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Implementation of Multiplication Ring Media for Deaf Students in Mathematics Learning in Special Elementary Schools

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Abstract: The purpose of this study was to test the effectiveness of using multiplication ring media in improving multiplication learning outcomes in deaf students. This type of research uses pre-experimental research with a one group pre-test post-test design in the study conducting treatment using this multiplication ring media twice. The Research result is data was processed using the SPSS version 24 program to produce the results of the hypothesis test to calculate the pre-test and post-test scores related to mathematics learning outcomes with single-digit multiplication and negative ranking. 15.00, the statistical test using Asymp produced Z count = -2.023. Sig. (both sides) = 0.043 less than 0.05. The Asymp.Sig (two-tailed) Z-score value calculated from the Wilcoxon Signed Rank Test is below the 5% significance level (α = 0.05) and the average result of 46 pre-tests and 91 post-tests Ho is rejected and Ha is accepted. Therefore, it can be concluded that the use of this multiplication ring media is effective in improving the mathematical abilities of single-digit multiplication material for deaf children with special needs in elementary schools Based on the analysis and discussion we can conclude that there is a significant difference in students' single-digit multiplication skills before and after the multiplication ring treatment. This is evident from the pre-test results, which showed that some students still scored below average. The multiplication ring treatment is a method used to help students improve their scores by assisting them with single-digit multiplication problems. This allows students to work more easily.

Keywords: Deaf; Mathematics; Single digit multiplication.

INTRODUCTION

Children with hearing impairment are children who experience hearing impairment, which causes them to have difficulty processing verbal information through hearing, with or without hearing aids (Hernawati, 2007). Children with hearing impairment are also children who suffer from partial or complete hearing loss or hearing impairment that prevents them from using hearing aids in their daily lives and can have complex effects on their lives. Therefore, children with hearing impairment require special care and education (Resti, 2012). Therefore, through the explanation above, it can be concluded that children with hearing impairment are children who have lost some or all of their hearing, which makes them experience obstacles in many things such as processing information and can affect the child's daily life. According to the introductory book on psych pedagogy for children with special needs, it is revealed that due to this hearing impairment, affected people experience various deficits in development, especially those related to language, intelligence, and social adjustment.

Based on the explanation above, it can be concluded that deaf children, in addition to impacting their daily lives, also experience difficulties in learning at school. This is because children experience learning difficulties (Efendi, 2017), who stated that deaf children often experience learning delays and sometimes appear to be retarded. Mathematics is a particularly challenging area of learning for deaf children (Thai & Yasin, 2018). Common problems encountered by deaf children include difficulties with multiplication, division, algebra, and other calculations.

This situation aligns with the facts in the field and the results of a research study conducted by researchers at a special elementary school, which found that many deaf students experience difficulties in mathematics (Yasin, et.al, 2017). Therefore, in most cases, deaf children also experience difficulties in certain subjects, one of which is mathematics. Mathematics is one of the main subjects taught in elementary schools. Mathematics, which is essentially a deductive, formal, and abstract thinking, must be taught to elementary school children whose thinking is still in the concrete operational stage (Hudojo, 2005). (Subarinah, 2006) states that multiplication is defined as repeated addition, so to understand the concept of multiplication you must be proficient and first understand the concept of addition.

Characteristics of students experiencing difficulties learning mathematics include; (1) Difficulty distinguishing numbers, symbols, and shapes (2) Difficulty remembering mathematical sentences (3) Illegible or small-sized numbers (4) Difficulty understanding mathematical symbols (5) Weak abstract reasoning skills (6) Weak metacognitive skills (weak ability to identify and use algorithms to solve mathematical problems) (Yeni, 2015). The above statements align with the facts in the field. The results of a preliminary study conducted by researchers indicate that in most cases, many deaf children still do not understand mathematics, particularly multiplication. Approximately 80% of students still cannot count or solve multiplication problems. With this background, researchers want to examine how the application of multiplication ring learning media can improve multiplication learning outcomes in deaf students with special needs in elementary schools.

