✓	✓	✓
	Sense of Success		✓			✓		✓
	Enthusiasm			✓				
Cognitive Traits	Suitability for Developmental Stage		✓					
	Ability to Guide			✓				
	Ability to Convey the Problem-Solving Process			✓				
	Learning the Concept of Place Values				✓			
	Learning the Concept of Carrying Over				✓	✓		
	Transfer				✓	✓	✓	✓
	Problem-Solving						✓	
	Traditional Multiplication							✓
	Synthesis with Traditional Multiplication							✓
Advantages	Compensation					✓		
	Widespread Impact					✓		
Disadvantages	Overshadowing Other Subjects				✓			
	Curriculum Differences				✓			
Limitations	Time					✓		✓

Pre-action research: In this study, the first step involved gathering the classroom teacher's perspectives on the students' process of learning multiplication using the traditional method. During the interviews conducted before the JAMED implementation, the teacher mentioned that students found multiplication difficult but necessary. The teacher also noted that students faced issues such as carrying over, shifting digits, failing to complete the multiplication process, and being unable to solve problems. The teacher attributed these problems to a lack of prerequisite knowledge, as well as difficulties in understanding rhythmic counting, the concept of multiples, the multiplication table, and the logic of multiplication. According to the teacher, students experienced prejudice, fear and anxiety, lack of confidence, lack of motivation, and learned helplessness when it came to multiplication. Some of the teacher's views related to these themes are provided below.

> **Perspective-Necessary:** *"Students tried to learn multiplication at the beginning of the process because they knew they could use it in their daily lives."* (Classroom Teacher)
> **Affective Traits - Prejudice:** *"Children developed a prejudice against multiplication because they could not perform rhythmic counting and did not understand the concept of multiples in multiplication."* (Classroom Teacher)
> **Issues - Carrying Over:** "*Students couldn't grasp the concept of carrying over during multiplication, which led to addition errors. They didn't understand that the carried number should be added after multiplying the other numbers. They kept writing the carry repeatedly."* (Classroom Teacher)
> **Causes of Issues - Lack of Understanding of Multiples:** "*Students couldn't grasp the concept of multiples. For example, when we say five times six, they couldn't add five sixes together. This made learning multiplication difficult."* (Classroom Teacher)

First action plan process: Feedback on the implementation of the first action plan related to JAMED indicates that after their initial experiences with this method, students developed perseverance, enjoyment, affection, interest, confidence, and a sense of achievement. During the first week, opinions also emerged about the suitability of this method for students' developmental stages. However, it was observed that students struggled with marking intersection points, achieving the appropriate speed, and counting points due to aesthetic concerns, inability to draw lines correctly, and hasty behavior. Some of the opinions on these issues are provided below:

> **Affective Traits - Interest:** *"Students enjoy drawing. Since the Japanese multiplication method is similar to drawing, it facilitated their learning and increased their interest in the lesson."* (Classroom Teacher)
> **Cognitive Traits - Suitability for Developmental Stage:** *"Since it is a fun drawing activity, children in this developmental stage can project it onto paper as they can think concretely, and I believe this method is more suitable and effective for their age group.*" (Classroom Teacher)
> **Issues - Marking Intersection Points:** *"I drew the points too close together, which led to mistakes in marking.*" (Ada)

> **Causes of Issues - Aesthetic Concerns:** *"Although I initially considered the reason to be a lack of understanding of the method, I found out that the student first solved the problem with a pencil using the Japanese multiplication method, then erased it and solved it with a different pencil. When I asked about this, the student said it was 'to make it look nicer.'"* (Researcher)

***Second action plan process*:** Following the implementation of the second action plan, students continued to exhibit positive affective traits such as perseverance, enjoyment, affection, confidence, and enthusiasm towards JAMED. However, students faced issues with carrying over, marking intersection points, speed, and counting dots due to aesthetic concerns, hastiness, and lack of knowledge of addition. Despite these challenges, it was observed that students were able to guide the researcher in solving a multiplication problem using JAMED and effectively convey their own problem-solving processes.

> **Affective Traits - Enjoyment:** "*It was very nice. We all had fun. We did the Japanese multiplication by drawing lines; I think it was very nice. It required carrying over. It felt easier*." (Songül)
> **Affective Traits - Enthusiasm:** "*Students were constantly raising their hands to come to the board and express their desire to solve multiplication problems*." (Researcher)
> **Cognitive Trait - Ability to Guide: Researcher**: "*After this example, may I take you to the board? Let's have you solve this example for me."* **All Students***: "For the tens place, draw two diagonal lines from the right. One, two."* ***Researcher****: "What should I do now?"* **All Students***: "Leave a bit of space and then draw three more lines."* **Researche***r: "What should I do now?"* **Ferit***: "Now we will make the dots, but first we will separate them."* ***Researcher:*** *"Well done, let's separate them into units and tens."* **All Students***: "Now we will count the dots."* **Researche***r: "Where should I start counting?"* **All Students***: "We will start from the bottom."* ***Teacher and All Students****: "One, two… nine. Then we moved to the next place."* **Researcher***: "We counted all of them; what should I do now?"* **Students***: "We will write the result."* **Researcher***: "Where do I start writing?"* **Students***: "Start with six, then nine."* **Seyran***: "The answer is 69.*"
> **Issues - Speed:** "*Songül drew the lines with great care and beautifully using the crayon today. However, this caused her to solve the problems after her peers, even though she completed the multiplication correctly*." (Researcher)
> **Issues - Carrying Over:** "*Ada initially did not grasp the concept of carrying over. Although she improved with more examples, she struggled significantly with adding the carry to the next place. Later, I instructed her to add dots to the higher place value instead of adding the carry, and this allowed her to perform the multiplication with carrying over*." (Researcher)
> **Causes of Issues - Lack of Knowledge of Addition:** "*I couldn't perform addition. That's why I couldn't manage the carry.*" (Ada)

