

DEVELOPMENT OF MONTESSORI BASED-MULTIPLICATION PROPS FOR ELEMENTARY SCHOOL

PENGEMBANGAN ALAT PERAGA PERKALIAN BERBASIS MONTESSORI UNTUK MI/SD

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Abstract

This study aims to describe the procedure of developing multiplication teaching props based on the Montessori method and to analyze students' responses to the Montessori multiplication props. research and development method through the ADDIE model was used in this research. The subjects of this study were 28 second-grade students at MIN 1 Malang City. Data collection was employed through questionnaires, interviews, observations, and documentation. Data analysis techniques encompassed both quantitative and qualitative data analysis. This research resulted in Montessori-based multiplication teaching props. The validation result of media products met very valid criteria, with scores of 80 from the material validator, 94 from the media design validator, and 86 from the expert validator. This media is equipped with components that are easy to understand and easy to use, as students scored 81% with positive criteria. Therefore, it can be concluded that students responded positively to the Montessori-based multiplication teaching props as a tool for mathematics learning.

Keywords: *Multiplication Teaching Props, Montessori Method, ADDIE Model*

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan prosedur pengembangan alat peraga perkalian berdasarkan metode Montessori dan menganalisis respon siswa terhadap alat peraga perkalian Montessori. Metode Penelitian dan Pengembangan melalui model ADDIE digunakan dalam penelitian ini. Subjek penelitian ini adalah siswa kelas II MIN 1 Kota Malang yang berjumlah 28 orang. Pengumpulan data dilakukan melalui angket, wawancara, observasi, dan dokumentasi. Teknik analisis data meliputi analisis data kuantitatif dan kualitatif. Penelitian ini menghasilkan alat peraga perkalian berbasis Montessori. Hasil validasi produk media berada pada kriteria sangat valid dengan skor 80 dari validator materi, 94 dari validator desain media, dan 86 dari validator ahli. Media ini dilengkapi komponen-komponen yang mudah dipahami dan mudah digunakan karena siswa memberikan nilai 81% dengan kriteria positif. Oleh karena itu, dapat disimpulkan bahwa siswa memberikan respon positif terhadap alat peraga pengajaran perkalian berbasis Montessori sebagai alat bantu pembelajaran matematika.

Kata Kunci: *Alat Peraga Perkalian, Metode Montessori, Model ADDIE*

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1. Introduction

Mathematics is a universal discipline (Green & Lambert, 2018) that plays a crucial role in various fields of science, contributing to the development of human

thinking and serving as the foundation for advanced technological progress (Manshuri, 2019). During mathematics learning activities, teachers need to implement teaching strategies that can accommodate and serve all students' characteristics, allowing the teacher to develop each student's potential optimally in the learning process (Khairi, Samsukdin, & Hairah, 2023). Thus, the objectives of mathematics learning can be achieved effectively and efficiently (Faizah & Ridwan, 2022).

Mathematics became one of the important subjects taught in schools (Brahier, 2020; Heuvel-Panhuizen, 2020). It is based on Law No. 20 article 37 of 2003 on the National Education System (Ulum, 2020), which establishes mathematics as one of the subjects required in the primary and secondary education curriculum. The process of mathematical learning consists of three components: product, process, and attitude (Sisman, Kucuk, & Yaman, 2021). The concepts and principles found in mathematical topics belong to the product aspect. The method or procedure by which knowledge is acquired is an example of an aspect of the process. Meanwhile, aspect attitude is the collection of views, opinions, and values that should be maintained by the individual studying (Afsari, Safitri, Harahap, & Munthe, 2021).

Mathematics seems to be a frightening course for every student (Boaler, 2016). They consider mathematics the most difficult subject in school (Fokides, 2018). Many students have difficulty learning mathematics (Mazana, Montero, & Casmir, 2018). A statement was conveyed by one of the teachers at MIN 1 Malang City that in the process of learning mathematics, especially with multiplication material, the students in his class had difficulty understanding the material. Besides that, the limitations of learning media become a factor in their difficulty in understanding multiplication material. In learning, teachers still use textbooks and modules only. The teacher still uses the lecture method to explain multiplication material.