The use of multiplication rings in mathematics instruction for deaf students in Special Elementary Schools (SDLB) is an innovation that more comprehensively accommodates the learning needs of students with special needs. This media is designed to help students understand the abstract concept of multiplication through visual displays and concrete manipulative experiences. From a Universal Design for Learning (UDL) approach, this media meets the main principles of UDL, namely providing diverse ways of presenting material, expressing understanding, and increasing student engagement. CAST (2018) explains that UDL is "a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn" (p. 3). In this context, multiplication rings provide rich visual representations—numbers, colors, and symbols—that are particularly beneficial for deaf students who rely on visual perception for their learning.

In terms of expression and action, this media allows students to rotate, point, and match numbers on the rings directly. This activity not only involves motor skills but also encourages students to actively demonstrate their understanding of multiplication operations without having to use verbal communication. This aligns with the UDL principle of "multiple means of action and expression" (CAST, 2018), which provides students with various ways to demonstrate their knowledge. In terms of engagement, the multiplication rings create a fun and interactive learning environment. Their toy-like design further motivates students to engage in learning activities. This aligns with the principle of "multiple means of engagement" in UDL, which aims to stimulate students' interest and motivation to learn sustainably (CAST, 2018).

In relation to Vygotsky's theory of cognitive development, the use of this medium strongly supports the concept of the Zone of Proximal Development (ZPD). Vygotsky (1978) defined the ZPD as "the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (p. 86). This media acts as a scaffolding that allows students to work on math problems with support

from teachers or peers. Social interaction is also a crucial element of learning according to Vygotsky. Although deaf students have limitations in verbal communication, they can still interact effectively through sign language, gestures, or facial expressions when using this media in groups or pairs. Vygotsky emphasized that learning occurs through social interaction and that language—both verbal and nonverbal—is a primary tool in transferring knowledge (Daniels, 2001). Thus, the implementation of multiplication rings media not only supports the understanding of mathematical concepts but also creates an inclusive, adaptive, and collaborative learning environment. This approach reflects the values of UDL and Vygotsky's theory of creating learning that supports the needs and potential of each student.

The researcher's background in creating this multiplication ring media stems from her experience teaching mathematics at a special needs elementary school, specifically multiplication. Based on this background, the ring media is designed using the same shape as an abacus but with a slightly different function. It could be said that this multiplication ring media is a modification of the abacus used for single-digit multiplication. Therefore, it is hoped that this media will be more efficient in facilitating children with hearing impairments in solving multiplication problems. This research aligns with previous research (Chasanah & Pradipta, 2019), which found that the use of a geometric abacus media for improving the addition of numbers 1-10 in fourth-grade students with intellectual disabilities significantly improves the children's numeracy skills. This finding also aligns with previous research (Ansori, 2015), which found that the use of an abacus media in learning mathematical operations significantly improves students' grades.

METHOD

This research was quantitative. The method employed in this study was pre-experimental. The experimental research used in this study was pre-experimental research. The research design used in this study was a one-group pre-test-post-test design, which involved administering a pre-test before and after treatment, followed by a single post-test.

This research was conducted at a special needs elementary school. The subjects were five deaf students learning multiplication. The study lasted for one week. The research activities were conducted during the school's learning process. The data analysis technique deemed appropriate for this study was the Wilcoxon test using SPSS (Statistical Product and Service Solution) version 24.

The inclusion of only five students in this study was based on several key considerations. First, the limited number of deaf students in the school as a whole, which naturally limited the availability of subjects. Second, the approach used in this study was direct intervention and required intensive observation of individual students' learning processes and outcomes. Therefore, the limited number of subjects allowed the researcher to conduct more careful and detailed observations and records of changes in student behavior and learning outcomes. Furthermore, this approach aligns with the characteristics of research in special education, where the effectiveness of a learning medium or method is tested in a real-world context and on students with specific needs. This study does not aim to make broad generalizations, but rather to examine the potential effectiveness of multiplication rings as an alternative learning strategy tailored to the conditions and characteristics of students with hearing impairments. While the involvement of these five students is considered sufficient to explore the impact of media use in depth, the researchers acknowledge that the results have limitations in terms of generalizability. Therefore, further research with a larger number of subjects and more varied contexts is needed so that the results can be used as a broader reference in the world of inclusive and special education.

