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The Effect of Mathematical Intelligence Stick Media on the Summation Skills of Students with Intellectual Disability

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Abstract

Children with intellectual disabilities face obstacles in their numeracy skills development. Stick intelligence is a learning media that is aimed to help these children enhance their numeracy skills. Therefore, this study aims to identify (1) the numeracy skills of students with intellectual disabilities before using the mathematical intelligence sticks, (2) the numeracy skills of students with intellectual disabilities after using the mathematical intelligence sticks, and (3) the effects of mathematical intelligence stick media in enhancing the numeracy skills of fourth-grade students with intellectual disability in State Elementary School for Exceptional Children 4 Batu, Indonesia. This experimental study used single-subject research (SSR) approach with an A-B-A design. The data were obtained by asking the students to complete the summation operation, and the results were analyzed using percentages. The analysis results showed that (1) the initial mean level of the numeracy skills of the children with intellectual disabilities was 52.2; (2) the mean level of the numeracy skills of the children with an intellectual disability after the treatment was 82.3; and (3) mathematical intelligence sticks carry effects on the numeracy skills of the children with intellectual disability. Therefore, an increase in summation skills of the students with intellectual disabilities is attained after they use the mathematical intelligence stick.

Keywords: mathematical intelligence stick, summation, children with intellectual disability.

Introduction

In the education system, students learn various courses, including mathematics. Sekarani (2015) reported that mathematics is one of the most frequently perceived challenging courses by elementary, junior high, and senior high school students. Consequently, many students have low comprehension in mathematics courses. Essentially, with a proper learning method and media, mathematics materials can be easily understood. Further, a concrete learning method and strategy can result in fun mathematic learning (Hidayat, 2014:1).

Commonly, elementary school students know numbers, summation, and subtraction, while some of them even mastered multiplication and division in abstract form. However, children with intellectual disabilities face challenges in understanding mathematical concepts without the help of concrete objects because their intelligence development is ended in the concrete operational period (Somantri, 2012). Therefore, in mathematical learning, children with intellectual disabilities need help from concrete media. Mohammad Effendi (2006) describes children with intellectual disabilities as children with a deficient intellectual level, requiring exceptional guidance and service in completing their developmental tasks. Linearly, these children also need a particular service in learning mathematics as they have difficulties in comprehending abstract mathematical explanations. Thus, the use of proper mathematical learning media is highly substantial, especially for children with mild intellectual disabilities.

The selection of learning media should be adjusted to the children's needs and intellectual development. Besides, the learning media's attractiveness, effectiveness, and efficiency should also be considered to ensure that the children do not quickly get bored during the mathematics course. Therefore, mathematics learning for students with mild intellectual disabilities should be modified through the use of concrete media. The presence of learning media is vital since teachers' mere explanation is insufficient due to children with intellectual disabilities have low learning skills. It positions the selection of proper learning media as a crucial element for children with mild intellectual disabilities' mathematical learning process. Arsyad (2013: 10) defines learning media as

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any media that can be used to engage students in the process of information and message delivery during the learning process. With learning media, students with intellectual disabilities are expected to have a better understanding of the summation material. Previous research reported that sixth-grade students with intellectual disabilities faced difficulties in learning the 1-10 summation material. In that case, the teachers had attempted to help the students by adjusting the curriculum, but they still failed to attain the desired results. At the end, the student only mastered the 1-5 summation material. This students became the only one who face difficulties, when all of his friends has comprehended the 1-20 summation, as he always forgot the results of calculating using his fingers , the moment he had to write the answer on his book.

In addition, students with intellectual disabilities are also reported to have confusion about the symbol of the number above 5. Therefore, learning media is required to help these students understand abstract concepts in mathematics learning. Soendari (2006) emphasizes that in mathematics learning, an authentic (real) approach is needed, such as through the use of models, media, student interaction, contextual concepts, and so forth. Meanwhile, Nugrahani (2007) defines media as a device that aids the learning process. Mathematical Intelligence Stick is a mathematics learning media that facilitates students to count using concrete objects directly, without thinking in the abstract. This media subsists of colorful sticks that are completed with number blocks that help students describe the question. This media aims to concretize abstract mathematics concepts so that they can be understood easily. By using this media, the students with intellectual disabilities are expected to understand the summation materials easily as they directly see the calculated object.