In addition to the problems faced by mathematics teachers at MIN 1 Malang City, other problems occur in mathematics learning. Firstly, because of the amount of material that must be taught, teachers have difficulty developing the material in the book. Secondly, teachers still use a conventional approach to the learning process. Thirdly, students are less interested in mathematics. Fourthly, there are misconceptions students have about mathematics. Fifthly, the inability of students to learn independently. The last is because the atmosphere of learning mathematics is less conducive (Maryanto, Rachmawati, Muhammad, & Sugianto, 2023; Nisa, Amir, & Vebrianto, 2021). As a solution to the problem, teachers can use props in the teaching process.

Mathematical props can be interpreted as a set of concrete objects that are designed, created, and used to help understand mathematical concepts (Lestari, 2020). Teaching aids are very important to use in the learning process (Puspitarini & Hanif, 2019). Mathematic props are used to explain the concept of learning mathematics in the form of real objects (Heuvel-Panhuizen, 2020), and teachers can teach concepts more easily so students can understand the material to be taught (Noreen & Rana, 2019). Understanding mathematic concepts is certainly important in achieving good learning outcomes. Several important things that must be considered when making math props are durability (made of strong enough material), the shape and color are interesting, uncomplicated management, size appropriate to the child's physique, can present a real picture of the mathematical concepts studied, correspondent with mathematical concepts, can demonstrate mathematical concepts clearly when the teacher wants the

students more active, the props can be touched, held, moved, and tweaked or paired removable and others (Annisah, 2017).

The use of props is very helpful for teachers in the process of teaching mathematics (Abbas & Zakaria, 2018). One of them is Montessori-based multiplication props. Montessori is named after the great Italian educator Maria Montessori (Bhat, 2021). According to Susiaty, Firdaus, & Andriati (2021), the Montessori method is a fundamental concept of science, observation of children, and pedagogy. This method emphasizes learning that promotes flexibility in choosing activities and play so that children grow and develop at their own pace and become more creative and independent. The Montessori method teaches that students should be smart not only in terms of cognitive but also in other skills (Wulandari, Saefuddin, & Muzakki, 2018). Based on previous research, these props have been proven to improve students' learning outcomes by 8.34% from cycle 1 and by 50% from the pre-cycle stage (Khoirunisa, 2018). From the results of the research and the issues identified by the researcher in the field, there is a correlation indicating that Montessori teaching aids can enhance students' learning outcomes in multiplication. Therefore, Montessori teaching props can be considered as a solution to the issue identified by the researcher in the field, which is the low learning outcomes in multiplication for students.

Montessori-based multiplication props are wooden boxes with 10 horizontal holes and 10 descending holes with numbers 1 to 10 in each row, for a total of 100 holes that will be filled with beads later. The shape of this medium is similar to a multiplication table, with the result being a number that will be depicted using beads of different colors, so students will be interested in trying it (Wahyudi & Choirudin, 2020). Previous studies have proven that students' ability to understand the material using Montessori-based multiplication board props has changed. Montessori-based multiplication boards can help students understand multiplication concepts as well as calculate multiplication results. Besides that, the application of this media in mathematics learning can also improve students' numeracy skills, which affects their learning outcomes (Ridwan, 2021; Wulandari & Prasetyaningrum, 2018).

In accordance with the issues outlined, Montessori-based multiplication teaching props can be used to support classroom learning in multiplication. Therefore, the researchers were motivated to develop teaching props based on the Montessori method for mathematics on multiplication material for second-grade students in MIN 1 Malang City.

2. Research Method

This study used research and development with the ADDIE model. There are 5 steps in the ADDIE model, namely analysis, design, development, implementation, and evaluation. This research was conducted at MIN 1 Malang City in the odd semester of the 2023/2024 academic year. The subjects were 28 second-grade students. Researchers collected data by observing madrasahs to observe the conditions in the field directly. In addition, researchers also conducted interviews with the headmaster and class guardians, documenting them through photos and notes. Researchers also distributed student response questionnaires to understand how students responded to multiplication teaching props based on the Montessori method. Data were analyzed in quantitative and qualitative formats. Qualitative data analysis techniques using model Miles and Huberman. When using the Miles and Huberman model, researchers analyze qualitative data by collection, reduction, presentation, and conclusion (Mahmudah, 2021). At the

same time, the quantitative data was analyzed in the form of product validity results through expert validation and student response questionnaires.

3. Results and Discussion

3.1 Result

The following describes the procedure of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) that had been done to develop props multiplication based on the Montessori method.