***Third action plan process*:** Observations and experiences from the implementation of the third action plan indicate that students continued to exhibit positive affective traits such as perseverance, affection, and confidence while learning multiplication with JAMED. They learned the concepts of place values and carrying over and were able to transfer their learning outcomes. However, students encountered issues with grouping due to difficulties in drawing lines correctly and hasty behavior. Additionally, the use of JAMED has revealed disadvantages such as overshadowing other subjects and curriculum differences. Some perspectives related to these observations are provided below:

> **Affective Traits - Perseverance:** "*In the first minutes of the lesson and in subsequent observations, I see that the students' efforts and enthusiasm while trying to learn multiplication remained consistent*." (Teacher)
> **Cognitive Traits - Learning Place Values:** "*Our lesson was very good. I really liked drawing the diagonal lines and separating them. I liked it because I learned the tens and units place values.*" (Ferit)
> **Issues - Grouping:** "*This week, grouping by place values was done. Although students initially found it strange, they learned as they practiced, but they struggled with grouping in some cases*." (Researcher)
> **Causes of Issues - Lines:** "*It was fine, but I solve problems more easily when I leave a bit more space and draw larger lines.*" (Ferit)
> **Disadvantages - Overshadowing Other Subjects:** "*They want to participate in that lesson because it seems fun. Also, as their success increased, their interest in the method for that lesson grew, and they wanted to attend that lesson rather than mine*." (Teacher)
> **Disadvantages - Curriculum Differences:** "*Children can perform multiplication here because we cover the classic method and include all operations, such as multiplication and division. For example, we solve problems related to currency and weight measurements. I think they are currently inadequate in this context. I wonder what they will do when these topics are finished, and there is no multiplication involved. Will they be able to apply what they learned or will they immediately revert to the shortcut method? I am not sure. Currently, we are working with the traditional method. Since students are applying this method, they might struggle when we revert to the traditional method in the future*." (Teacher)

***Fourth action plan process*:** In the implementation of the fourth action plan, an ongoing issue has been counting the dots. This problem is attributed to students' hasty behavior, lack of attention to the required spacing, size, and shape of lines, and low motivation. Despite these challenges, students continue to demonstrate feelings of affection, confidence, and success towards JAMED. They have reinforced their understanding of the carrying concept learned in the previous week and have applied their knowledge in various contexts. The observations indicate that while JAMED has limitations in terms of time, it is advantageous in attracting other students, creating a widespread impact, and compensating students' readiness deficiencies. Some views related to this are presented below:

> **Affective Traits - Confidence:** "*Three-digit numbers seemed easier. One and two-digit numbers are good, but three-digit numbers are even better. I feel that I can now perform multiplication. When my teacher asks about multiplication, I can do it now. When my teacher asks for multiplication, I solve it using this method.*" (Seyran)
> **Affective Traits - Low Motivation:** "Comparing with others, *Ferit appeared to lose interest in learning. He wanted to finish the activity quickly to play games with his friends. Therefore, he tried to complete it hastily.*" (Researcher)

> **Advantages - Widespread Impact:** "*They constantly want to attend our teacher's (researcher) class. Other students in my class are also curious about this method and want to participate in the lesson*." (Teacher)
> **Advantages - Compensation:** "*In the classic method, students need to know rhythmic counting and multiplication tables. However, with this method, there are shapes and very basic rhythmic counting, which makes it easier for them. This method has become easier for them*." (Teacher)
> **Cognitive Traits - Learning the Carrying Concept:** "*I had mistakes with carrying, but then we solved them. I no longer miss carrying. It is easier to do carrying. I can solve problems with JAMED.*" (Ada)
> **Issues - Counting Dots:** "...he wanted to finish quickly to play games with his friends. Therefore, he tried to complete it hastily, which led to some mistakes in counting and marking dots." (Researcher)
> **Limitation - Time:** "I think the only issue might be time. Our students are taking exams and racing against time. The multiplication process here might delay their results." (Teacher)

Fifth action plan process**:** In the implementation of the fifth action plan, it was observed that students sometimes struggled with grouping due to issues with lines and were unable to express data numerically. However, students exhibited a confident and affectionate approach towards performing multiplication with JAMED. They were able to learn problem-solving this week and transfer their knowledge to more advanced multiplication tasks.

> **Affective Traits - Affection:** "*Our students really loved the multiplication process. They constantly wanted to do it. When our teacher (researcher) said that this would be the last week, I could see the sadness in the students. They wanted to continue*." (Teacher)
> **Cognitive Traits - Problem Solving:** "*It was very nice and easy. I couldn't solve problems before, but now I can.*" (Songül)
> **Cognitive Traits - Transfer:** "*It would have been better if we could go up to ten-digit numbers. Now I can do four-digit numbers myself.*" (Songül)
> **Issues - Inability to Express Data Numerically:** " *Students showed me their solutions. They had solved the problems correctly, but sometimes they struggled because they did not understand certain aspects. For instance, there was a problem with an expression like 'in one week,' where they could not multiply by 7. Otherwise, they were generally good.*" (Teacher)

Sixth action plan process**:** In the implementation of the sixth action plan, which combined JAMED with the traditional multiplication method, students experienced feelings of affection, confidence, and success. They were able to transfer their knowledge, learn the classical multiplication method, and integrate it with JAMED. However, time was still mentioned as a limitation this week, and students struggled due to reasons such as the lines, their confusion regarding the integration of the two methods, and issues with the sequential steps. As a result, they made some errors in shifting digits, counting dots, and transferring JAMED results to the traditional method. The following views reflect these issues:

Affective Traits - Sense of Success: "*I could do a few with the previous method. It improved a bit with the Japanese method.*" (Ferit)
Cognitive Traits - Synthesis with Traditional Multiplication: "*It seemed like they struggled with the traditional multiplication at the beginning of the lesson. When I observed later, the students had mastered it and were able to perform it. They were happy. They could do carrying, shifting digits, and addition. They couldn't finish the multiplication previously, but now they found the result.*" (Teacher)
Issues - Transferring JAMED Results to the Traditional Method: Seyran*: "Teacher, I did this (with JAMED), where should I write it now?"* **Researcher***: "(In traditional multiplication), the result of the unit place multiplication should be written in the unit place, right*?"
Reasons for Issues - Confusion: "*I noticed initial confusion among the students. They seemed to struggle with classical multiplication at the beginning of the lesson*." (Teacher)
Reasons for Issues - Sequential Steps: "*They struggled with the multiplication of two two-digit numbers. I think this is due to the progression through steps. Initially, they confused where to write the results after each step*." (Teacher)

Findings Related to Assessment

At the end of the instructional process, three activities were presented to assess students' understanding of the topic, and these activities were scored using rubrics.