In basic mathematics instruction for students with special needs, particularly those with hearing impairments, the choice of media significantly influences the effectiveness of concept delivery. Two media frequently used in the context of numeracy learning are the multiplication ring and the abacus. Both have different characteristics in terms of form, usage, and accessibility for students with communication and cognitive disabilities. The multiplication ring is specifically designed to facilitate the understanding of multiplication concepts. This media consists of two or more concentric, rotatable circles, with numbers printed on the outer and inner circles. When two numbers are matched, the result appears on a display or results window. This simple and straightforward operation allows students to see and understand the relationships between numbers in multiplication operations without having to go through complex calculations. The colorful and visual appearance of this media makes it very user-friendly for deaf students who rely heavily on visual stimulation in their learning process.

Meanwhile, the abacus is a more traditional calculation aid, widely used in various educational systems around the world. An abacus consists of a series of rods, each with several beads. In use, students slide the beads to represent numbers and perform arithmetic operations based on the place value system. Although the abacus can be used for various operations such as addition, subtraction, multiplication, and division, it requires a higher level of concentration and understanding of algorithms than a multiplication ring.

In terms of complexity of use, the multiplication ring has the advantage of presenting immediate and concrete results. Students do not need to perform step-by-step calculations, making it particularly helpful for deaf students or those with intellectual disabilities in mastering basic mathematical operations. In contrast, the abacus has a more complex system and requires a deeper understanding of place value and calculation strategies, so its use requires more intensive guidance and practice. In terms of accessibility, the multiplication ring is superior for deaf students due to its visual display and intuitive use. While the abacus still has advantages as a tool that can develop accuracy and deeper numerical understanding, it is more appropriate for use at an advanced level when students already have a strong foundation of numeracy skills. Overall, the multiplication ring media is more appropriate for use in the context of early multiplication learning for deaf students in special elementary schools, because this media provides a simple, concrete, and visual learning experience, and can increase student engagement in the learning process actively and enjoyably. Meanwhile, the abacus remains a useful media, but is more effective for reinforcing advanced concepts in a more systematic learning context.

FINDING AND DISCUSSION

Finding(s)

Based on initial multiplication ability data obtained from pre-test results at a special needs elementary school, which were conducted twice during mathematics instruction, due to several subjects being absent during the first pre-test. The material presented in this lesson was understanding single-digit multiplication of numbers 1-10.

Table 1. Subject Initial Ability Data (Pre-Test)

No.	Subject Name	Test Results (points)	Category	Description
1	SU	5 points	Very Bad	Child Unable to Do Multiplication
2	AR	85 points	Very good	Child is very capable of doing multiplication
3	IDW	55 points	Bad Children	Child is Able to Do Multiplication and Answer Fewer Wrong Questions
4	PK	75 points	Good Child	Child is Able to Do Multiplication and Answers Wrong Fewer
5	LA	10 points	Very bad	Child is Unable to Do Multiplication

Table 2. Final Subject Ability Data (Post-Test)

No.	Subject Name	Test Results (points)	Category	Description
1	SU	75 points	Good	Child is Able to Do Multiplication and Answers Wrong Fewer
2	AR	100 points	Very good	Child is very capable of doing multiplication
3	IDW	90 points	Very good	Child is very capable of doing multiplication
4	PK	100 points	Very good	Child is very capable of doing multiplication
5	LA	90 points	Very good	Child is very capable of doing multiplication

After looking at tables 1 and 2, it will be further clarified by the presence of a graph that includes the initial ability of the subject in single-digit multiplication (pre-test) before the multiplication ring media treatment and also the results of the final ability of the subject in single-digit multiplication (post-test) after the provision of intervention with the multiplication ring media in Figure 1.