The use of learning media in summation learning is forecasted to help students resolve their difficulties in learning. The implementation of mathematical intelligence sticks (MIS) in students with mild intellectual disabilities' learning process is expected to facilitate the learning, so that they can understand the materials delivered by the teachers and have increasing ability in 1-10 summation material.

Research methods

This study used an experimental method with single-subject research (SSR) design. Janosky et al. (2009) explain that single-subject design research focuses on measuring the effects of an intervention on variables. Besides, this study also used the A-B-A design, with A being the baseline and B being the intervention. This A-B-A design discloses a causal effect relationship between the dependent and independent variables (Sunanto et al., 2005:59). In single-subject research (SSR), the target behavior or dependent variable is measured using repetition in a specific period of time, such as per week, day, or minute. The independent variable in this study was the mathematical intelligence stick (MIS), while the dependent variable was the students with mild intellectual disabilities.

We gathered the data directly through a written test conducted in baseline-1, intervention, and baseline-2. We noted the condition of the dependent variables in baseline-1 (initial condition), intervention (during the intervention), and baseline-2 (final condition). The intervention was completed using a mathematical intelligence stick (MIS) and planned learning.

The obtained data were analyzed using graphic visual analysis by adding the data into a graphic. Later, the graphic was analyzed throughout every condition (A-B-A). During the analysis, we determined the length of a condition, and estimated trend direction using the split half method, data-trace, stability trend, stability level and range, as well as change level.

Further, we also carried out an analysis of the condition by looking for the number of variables being transformed, changes in trend direction, changes in stability trend, level of changes, and overlap percentage.

Results

This SSR research with the A-B-A design gathered data in 16 lesson meetings, divided into baseline -1 (A1 for five sessions), intervention (B for six meetings), and baseline-2 (A2) for five sessions. The baseline-1 was started from the first to fifth meetings. The intervention (B) session began from the sixth to eleventh meetings, while the baseline-2 session was started from the 12th to 16th meetings. Each meeting was completed in 60 minutes. The obtained data were analyzed using visual data and graphics in percentage analysis. In baseline-1, the obtained data represented the initial students' situation before the intervention. Comparatively, the intervention data reflected students' situation after the treatment. Lastly, the baseline-2 data indicated the data with no treatment or the control data. One of our participants, DF, a student with mild intellectual disability, attained 50, 60, 50, 50, and 50% results in baseline-1. In intervention, DF obtained scores of 80, 90, 100, 100, 100, and 100%, while in the baseline-2 DF got 80, 80, 80, and 90% scores.

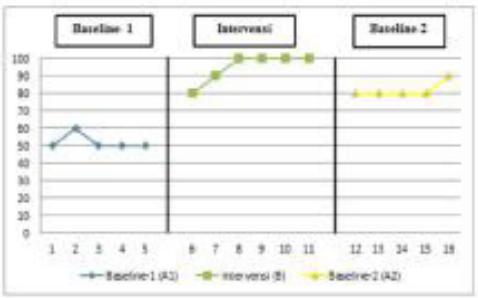

Fig. 1: Recapitulation of the Summation Numeracy Skills Assessment Results on Students with Intelligent Disability

Condition Analysis

The baseline-1 session was carried out from the first to the fifth session. Students' summation skills 1-10 from the first to fifth sessions were 50, 60, 50, 50, and 50, respectively. The score increased in the second session and was constant from the third to the fifth session. Further, the result of trend direction in the baseline-1 was horizontal (flat). This trend shows no increase and decreases on every side. Meanwhile, the stability percentage in baseline-1 was 80%, suggesting that the data were stable. The data trace in baseline-1 was in parallel with the X axis, indicating an equal value (=). The stability level and range were between 50 to 60%, categorized as stable. Lastly, the changing level of students with intellectual disability in 1-10 summation was 0, showing no changes in skills in this phase.