***First action plan assessment*:** The rubric assessment of the activities conducted at the end of the first action plan, where students learned to multiply two single-digit numbers, is presented in Table 4.

As shown in Table 4, the students generally struggled with drawing lines correctly from the right side for the first factor during the first activity. While Songül, Ferit, and Seyran received high scores in multiplying two single-digit numbers using the JAMED method, Ada received a relatively low score. In the second activity, Ada continued to have difficulty drawing lines from the right side for the first factor. However, all students, including Ada, were generally successful in multiplying a single-digit number by zero. In the third activity, Ada, Songül, and Seyran achieved high scores, while Ferit received a lower score compared to the others.

Table 4 Results of the First Action Plan Activity Assessment

	First activity				Second activity				Third Activity			
Criteria	A	So	F	Se	A	So	F	Se	A	So	F	Se
1. Drew diagonal lines from the right for the first factor.	1	1	1	2	1	2	2	2	2	2	2	2
2. Drew diagonal lines from the left intersecting with the diagonal lines from the right for the other factor.	1	2	1	2	-	-	-	-	2	2	2	2
3. Drew curved lines for the factor with a zero value.					2	2	2	2	-	-	-	-
4. Marked the intersection points of the lines.	1	2	2	2	-	-	-	-	2	2	1	2
5. Counted the marked intersection points.	1	2	2	2	-	-	-	-	2	2	2	2
6. Wrote down the product.	2	2	2	2	2	2	2	2	2	2	2	2
Total point	6	9	8	10	5	6	6	6	10	10	9	10

Figure 2-4 illustrates some of the students' assessment activities:

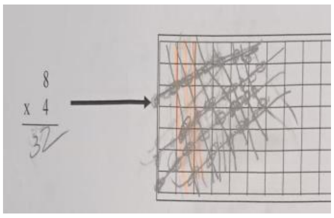

Figure 2 Ada (First Activity)

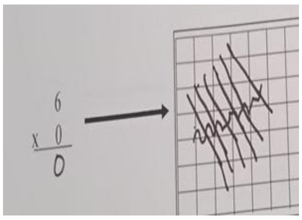

Figure 3 Seyran (Second Activity)

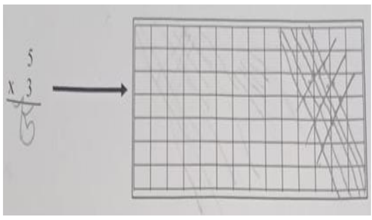

Figure 4 Ferit (Third Activity)

As illustrated in Figure 2-4, Ada was considered "partially adequate" in the first activity for drawing crooked lines for the first factor from the right side and "adequate" for correctly writing the product result. In the second activity, Seyran successfully drew lines from the right side, earning sufficient points for the first criterion, and also met the criteria for "drawing curved lines for the factor with zero" and "writing the product result," thus receiving "adequate" scores. In the third activity, Ferit did not clearly mark the intersection points of the lines, earning a "partially adequate" score for the criterion "marked the intersection points of the lines," but received "adequate" scores for all other criteria. This indicates that students were generally able to use the JAMED method at a partially adequate or adequate level for multiplying two single-digit numbers.

***Second action plan assessment*:** The rubric assessment of the activities conducted at the end of the second action plan, where students learned to multiply a two-digit number by a single-digit number, is presented in Table 5.

According to Table 5, Ada, Songül, and Ferit scored full points in all activities for multiplying a two-digit number by a single-digit number using the JAMED method. However, Seyran scored lower than the others in the first and third activities.

Table 5 Results of the Second Action Plan Activity Assessment

Criteria	First activity				Second activity				Third activity			
	A	So	F	Se	A	So	F	Se	A	So	F	Se
1.Drew diagonal lines from the right equal to the number in the tens place of the two-digit factor.	2	2	2	2	2	2	2	2	2	2	2	2
2.Left a space for the ones place of the two-digit factor on the same line.	2	2	2	2	2	2	2	2	2	2	2	2
3.Drew diagonal lines from the right equal to the number in the ones place of the two-digit factor.	2	2	2	2	2	2	2	2	2	2	2	1
4.Drew diagonal lines from the left that intersected with the diagonal lines from the right, corresponding to the one-digit factor.	2	2	2	2	2	2	2	2	2	2	2	2
5.Drew curved lines for the factor containing the zero value.	-	-	-	-	2	2	2	2	-	-	-	-
6.Marked the intersection points of the lines.	2	2	2	1	2	2	2	2	2	2	2	1
7.Marked the points on the lines according to place values if they appeared.	2	2	2	2	2	2	2	2	2	2	2	1
8. Began counting points from the units place and continued sequentially through the tens, hundreds, and thousands places if applicable.	2	2	2	2	2	2	2	2	2	2	2	2
9.Carried over the first digit of the two-digit count of intersection points to the next higher place value.	2	2	2	2	-	-	-	-	2	2	2	2
10.Wrote the resulting values from left to right starting from the beginning and obtained the final product.	2	2	2	2	2	2	2	2	2	2	2	0
Total point	18	18	18	17	18	18	18	18	18	18	18	13

Figure 3-6 depicts some of the students' assessment activities:

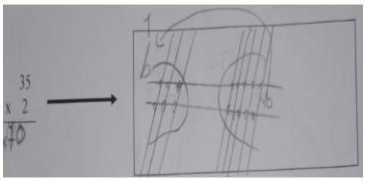

Figure 5 Songül
(First Activity)

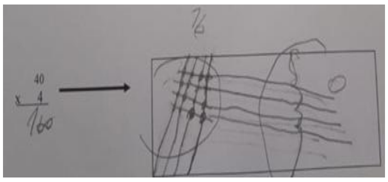

Figure 6 Ferit
(Second Activity)

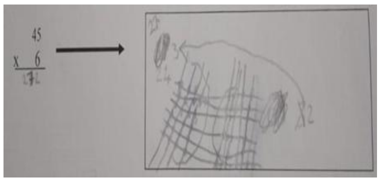

Figure 7 Seyran
(Third Activity)

As seen in Figure 5-7, Songül met all the criteria in the first activity and was considered "adequate." In the second visual, Ferit successfully drew curved lines for the factor with zero, understood that there should be no marking on the curved lines, and correctly identified the product as zero, thus meeting the "drew curved lines for the factor with zero" criterion. In the third activity, Seyran was evaluated as "partially sufficient" in the criterion "drew diagonal lines to the right based on the number in the ones place of the two-digit factor" because the lines were uneven and lacked clarity. Additionally, Seyran did not clearly mark the intersection points, leading to a "partially sufficient" assessment in the criterion "marked the intersection points of the lines”. She did not write the product result correctly, leading to no points for the criterion "wrote the calculated value from left to right starting from the first digit and obtained the product result." The inability to earn sufficient points in these criteria caused Seyran to receive the lowest score in the test, despite having scored high in the first and second activities.

***Third action plan assessment*:** The rubric assessment of the activities conducted at the end of the third action plan, where students learned to multiply to multiply two two-digit numbers, is presented in Table 6.

Table 6 Results of the Third Action Plan Activity Assessment

Criteria	First activity				Second activity				Third activity			
	A	So	F	Se	A	So	F	Se	A	So	F	Se
1. Drew diagonal lines from the right corresponding to the number in the tens place of the first factor.	2	2	2	2	2	2	2	2	2	2	2	2
2. Left a space for the units place of the first factor on the same line.	2	2	2	2	2	2	2	2	2	2	2	2
3. Drew diagonal lines from the left corresponding to the number in the tens place of the second factor.	2	2	2	2	2	2	2	2	2	2	2	2
4. Left a space for the units place of the second factor on the same line.	2	2	2	2	2	2	2	2	2	2	2	2
5. Drew diagonal lines from the left corresponding to the number in the units place of the second factor.	2	2	2	2	-	-	-	-	2	2	2	2
6. Drew curved lines for factors that include zero.	-	-	-	-	2	2	2	2	-	-	-	-
7. Marked the intersection points of the lines.	2	2	2	2	2	2	2	2	2	2	2	2
8. Marked the points on the lines according to their place values if they appeared.	2	2	2	2	2	2	2	2	2	2	2	1
9. Began counting points from the units place and continued sequentially through the tens, hundreds, and thousands places if applicable.	2	2	2	2	2	2	2	2	2	2	2	2
10. Carried over the first digit of the two-digit count of intersection points to the next higher place value.	2	2	1	2	-	-	-	-	2	2	2	2
11. Wrote the resulting values from left to right starting from the beginning and obtained the final product.	2	2	0	2	2	2	2	2	2	2	2	2
Total point	22	22	19	22	20	20	20	20	22	22	22	21

As shown in Table 6, Ada, Songül, and Seyran met all the criteria and scored full points in the first activity, while Ferit received the lowest score in the test. Although all students scored full points in the second activity, Seyran received a lower score than the others in the third activity due to being "partially adequate" in only one criterion. Figure 8-10 presents an overview of some of the students' assessment activities:

As seen in Figure 8-10, Ferit incorrectly carried over the first digit in the tens place for the criterion " carried over the first digit of the two-digit intersection point count to the next higher place value," earning a "partially adequate" score, and was marked "inadequate" for "wrote the calculated value from left to right starting from the first digit and obtained the product result" as he did not obtain the correct product. In the second activity, Seyran correctly applied the JAMED method, marked the intersection points, grouped the points, and wrote the product result accurately.

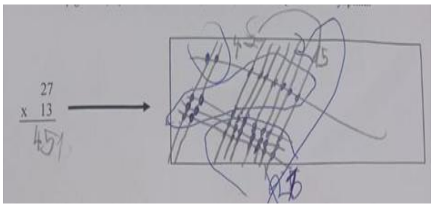

Figure 8 Ferit
(First activity)

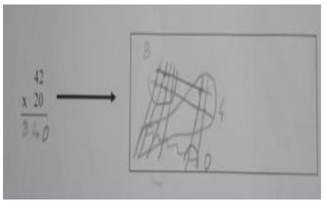

Figure 9 Seyran
(Second activity)

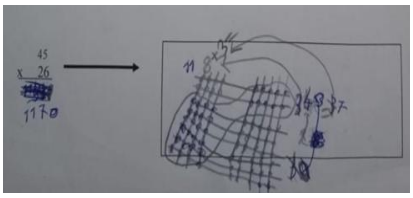

Figure 10 Seyran
(Third activity)

However, in the third activity, she did not group the points in the hundreds and units places, resulting in a "partially adequate" score for the criterion "marked the points on the lines according to place value if they exist." This caused Seyran to score one point lower than the other students on the test.

***Fourth action plan assessment*:** The rubric assessment of the activities conducted at the end of the fourth action plan, where students learned to multiply a three-digit number by a single-digit number, is presented in Table 7.