3.1.1 Analysis

In the analysis phase, the researchers identify the problems and needs of students. The researcher interviewed the second-grade teacher at MIN 1 Malang City as a way for researchers to collect data. The results of the interview showed that the learning of mathematics in second grade on multiplication material experienced problems; namely, students have less understanding of multiplication material. One of the causes of this problem is that the teacher was still using the learning module. After knowing the problem, the researchers then set a solution in the form of learning media development. Learning media was developed in the form of Montessori-based multiplication board media that can be used for mathematics learning.

3.1.2 Design

The researcher designed the product, starting from the material, color, size, shape, layout, and other supporting components at this stage. In addition, the researchers also designed expert validation and student response instruments.

3.1.3 Development

The finished product design was then developed into a complete product. Here are the results of product development.

3.1.3.1 Multiplication Board

The multiplication board is made of plywood. The size is 40 x 40 cm when opened and 40 x 20 cm when closed. The board is then drilled to a depth of 1 cm. A total of 100 holes were created, arranged in 10 columns and 10 rows.



Figure 1. Multiplication Board

3.1.3.2 Beads

Red beads are placed in a box for storage consisting of 150 pieces. These beads are used to calculate multiplication results by placing them into the holes on the board.



Figure 2. Beads

3.1.3.3 Marker Pawns

Marker pawns are created with two characters representing male and female students in the madrasah. The female student, wearing a hijab, is depicted as carrying beads, while the male student is depicted as carrying the multiplication symbol. The marker pawns are printed on acrylic with dimensions of 9 x 5 cm and a thickness of 5 mm.



Figure 3. Marker Pawns

3.1.3.4 Question Cards and Answer Cards

The researcher developed 25 questions and their corresponding answers, which were created separately. The questions and answers, once created, were assembled into a box for question cards and a separate box for answer cards. This separation was intentionally done to prevent any cheating during the completion of the questions.



Figure 4. Question and Answer Cards

3.1.3.5 Guidebook

The guidebook is printed on art paper. It contains various information about the multiplication teaching pops based on the Montessori method, including explanations about the teaching pops, its components, usage instructions, and the developers' profile.



Figure 5. Guidebook

At this stage, the researchers also performed validation on media design, material, and learning experts. The following are the results of the test data.

Table 1. Material Validation Results

No	Aspect Assessed	Score	Score Max	Score Value	Validity Level
1	Conformity of the material to the curriculum.	4	5	80	Valid
2	Conformity of the material to the theme and KD (basic competence).	4	5	80	Valid

No	Aspect Assessed	Score	Score Max	Score Value	Validity Level
3	Learning media developed to facilitate the achievement of learning objectives.	4	5	80	Valid
4	The material presented is in accordance with the ability level of students.	4	5	80	Valid
5	Teachers and students easily understand media.	4	5	80	Valid
6	The material presented is simple and clear.	4	5	80	Valid
7	Media according to students' needs.	4	5	80	Valid
8	Illustrations in appropriate media to explain the teaching material.	4	5	80	Valid
9	Suitability of media components to explain teaching material.	4	5	80	Valid
10	Students are helped to understand the multiplication material by using the learning media developed.	4	5	80	Valid
Total		40	50	800	
Final Grade (P)				80	Valid

Based on the recapitulation of the validator response questionnaire, which was filled out using validator material, the results were 80 with valid criteria. This finding meant that Montessori-based multiplication props were not revised too much.

Table 2. Media Design Validator Results

No	Aspect Assessed	Score	Score Max	Score Value	Validity Level
1	The accuracy of the layout of media components.	5	5	100	Very Valid
2	The accuracy of media size selection.	5	5	100	Very Valid
3	The suitability of color selection with students' characteristics.	5	5	100	Very Valid
4	The suitability of media development design with students' characteristics.	4	5	80	Valid
5	Teachers and students easily understand media.	4	5	80	Valid
6	The media developed is a new innovation for mathematics learning media in multiplication	5	5	100	Very Valid

No	Aspect Assessed	Score	Score Max	Score Value	Validity Level
	material.				
7	The media is safe and harmless for students.	4	5	80	Valid
8	The media is easy for students to use in learning.	5	5	100	Very Valid
9	The suitability of the selection of the background with the material and characteristics of students.	5	5	100	Very Valid
10	Illustration selection accuracy.	5	5	100	Very Valid
Total		47	50	940	
Final Grade (P)				94	Very Valid

Based on the results of the validator response questionnaire, which was filled out by validator design, the results were 94 with very valid criteria. This finding meant that Montessori-based multiplication props were not revised too much.