In addition, the intervention session (B) was carried out from the sixth to 11th meetings. The phase length was observed through the number of sessions in the intervention phase, which was six sessions.

Students' summation scores from the sixth to 11th meetings were 80, 90, 1000, 100, and 100, showing a stable increase in the last three meetings. The trend direction in this intervention session was increasing (+), with an 83.3% stability. Thus, the obtained data were classified as stable. The data-trace was determined by adding the same data as the data used in estimating the trend direction, resulting in increasing (+), decreasing (-), or parallel (=) results. In the intervention (B) condition, the data-trace tendency was increasing, classified as positive. The stability range of this intervention condition was between 80 to 100%. The changes in students' skills in this condition were estimated by subtracting the lowest data from the biggest data (100% - 80% = 20%). Therefore, the students with mild intelligent disabilities attained increasing skills in 1-10 summation.

Table 1: Results of Condition Analysis

Kondisi	A1	B	A2
1. Panjang Kondisi	5	6	5
2. Estimasi Kecenderungan Arah	(=)	(+)	(=)
3. Kecenderungan Stabilitas	Stabil	Stabil	Stabil
4. Jejak Data	(=)	(+)	(=)
5. Level Stabilitas dan Rentang	Stabil (50-50)	Stabil (80-100)	Stabil (80-90)
6. Perubahan Level	50-50 (0)	80-100 (+20)	90-80 (+10)

In addition, the baseline-2 was completed from the 12th to 16th meetings, with obtained scores of 80, 80, 80, 80, and 90, respectively. The length of condition in baseline-2 was five sessions. Meanwhile, the estimated trend direction in baseline-2 was horizontal, showing no changes. The stability trend in this baseline-2 was 80%, signifying stable data. Similarly, the data-trace in baseline-2 was also flat (=), which means there were no changes in mild intelligent disabled students' 1-10 summation skills. The baseline-2 also gained great stability in the range of 80 – 90%. Lastly, the change level in this baseline-2 was +10, indicating a 10% increase in mild intelligent disabled students' 1-10 summation skills.

Analysis between Condition

This study was carried out in 16 meetings, divided into five meetings for baseline-1 (A1), six meetings for intervention (B), and five meetings for baseline-2 (A2). The obtained data from those meetings are illustrated in Figure 2.

The dependent variable in this study was only the 1-10 summation skills of the mildly intelligent disabled students. The changes in trend direction and their effects were observed through condition analysis. The results of that analysis are shown in table 2.

The target behavior of this research was to enhance the 1-10 summation skills of students with mild intellectual disabilities. Thus, the obtained increasing trend shows that the students with mild intellectual disabilities have increasing skills, while the horizontal (flat) trend shows that the students have stable skills. The stability changes from the baseline-1 (80% trend) to intervention (83.3% trend) showed stable to stable changes. Similarly, the changes from the intervention to baseline-2

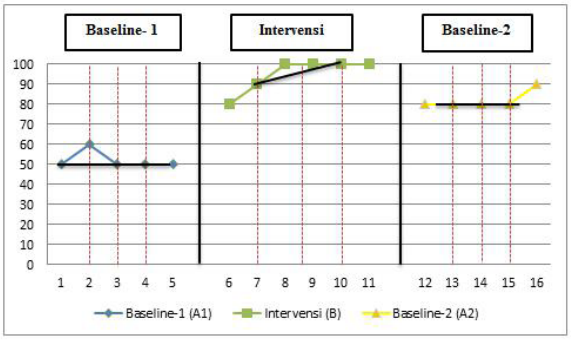

Fig. 2: Data obtained from Baseline-1, Intervention and Baseline-2 Sessions

Table 2: Changes of Trend Direction and Its Effects

Perbandingan Kondisi	B/A1		A2/B	
Perubahan Kecenderungan Arah dan Efeknya	(=)	(+)	(+)	(=)

(80% trend) also indicated stable to stable changes. The level changes from baseline-1 to intervention increased by 30%, but it decreased by 20% from the intervention to baseline-2.