Table 7 Results of the Fourth Action Plan Activity Assessment

Criteria	First activity				Second activity				Third Activity			
	A	So	F	Se	A	So	F	Se	A	So	F	Se
1. Drew diagonal lines from the right corresponding to the number in the hundreds place of the three-digit factor.	2	2	2	2	2	2	2	2	2	2	2	2
2. Left a space for the tens place of the three-digit factor on the same line.	2	2	2	2	2	2	2	2	2	2	2	2
3. Drew diagonal lines from the right corresponding to the number in the tens place of the three-digit factor.	2	2	2	2	-	-	-	-	-	-	-	-
4. Left a space for the units place of the three-digit factor on the same line.	2	2	2	2	2	2	2	2	2	2	2	2
5. Drew diagonal lines from the right corresponding to the number in the units place of the three-digit factor.	2	2	2	2	2	2	2	2	2	2	2	2
6. Drew diagonal lines from the left intersecting the diagonal lines from the right according to the value of the single-digit factor.	2	2	2	2	2	2	2	2	2	2	2	2
7. Drew curved lines for factors that include zero	-	-	-	-	2	2	2	2	2	2	2	2
8. Marked the intersection points of the lines.	2	2	2	2	2	2	2	2	2	2	2	2
9. Marked the points on the lines according to their place values if they appeared.	2	2	2	2	2	2	2	2	2	2	2	2
10. Counted the points in the formed groups.	2	2	2	2	2	2	2	2	2	2	2	2
11. Sent the digit in the tens place to the next higher place value if the number of points in the group was two-digit.	2	2	2	2	2	2	2	2	2	2	2	2
12. Wrote the number of points in each group and then listed them from left to right to obtain the final product.	2	2	2	2	2	2	2	2	2	2	2	2
Total Point	22	22	22	22	22	22	22	22	22	22	22	22

As shown in Table 7, all students performed at an "adequate" level across all criteria in the activities conducted during the fourth week. Figure 10-12 provides examples of some of the students' assessment activities.:

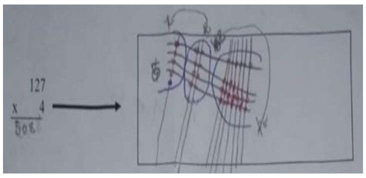

Figure 10 Ada
(First Activity)

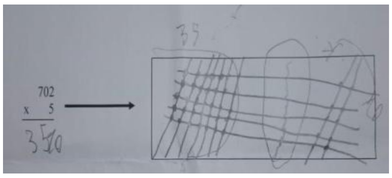

Figure 11 Ferit
(Second Activity)

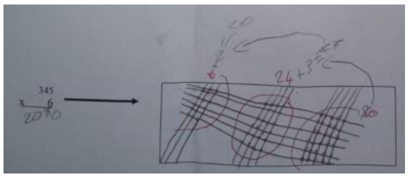

Figure 12 Songül
(Third Activity)

The visuals in Figures 10-12 showing the multiplication of a three-digit number by a single-digit number using the JAMED method by Ada, Songül, and Ferit show that the students understood how to draw diagonal lines, mark intersection points, group the points, carry over to the next place value, and draw curved lines for the zero value. Therefore, all students were considered "adequate" in all criteria and received the highest possible score on the test.

***Fifth action plan assessment*:** At the end of the fifth action plan, where students learned to use JAMED for problem-solving, four problems were presented to them. The first problem required multiplying two single-digit numbers, the second required multiplying a two-digit number by a single-digit number, the third required multiplying two two-digit numbers, and the fourth required multiplying a three-digit number by a single-digit number. The students' solutions to these problems using JAMED were evaluated based on the rubric criteria used in the first four action plans, as shown in Tables 3, 4, 5, and 6. All students were evaluated as "adequate" in meeting the criteria for the first three problems using JAMED. In the fourth problem, Ferit and Seyran again received full points, while Ada and Songül scored 20 out of 22 points due to criteria 10 and 12 in Table 6. Figure 13-16 illustrates several examples of the students' assessment activities.:

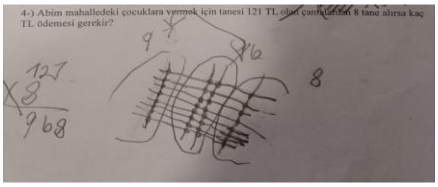

Figure 13 Ferit (First Activity)

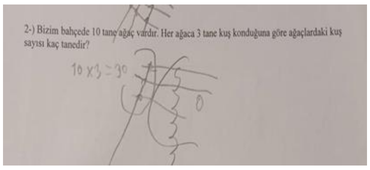

Figure 14 Seyran (Second Activity)

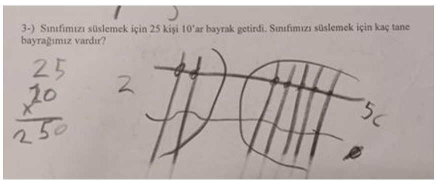

Figure 15 Songül (Third Activity)

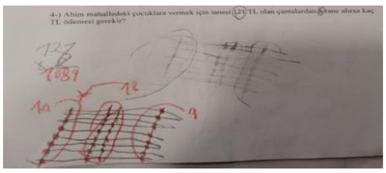

Figure 16 Ada (Fourth Activity)

Figure 13-16 shows that Ferit successfully used the JAMED method to solve the problem in the first activity by meeting the relevant criteria. In the second activity, Seyran demonstrated an understanding of place value, left space between digits, drew curved lines for the zero value, and successfully met the criteria for grouping. In the third activity, Songül met the criteria for solving problems that required multiplying two two-digit numbers, earning the highest score on the test. However, in the fourth activity, Ada incorrectly counted the intersection points in the groups and failed to obtain the correct product result despite performing the relevant operations. These results suggest that students were largely successful in using the Japanese multiplication method (JAMED) to solve problems requiring the multiplication of numbers with different digits.