Based on the results of the pre-test, the average score for single-digit multiplication in mathematics was 46, with a highest score of 85 points and a lowest score of 5 points. The treatment was conducted four times, as described below; 1) Treatment I was conducted after the subjects completed the pre-test. The subjects were then taught using the multiplication rings. In this first treatment, the researcher explained how to use the multiplication rings to the subjects until they understood how to use them. This was done by teaching each subject individually, explaining the process repeatedly, and also having them count the rings together; 2) The second treatment was carried out during the first hour of learning. In this second treatment activity, the researcher delivered the same material as the first treatment but with increased difficulty. And also the researcher re-explained and re-explained how to use this multiplication ring media to the subjects who were unable to attend the first treatment; 3) The third treatment was carried out during the first hour of learning in this third treatment activity, the researcher still explained how to use the media, and then asked the subjects to try the media without the researcher's help; 4) This fourth treatment was carried out during the first hour of learning in the fourth treatment activity, the researcher still explained how to use the media, and then asked the subjects to try the media without the researcher's help.

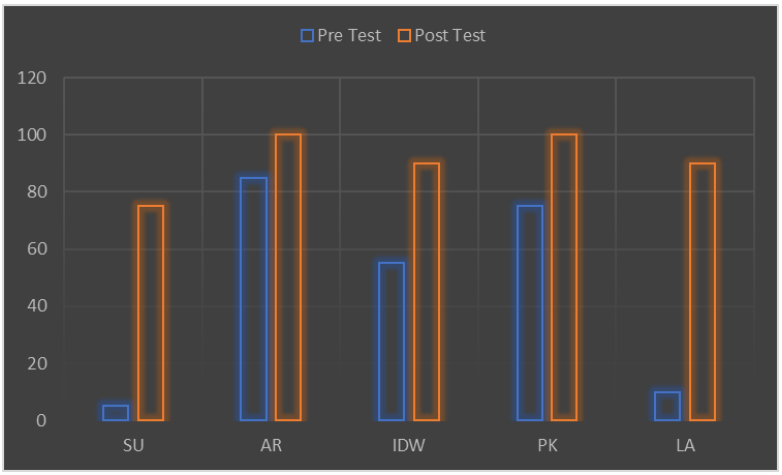

Figure 1. Example of Line Graphs Using the Contrast

Based on the description of the final ability points (post-test) conducted by the researchers, it can be seen that each child's test results showed significant improvement compared to their abilities before treatment with this multiplication ring media. To demonstrate and clarify this improvement, the following table presents data on the subjects' final ability and the post-test graph. Table 2 shows that the subjects' ability levels in single-digit multiplication varied in their mastery of the material. However, the average results from each subject during treatment showed an increase in their understanding of multiplication. To clarify the data above, a skill chart is presented below at the end of the post-test.

Based on previous data, as a form of proof of the hypothesis that there is effectiveness in the use of multiplication ring media on the mathematical ability of single-digit multiplication material in deaf children in exceptional elementary schools. Wilcoxon Signed Rank Test analysis was then used. The following is the analysis of the Wilcoxon signed rank test based on SPSS version 24 calculations on table 3 and table 4.

Table 3. Wilcoxon Signed Rank Test Results

Ranks

		N	Mean Rank	Sum of Ranks
Post Test - Pre Test	Negative Ranks	0a	.00	.00
	Positive Ranks	5b	3.00	15.00
	Ties	0c		
	Total	5		

Table 4. Statistical Test Results

Test Statistics

	Post Test - Pre Test
Z	-2.023b
Asymp. Sig. (2-tailed)	.043

The data was processed using the SPSS version 24 program to produce the results of the hypothesis test to calculate the pre-test and post-test scores related to mathematics learning outcomes with single-digit multiplication and negative ranking. 15.00, the statistical test using Asymp produced Z count = -2.023. Sig. (both sides) = 0.043 less than 0.05. The Asymp.Sig (two-tailed) Z-score value calculated from the Wilcoxon Signed Rank Test is below the 5% significance level ($\alpha = 0.05$) and the average result of 46 pre-tests and 91 post-tests Ho is rejected and Ha is accepted. Therefore, it can be concluded that the use of this multiplication ring media is effective in improving the mathematical abilities of single-digit multiplication material for deaf children with special needs in elementary schools.