Table 3. Expert Validator of Learning

No	Aspect Assessed	Score	Score Max	Score Value	Validity Level
1	Learning media developed in accordance with the learning objectives.	4	5	80	Valid
2	Learning media and instructions for use are easy to understand.	4	5	80	Valid
3	Learning media can increase students' motivation.	4	5	80	Valid
4	Learning media can help students calculate multiplication.	5	5	100	Very Valid
5	Learning media in accordance with students' characteristics.	4	5	80	Valid
6	Learning media is in accordance with the needs of teaching material in multiplication.	4	5	80	Valid
7	User guide easy to understand by students.	5	5	100	Very Valid
8	Learning media can attract students' attention.	5	5	100	Very Valid
9	Learning media can be used in individuals and groups.	3	5	60	Quite Valid
10	Learning media can add variety to teachers' teaching of multiplication.	5	5	100	Very Valid
Total		43	50	860	
Final Grade (P)				86	Very Valid

Based on the recapitulation of the validator response questionnaire, which was filled out by validator learning, the results were 86 with very valid criteria. This finding meant that Montessori-based multiplication props were valid to use in the teaching process.

3.1.4 Implementation

The researcher then introduced the Montessori multiplication board props to students. They used Montessori multiplication board props in groups. When the students used it, they were enthusiastic about using the media. Students felt happy because they could play while learning mathematics at the same time.

During the implementation process, students were required to work on 25 question cards and write them on the answer sheets that have been provided. After completion, they were asked to match the answers on existing answer cards, whether their answers were correct or incorrect.



Figure 6. Pupils Answer the Questions

In the implementation phase, students were also asked to fill out a questionnaire. It aimed to determine students' responses to the media. Students were asked to give a score of 1 to 4 for 10 statements about the Montessori-based multiplication board props that had been developed. The following table shows the results of the students' response questionnaire.

Table 4. Students' Responses

No	Rated Aspect	Σ Score	Score Max	Percentage	Criteria
1	Montessori multiplication props are easy to use in learning.	52	60	86%	Very Positive
2	Montessori multiplication props help in calculating multiplication.	54	60	90%	Very Positive
3	Montessori multiplication teaching props encourage students to learn mathematics.	52	60	82%	Positive

No	Rated Aspect	Σ Score	Score Max	Percentage	Criteria
4	The display of Montessori multiplication props attracts learning interest.	48	60	80%	Positive
5	Montessori multiplication props are easy to understand.	47	60	78%	Positive
6	Instruction for Montessori multiplication props is clear, making it easier for students to use.	48	60	80%	Positive
7	The selection of colors and components in Montessori multiplication props is interesting.	46	60	76%	Positive
8	Montessori multiplication practices motivate students to understand multiplication.	48	60	80%	Positive
9	Montessori multiplication props help students calculate multiplication results correctly.	47	60	78%	Positive
10	Montessori multiplication props make students feel happy when learning math.	46	60	76%	Positive
Total		488	600	81%	
Final Grade (P)				81%	Positive

3.1.5 Evaluation

In the evaluation phase, the researchers evaluated the media that had been developed. They paid attention to the suggestions and criticisms from the validators and students that had been obtained from the previous phase. The suggestion from the validators about this media was that the language in the guidebook was still too complex for second-grade students. In addition, there was no identity in the developed media. Therefore, the researcher revised the media by simplifying the language of the guidebook and adding an identity or writer profile to the media cover.

Apart from the validators, evaluation was also obtained from students when implementing media. When having problems with the multiplication of large numbers, students were too lazy to put beads. This problem is known from students' response questionnaire distributed. In the opinion column, one of the students wrote that he was happy to use this medium but was lazy to put beads when getting problems with numbers and lots of results.

After developing the teaching props and validating them with validators, before conducting trials on students, the researchers conducted a pre-test to find out their initial understanding of multiplication material. Then, a product trial was carried out to measure students' understanding using Montessori method-based multiplication teaching props. Students were given post-test questions. The following figure is the result of using multiplication props based on the Montessori method.