Sixth action plan assessment: The sixth action plan focused on how to apply the JAMED method in the process of using the traditional multiplication method. This action plan was designed to combine the traditional method with the JAMED when solving multiplication problems. Table 8 presents the rubric for the multiplication of two two-digit numbers:

Table 8 Results of the Sixth Action Plan Activity Assessment

Criteria	A	So	F	Se
1. Drew diagonal lines from the right according to the units digit of the first factor.	2	2	2	2
2. Drew diagonal lines from the left that intersected the diagonal lines from the right according to the units digit of the second factor.	2	2	2	2
3. Drew curved lines for factors containing zero.	-	-	-	-
4. Marked the intersection points of the lines for the first operation.	2	2	2	2
5. Counted the intersection points for the first operation.	2	2	2	2
6. If the number of points was two-digit, wrote the tens digit as a carry-over.	2	2	2	2
7. Wrote the product result of the first operation in the units place.	2	2	2	2
8. Drew diagonal lines from the right according to the tens digit of the first factor.	2	2	2	2
9. Drew diagonal lines from the left that intersected the diagonal lines from the right according to the units digit of the second factor.	2	2	2	2
10. Marked the intersection points of the lines for the second operation.	2	2	2	2
11. Counted the intersection points for the second operation.	2	2	2	2
12. Added the number of points from the second operation if there was a carry-over.	2	2	2	2
13. Wrote the product result of the second operation in the tens place.	2	2	2	2
14. Drew diagonal lines from the right according to the units digit of the first factor.	2	2	2	2
15. Drew diagonal lines that intersected the diagonal lines from the right according to the tens digit of the second factor.	2	2	2	2
16. Marked the intersection points of the lines for the third operation.	2	2	2	2
17. Counted the intersection points for the third operation.	2	2	2	2
18. Wrote the product result of the third operation by shifting the digits.	2	2	2	2
19. Drew diagonal lines from the right according to the tens digit of the first factor.	2	2	2	2
20. Drew diagonal lines from the left that intersected the diagonal lines from the right according to the tens digit of the second factor.	2	2	2	2
21. Marked the intersection points of the lines for the fourth operation.	2	2	2	2
22. Counted the intersection points for the fourth operation.	2	2	2	2
23. Wrote the product result of the fourth operation in the tens place.	2	2	2	2
24. Added the results to obtain the final product.	2	2	2	2
Total point	46	46	46	46

As seen in Table 8, Ada, Songül, Ferit, and Seyran successfully used the JAMED method while performing multiplication using the traditional method for multiplying two two-digit numbers. Figure 17 contains the visual of the assessment activity for Songül.

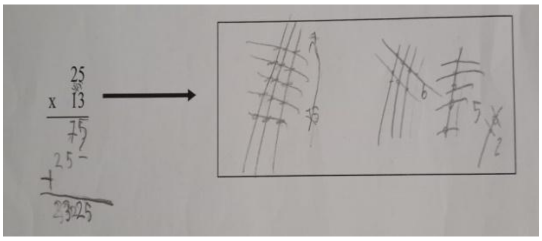

Figure 17 Assessment Activity Visual for Songül

As seen in the visual, Songül successfully used the JAMED method for multiplying two single-digit numbers, then applied the results to the traditional method for multiplying two two-digit numbers, performing well in the multiplication process. Songül effectively used skills such as carrying over, shifting place value, finding the product result, and completing the multiplication process by using the JAMED method. This indicates that students can benefit from JAMED, even during the traditional multiplication process, particularly when they have not memorized the multiplication table.

Findings Related to the Achievement Test

At the end of the implementation process, the Grade 3 Multiplication Achievement Test, initially administered at the beginning of the process, was re-administered. The code names and pre- and post-test scores of the students involved in the study are shown in Table 9.

Table 9 Initial and Final Test Results of the Grade 3 Multiplication Achievement Test

Student		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Point
Ada	İT	0	5	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	ST	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	0	90
Ferit	İT	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0	5	5	0	5	0	65
	ST	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	95
Seyran	İT	0	5	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	5	0	20
	ST	5	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	95
Songül	İT	0	5	0	0	5	5	5	0	5	5	0	0	0	0	5	5	5	5	0	0	50
	ST	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100

In Table 9, correct answers were awarded "5" points, while incorrect answers received "0" points. Comparing the initial and final test scores, Ada increased her score from 15 to 90, Ferit from 65 to 95, Seyran from 20 to 95, and Songül from 50 to 100. This demonstrates that students successfully completed the implementation process and effectively learned multiplication using the JAMED method. It also suggests that JAMED can serve as a helpful method for students who struggle with learning multiplication.

Discussion, Conclusion, and Suggestions

Based on the findings of the current study, third-grade primary school students began the multiplication instruction process with JAMED with some negative affective inputs, including prejudice, fear, anxiety, lack of confidence, reluctance to learn, and learned helplessness. A review of the literature reveals that other students also exhibit high levels of anxiety towards mathematics in general (Süren, 2019). This study found that third-grade students perceived multiplication as both difficult and necessary. Similarly, Kubanç (2012) observed that third-grade students experienced significant difficulties with multiplication.

Interviews with teachers revealed that students encountered difficulties with carry-over, shifting digits, concluding multiplication processes and problem-solving when using traditional methods. Cox (1975) supports this finding by noting that students frequently make errors in multiplication. Additionally, other studies have identified similar issues with carry-over, shifting digits, incomplete multiplication processes, and problem-solving (Attisha Yazdani, 1984; Damayanti et al., 2021; Doğan, 2022; Gürsel, 2000; İspir & Gürsel, 2018; Kilian et al., 1980; Ma et al., 2015; Soylu Makas, 2017; Taraghi et al., 2015; Üçüncü, 2010; Yorulmaz & Önal, 2017).