Discussion(s)

This study has several limitations that must be considered when interpreting the findings and drawing broader conclusions. The subjects in this study only included five deaf students at one special elementary school (SDLB). This limited number of subjects allowed the researcher to conduct in-depth observations of each student, but also limits the possibility of generalization to the broader population. As Sugiyono (2019) noted, quantitative research with small groups emphasizes depth of understanding rather than broad representation. Therefore, the results of this study are contextual and exploratory, rather than generalizable. Furthermore, the individual characteristics of each student, the learning environment, the active role of the teacher, and sociocultural backgrounds also influence the implementation of the multiplication ring media. This suggests that the results obtained cannot be separated from the context in which the research was conducted. According to Yin (2018), contextual and small-scale case studies are very useful in revealing how an intervention works in real-life situations, but caution is needed when developing universal claims based on these results.

Despite its limitations, this study makes important contributions to formulating implications for inclusive education policy and adaptive curriculum design. First, the findings confirm that the use of visual and concrete learning media, such as multiplication rings, is effective in helping deaf students understand basic mathematical concepts. This reinforces the ideas of Rose et al. (2006) on Universal Design for Learning (UDL), which emphasize the importance of providing a variety of representations, expressions, and modes of engagement in learning so that all students can learn optimally. Second, the results of this study demonstrate the urgency of developing a flexible and differentiated curriculum, particularly in the context of inclusive classrooms. Curricula need to be designed with the needs, abilities, and learning styles of students with special needs in mind so they can access and understand learning materials equally (Tomlinson, 2014). In this regard, learning media, such as multiplication rings, represent a concrete example of curriculum adaptation at the classroom level. Third, this study also has implications for teacher training policy. Teachers, as the primary facilitators in inclusive learning, need to be equipped with the knowledge and skills to design, select, and use learning media appropriate to the characteristics of students with special needs. According to Efendi (2018), inclusive teachers must be able to respond to student diversity in a reflective and adaptive manner to their learning needs. Thus, although this research is limited, its findings can provide an empirical basis for policymakers, curriculum developers, and education practitioners in strengthening the principles of inclusivity, media accessibility, and learning differentiation in elementary education, particularly in mathematics.

The initial ability of the subjects before being given treatment in the form of this multiplication ring media, shows that most subjects are still unable to do multiplication mathematics, it can be seen from the results of the subject's pre-test which shows the highest score is 85 points while the lowest score is 5 points with an average of 46. It can be seen from these results that there are still many subjects, namely deaf students in special elementary schools, who are still unable to do this single-digit multiplication problem. It can be assumed that the main cause of the low level of understanding of multiplication mathematics of deaf students in special elementary schools is because they are still unable to do this single-digit multiplication because there are still many students who are confused about answering the question.

Students often lose focus during multiplication lessons. They rush through the material because their peers are busy, leading to careless answers. This is also due to the lack of media use in teaching multiplication. This aligns with research by Dewi (2021), who found that students' scores improved before and after using media. The study also demonstrated that learning without media yielded lower results than learning with media.

Students often lose focus during multiplication lessons. They rush through the material because their peers are busy, leading to careless answers. This is also reflected in research by Dewi (2021), who found that students' scores before and after using media improved. The study also demonstrated that learning without media yielded lower scores than learning with media. This finding aligns with research by Irsyandi & Nugroho (2015), which found that using media in mathematics instruction for children with special needs is highly effective. Furthermore, the game-based media is highly engaging and encourages children to play joyfully. This game can also be used to develop children's motor skills.

This treatment was administered twice. The researchers received a very positive response from the subjects. They were very interested in the multiplication ring media because: 1) The unique shape of the media makes it interesting for children; 2) The bright colours also attract children's interest; 3) The simple shape makes this multiplication ring media easy to use; 4) Because of its simple shape, children can quickly understand how to use this multiplication ring media; 5) In addition, this media is also made on a large scale so that it allows them to count from 1 to 10.