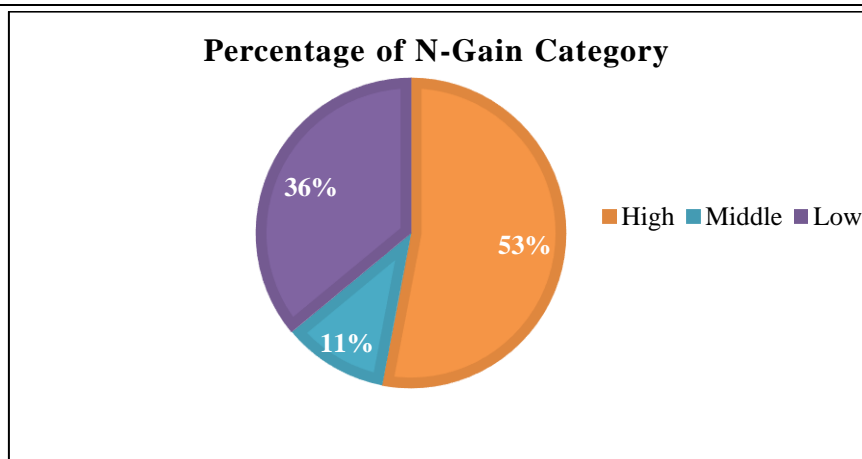


Figure 7. Percentage of N-Gain Category

Based on pre-test results, the average score is 87.14, and 3 students had not yet completed the minimum completeness criteria called KKM. The post-test results in the trial obtained an average score of 95.87, and the scores of all students had completed the KKM. N-gain trial results showed 36% in the low category, 11% in the medium category, and 53% in the high category. The average N-gain test result was 0.61 in the medium category. This result revealed that multiplication teaching props based on the Montessori method could improve student learning outcomes in mathematics subjects in multiplication material by 0.61 in the medium category.

3.1 Discussion

3.2.1 Product Development

The products produced in this study were developed with the ADDIE model. There are five stages in the ADDIE model, namely analysis, design, development, implementation, and evaluation. This statement corresponds to what Faizah, Ulfa, & Faizah (2023) stated that the five stages in the ADDIE model are analysis, design, development, implementation, and evaluation. This research and development was carried out at MIN 1 Malang City in the even semester of the 2022/2023 academic year. This research results in a product of Montessori multiplication props used as a teaching aid in mathematics for second-grade students in MIN 1 Malang City. Montessori multiplication teaching aids were conventional media consisting of several components, namely multiplication boards, beads, marker pawns, question cards, answer cards, and user manuals. This media was developed to help the learning process of mathematics, especially in multiplication material.

Montessori multiplication props are equipped with answer sheets for students to write down their answer when the media is used. There are also two characters as illustrations that represent students of madrasah ibtidaiyah. Montessori multiplication props is packed in a box with 45 x 45 x 8 cm so that all components can be entered and practical to carry out. Second-grade students at MIN 1 Malang City love to play and are very active. Therefore, the design in this medium is adapted to the characteristics and conditions of the students, referring to Vygostky's in a book written by Moll in 1994, that meaningful learning can be created from designed and developed learning that refers to the condition of the student as a subject of learning (Rahmawati & Purwaningrum, 2022). There are five stages in the procedure of making Montessori based-multiplication props products in accordance with the ADDIE model stages.

3.2.2 Pupils Response to Montessori Multiplication Trainer

To find out how the students' response to the Montessori based-multiplication props, researchers distributed a questionnaire assessment of the media to the second grade students at MIN 1 Malang City as the subject of this research. Overall, Montessori multiplication props gained 81% response with positive criteria. This result meant that positive responses were given by students when using Montessori multiplication props in learning. This finding aligned to the previous research that had been conducted, indicating that the application of this media in mathematics learning could also improve students' numeracy skills so that it also affected their learning outcomes (Ridwan, 2021; Wulandari & Prasetyaningrum, 2018). Based on Montessori theory, this props make students learning by doing and more creative and independent (Ridwan, 2021; Sari & Montessori, 2021; Sitingjak, Anzelina, Mahulae, & Silaban, 2021). Therefore, this props also supports students' cognitive and skills.

4. Conclusion

The conclusions of this study showed that the development of multiplication teaching props based on Montessori method for the second-grade students in MIN 1 Malang City followed ADDIE model. The validation result of media products was in the very valid criteria with scores 80 from material validator, 94 from media design validator, and 86 from expert validator. This media is equipped components that are easy to understand and easy to use as students scored 81% with positive criteria. This results indicated that Montessori multiplication props get a positive response from students when it is used in learning multiplication.

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