One of the identified reasons for these errors was a lack of prerequisite knowledge. Doğan (2022) notes that insufficient understanding of the information required for multiplication impedes grasping the logic of multiplication. Additionally, a failure to understand the concept of grouping and the logic of multiplication was also identified as a cause of errors. This lack of understanding suggests that students struggled with the conceptualization of multiplication. Similarly, Özdemir Baki (2023) found that second-grade students had difficulty understanding the concepts related to multiplication. Furthermore, Doruk and Doruk (2019) highlighted that students held conceptions of multiplication that were inconsistent with its conceptual understanding, Masroni and Nusantara (2016) noted that students did not grasp the rules of multiplication, and Soylu and Soylu (2006) found that students did not fully develop the concepts related to multiplication.

The study also revealed that the inability to perform rhythmic counting was a significant factor contributing to errors in multiplication using traditional methods. Yorulmaz and Önal (2017) supported this finding by demonstrating that rhythmic counting skills affect multiplication learning. The findings indicate that not knowing the multiplication table also triggers errors in multiplication. Ma et al. (2020) and Üçüncü (2010) reinforced this by noting that a lack of knowledge of the multiplication table hinders the teaching of multiplication.

According to the findings of this study, the classroom teacher reported that students began the multiplication process with traditional methods exhibiting affective characteristics such as prejudice, fear, anxiety, lack of confidence, learned helplessness, and low motivation. However, after instruction with JAMED, these negative emotions were replaced by perseverance, enjoyment, and enthusiasm. Similarly, Alptekin (2019) implemented the Discover-Copy-Compare (DCC) technique to teach multiplication to students with low math achievement and found that the students did not struggle with multiplication, were happy, and enjoyed the multiplication process. This study, like the current one, demonstrates that teaching multiplication using different methods can foster positive feelings towards the subject.

The results of the current study indicate that the JAMED method helped students experience a sense of achievement in multiplication and thus enhance their self-confidence. Bakan (2017) showed that the use of the dot-marking technique in teaching multiplication also improved students' multiplication success and self-confidence. The success and confidence outcomes associated with the dot-marking technique, which is based on counting dots like JAMED, suggest that students can develop their multiplication skills through visual methods. Results similar to JAMED’s reduction of anxiety and fear and enhancement of self-confidence were also found in Karbeyaz’s (2018) study using multiple intelligence-based activities. This similarity may be related to JAMED incorporating multiple intelligence-based activities, at least visual and logical ones.

The action process conducted in this study showed that JAMED increased students' affection and interest in multiplication. Similarly, Abari and Tyovenda (2022) and Suherdi and Mujib (2020) found that teaching multiplication with the JAMED method increased students’ interest in math and made them happy while solving problems. These findings suggest that the reluctance and avoidance of solving problems observed in other studies (Ekici & Demir, 2018) may change with the JAMED method.

The results of the study indicate that JAMED is well-suited for student development, allowing students to guide others through the multiplication process and verbally convey how they solve multiplication problems. Cevizci (2018) used the Russian peasant multiplication method with unit cubes and found improvements in students’ conceptual and procedural knowledge of multiplication. This result aligns with JAMED, as the study found that students understood the abstract concept of multiplication by making it concrete with lines. Thus, third-grade students, who are likely in the concrete operational stage, learned multiplication and were able to articulate how they solved the problems through JAMED.

The findings of this study demonstrate that JAMED helps students not only learn to solve multiplication problems involving place value and carry-over but also transfer multiplication skills to different contexts and advancing topics independently. Additionally, integrating the JAMED method with traditional multiplication methods has prevented students from repeating previous errors, such as carry-over, shifting digits, and incomplete multiplication processes. As a result, students have been able to perform multiplication using both JAMED and traditional methods.

Assessment activities examined using rubric scales over six weeks showed that students could effectively apply almost all steps of JAMED for multiplying two single-digit numbers, a two-digit number by a single-digit number, two two-digit numbers, and a three-digit number by a single-digit number. This finding suggests that JAMED could be a suitable tool for teaching multiplication. A review of the literature also reveals other studies where this method has improved students' multiplication skills (Fuadah et al., 2019; Grain & Kumar, 2018; Nuranifah & Fuadah, 2022).

The findings obtained from the rubric scales aligned with the results of the pre- and post-tests. There were big differences between the pre-test and post-test scores, with the latter showing higher scores. These quantitative findings, consistent with other qualitative results, demonstrate that the JAMED method enhances students' academic success in multiplication. Similarly, Sidekli et al. (2013) found that a simplified multiplication method, partially resembling JAMED, improved students' multiplication success scores. The fundamental reasons for the success of methods like JAMED are believed to be their facilitation of understanding mathematical concepts and their positive impact on computational skills. Indeed, studies by Fuadah et al. (2019) and Hidayah (2016) have shown that the JAMED method positively affects the understanding of mathematical concepts, while Mustafa et al. (2021) found that it positively impacts computational skills.

This study found that, similar to Altıntaş and Sidekli’s (2017) findings on Napier's bones, JAMED enhances academic success in multiplication. Both JAMED and Napier's bones are used to visualize multiplication, highlighting the importance of visualization methods and materials in teaching multiplication. Therefore, when considered together, these studies underscore the value of visual methods and materials, like JAMED, in teaching multiplication.

However, the results of this study also reveal one of JAMED's primary disadvantages: overshadowing other subjects. The students involved in the study showed a strong preference for JAMED, which led them to focus all their attention on learning multiplication with this method, thereby reducing their performance and interest in other subjects. Another disadvantage is the possibility that students may feel lost at the end of the process due to the absence of the JAMED method in the curriculum applied in Turkey. This issue was addressed by blending JAMED with traditional methods in the sixth-week action plan. Nevertheless, Rianti (2017) highlighted that JAMED may not be suitable for every topic and that children who do not have adequate counting skills might struggle with this method, pointing out other disadvantages of JAMED.

Time constraints are another limitation of JAMED. Findings from interviews and observations indicate that JAMED is time-consuming and can lead to inefficiencies. Supporting these findings, Grain and Kumar (2018) and Rianti (2017) have also noted that the JAMED method takes considerable time. Thus, the feasibility of using JAMED may be reduced in situations where teachers and students have limited time.