During the first treatment conducted in the study conducted by me as a researcher, it showed that 3 subjects could easily immediately understand the use of this multiplication ring media, while the remaining 2 subjects experienced difficulty and confusion at the beginning of the treatment using this multiplication ring media, so the researcher had to direct and continue to explain how to use it. However, when the second treatment was given, the two subjects who were previously still confused already understood and were able to use this multiplication ring media easily and were able to use the media fluently. And for subjects who had understood from the beginning how to use this multiplication ring media, they could immediately use the media directly.

This condition is in line with the statement from the research conducted by (Prasetyo, 2018) which states that deaf children need learning media to help children improve their learning outcomes, and help in understanding the learning material. This is proven based on research conducted by researchers, which shows an increase in the learning process as indicated by increased student learning participation during the learning process, in addition to that teacher performance also increased. This research also agrees with research conducted by (Sari, 2020) which states that using interesting media can increase the interest in learning of children with special needs well, which can be seen in research conducted by researchers showing the effectiveness of student learning completion reaching 80%.

After the researchers administered treatment using multiplication rings, the learning outcomes and grades of elementary school students with special needs significantly improved. This was evident in the post-test scores, with the highest score being 100 points and the lowest being 75 points, with an average of 91 points. This was a significant difference from the pre-test scores, which had a highest score of 85 points and a lowest score of 5 points. This demonstrates an improvement in students' learning outcomes. Therefore, it is clear that the use of media in teaching multiplication to students is highly effective in increasing student interest, learning outcomes, and grades. Furthermore, student interest in learning also increased after using this media, as students felt engaged with the multiplication rings, which stimulated their learning.

This opinion aligns with research conducted by Pratama & Permatasari (2021), which stated that the use of media in learning for students with special needs is very effective in improving learning outcomes and grades for students with special needs. This is demonstrated by the validation results conducted by researchers, which showed that the use of learning media in student learning is highly effective, with an average increase in student learning outcomes to 80.75. This research also aligns with previous research. Ariyantika (2019) explained that the use of media in mathematics learning for children with special needs is very effective. This can be seen from the responses given by students, who found the use of media to be very interesting and effective in its application. Students' grades also improved when using these media.

A comparison of student performance before and after using the multiplication rings can be seen. Before the treatment using the multiplication rings, some students' scores were still below average and categorized as very poor. This was evident in the results of the students' pre-test. This was due to various factors, including loss of focus while working, experiencing difficulties due to being denied permission, and being unable to complete tasks due to being interrupted by peers.

The treatment using the multiplication rings was intended to assist students in working on single-digit multiplication problems and also to stimulate their interest in learning. After administering the treatment using the multiplication rings, it was demonstrated that it was highly effective in improving student scores. Furthermore, students became more enthusiastic about learning. However, other factors, such as praise from the researcher, encouragement from the researcher, minimal coercion from the researcher, and rewards from the researcher, also contributed to the success of this study.

This research is also in line with previous research. (Aljena, 2020) stated that giving rewards to students can increase their learning motivation. This research is also in line with previous research. (Utomo & Kartiko, 2015) stated that providing extrinsic motivation in the form of rewards significantly increased student participation rates, indicating that the use of rewards significantly improved basketball performance in the experimental group compared to the control group, proven to have a significant impact on shooting results.

CONCLUSION

Based on the analysis and discussion above, we can conclude that there is a significant difference in students' single-digit multiplication skills before and after the multiplication ring treatment. This is evident from the pre-test results, which showed that some students still scored below average. The multiplication ring treatment is a method used to help students improve their scores by assisting them with single-digit multiplication problems. This allows students to work more easily. During the multiplication ring treatment, the subjects responded very positively, significantly assisting the researchers in applying the multiplication ring method to the subjects. The post-test showed a visible improvement in

the students' scores after working on single-digit multiplication problems using the multiplication ring method. However, the media alone contributed to the success of this study; the researchers' provision of rewards and praise was also a contributing factor.

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