Throughout the research process, students experienced various difficulties with both traditional and JAMED methods. The difficulties identified included marking intersection points, counting dots, grouping, carrying over, drawing diagonal lines, shifting digits, and transferring the results obtained with JAMED to the traditional method. The reasons for these difficulties were examined and addressed. Issues with marking intersection points, counting dots, and grouping were attributed to crooked or overly close diagonal lines and students' haste. Difficulties with carrying over were found to stem from a lack of knowledge of addition. Problems with diagonal lines arose from aesthetic concerns. The difficulties with place value shifting and communicating the results of JAMED in the sixth-week action plan were due to confusion caused by blending traditional and JAMED methods.

During this research, various strategies were attempted to address the challenges students faced. For difficulties with marking intersections, counting dots, and grouping, students were initially given grid paper to help them practice, eventually transitioning to unlined paper as they became more comfortable. Additionally, students were encouraged not to rush, which gradually resolved this issue. To tackle the problem of students' lack of understanding of addition, which led to errors in carrying over, a week of remedial lessons on addition was provided to the affected student. However, this was insufficient, so it was suggested that students draw a number of dots on the next higher place value corresponding to the carry-over. This approach successfully resolved the issue and also helped the student improve their addition skills over time. Colored pencils were used to address the grouping issues, and this approach proved to be successful. The difficulty stemming from students' aesthetic concerns when drawing diagonal lines was addressed through practice, and over time, this issue was also resolved. During the implementation of the sixth action plan, the difficulties related to shifting digits and transferring the results obtained with JAMED to the traditional method were overcome through extensive practice. By the end of the process, students were able to correctly solve multiplication problems using the JAMED method along with traditional methods.

In conclusion, the JAMED method has been shown to have a positive impact on developing multiplication skills. This research demonstrates that even when the JAMED method cannot be fully utilized or is not desired, multiplication can still be taught to students by partially incorporating this method. Additionally, the successful implementation of this research process with students who have reading and writing difficulties highlights another aspect of the JAMED method's effectiveness.

Based on the results of this study, the following recommendations are made:

- The JAMED method could be included in the Mathematics Curriculum.
- When teaching multiplication with the JAMED method, it is advisable to start with grid paper in the first week.
- Colored pencils should be used for place value grouping during the JAMED multiplication process.
- Prior to teaching multiplication with the JAMED method, students should be equipped with prerequisite skills, such as addition, that are necessary for multiplication.
- It should be emphasized to students that they should not rush when solving multiplication problems using the JAMED method.
- To reduce students' aesthetic concerns, more practice with drawing diagonal lines should be encouraged.
- The combination of traditional methods and the JAMED method can be used to teach multiplication skills.

- Students should be given adequate time when solving multiplication problems using a combination of traditional and JAMED methods.
- Continuous practice should be provided to students to speed up their problem-solving skills when using both traditional and JAMED methods.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

Authors declare no conflict of interest.

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CRediT author statement

The thesis from which this study was derived was written by the second author under the supervision of the first author. The process of preparing the manuscript from the thesis was carried out under the responsibility of the second author (corresponding author).

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission (Date: 14.11.2022, Number: 392051) was obtained from Dicle University Social and Human Sciences Research Ethics Committee. The study has been performed in accordance with the ethical standards.

Japon Çarpma Yöntemi ile Çarpma İşlemi Öğretimi: Bir Eylem Araştırması

Özet:

Japon çarpma (JAMED) yöntemi, soldan çapraz çizgilerin üzerine sağdan çapraz çizgiler çizildikten sonra bu çizgilerin kesiştiği yerlere konulan noktaların sayılıp çarpım sonucuna yazılması olarak tanımlamaktadır. Bu araştırmada, ilkokul 3. sınıfta çarpma işlemini klasik yöntemle öğrenememiş çocuklara Japon çarpma yöntemi ile çarpma işleminin öğretilmesi ve bu sürecin değerlendirilmesi amaçlanmıştır. Bu araştırmada eylem araştırması türlerinden teknik/bilimsel/işbirlikçi model kullanılmıştır. Araştırma Diyarbakır ili Hani ilçesinde bulunan bir ilkokulda 3. sınıf düzeyinde öğrenim gören ve geleneksel yöntem ile çarpma işlemini öğrenememiş dört öğrenci ile yürütülmüştür. Bu araştırmanın verileri, araştırmacı tarafından geliştirilen 3. sınıf Çarpma İşlemi Başarı Testi, Uygulama Öncesi ve Sonrası Öğretmen Görüşme Formu, Uygulama Sonrası Öğrenci Görüşme Formu, Araştırmacı Günlüğü, Öğretim Sürecinde Alınan Ses Kayıtları, Ders Sonu Değerlendirme Etkinlik Kâğıdı ve bu etkinlik kâğıtlarına ilişkin Dereceli Puanlama Anahtarları aracılığıyla toplanmıştır. Araştırmadan elde edilen nitel verilerin analizinde içerik analizi ve betimsel analiz kullanılmıştır. Sonuç olarak JAMED yönteminin çarpma işlemi becerisini geliştirme ve çarpma işlemine yönelik negatif duyuşsal özelliklerin olumlu duyuşsal özelliklere dönüşmesi konusunda olumlu bir etkisinin olduğu görülmüştür. Buna rağmen öğrencilerin JAMED ile çarpma işlemi yaparken kesişim noktalarını işaretleme, nokta sayımı, gruplandırma, elde ekleme, çapraz çizgi, basamak kaydırma ve JAMED'le elde ettiği sonucu geleneksel yönteme aktarma gibi konularda zorluk yaşadığı görülmüştür. JAMED'in bir yöntem olarak diğer dersleri gölgeleme gibi bir dezavantajı ile birlikte zaman açısından da bir sınırlılığı olabileceği anlaşılmıştır.

Anahtar kelimeler: Çarpma işlemi, JAMED, Japon çarpma yöntemi, dört işlem, çapraz çizgi yöntemi.

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