The overlapped data represents the similar situation between the baseline and intervention conditions. The overlap percentage was attained through estimating the data point on the intervention, which was still within the upper and lower limit of the baseline. The calculation resulted in a 0% of overlap percentage, signifying no overlapped data from the baseline and intervention (Figure 3).

According to Figure 3, the mathematical intelligence stick carries effects on the 1-10 summation skills of students with mild intellectual disabilities. Additionally, the results of visual analysis between conditions are presented in Table 3.

The significant increase observed from baseline-1 (A1) to intervention (B), as well as the overlap percentage, suggests the effects of mathematical intelligence stick media on students' summation skills. Additionally, reward and punishment were used to improve the effects of mathematical intelligence sticks. In this study, the learning process was started by introducing the function of number blocks and sticks to the students.

After that, the students started to use the media by arranging the sticks and blocks in order. To reinforce students' motivation, they were provided with verbal support. Then, they used the mathematical intelligence stick in the 1-10 summation operation.

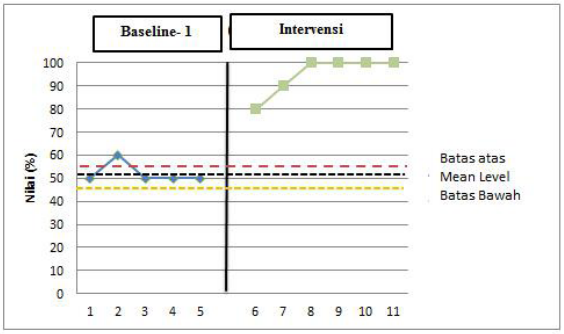

Figure 3: Overlap Percentage

Table 3: Results of Visual Analysis between Conditions

Perbandingan Kondisi	B/A1	A2/B
Jumlah Variabel yang Diubah	1	1
Perubahan Kecenderungan Arah dan Efeknya	(+)	(+)
Perubahan Stabilitas	Stabil ke Stabil	Stabil ke Stabil
Perubahan Level	80 – 50 (+30)	80- 100 (-20)
Presentase Overlap	0%	

In this 1-10 summation learning process, the students face challenges in memorizing the number that symbolizes the summation results. As students' increased summation skills were the target behavior in this study, they were asked to remember the 1-10 number symbol gradually. If the students did not attain a maximum result in a particular learning stage, then the stage was repeated to ensure that the students had excellent comprehension of this summation material.

Discussions

Sekarani (2015) reports that elementary, junior high, and senior high school students mostly perceive mathematics as a difficult course. Without the mathematical intelligence stick media, students' perceived the 1-10 summation material as complex, as shown in their relatively low obtained score in the baseline-1.

Mumpuniarti & Pujaningsih (2016: 135) explain that the academic skills of students with intellectual disabilities stopped at the concrete operational stage.

Therefore, the absence of learning media complicates these students' learning processes. Without the mathematical intelligence sticks, the explanation of summation material was challenging since the students had issues understanding the material. The obtained low scores in the baseline-1 indicated mild intellectually disabled students' difficulties in answering the summation questions. Students with mild intellectual disabilities tend to easily lose their concentration and get bored if they feel the learning is not enjoyable. Besides, the completion of the summation exercise requires a more extended period.

This study used mathematical intelligence sticks as a learning media in the 1-10 summation learning. This media was selected as it consisted of concrete objects, namely the wooden stick and number block. During the intervention period, the students were given ten items summation exercise for six days to attain stable data. The correct answer to each exercise item was given 10 points, while the wrong answer was given 0 points.

The summation learning using MIS media was carried out in a fun environment that gave no pressure to the students. The students were asked to learn while playing with the colorful sticks. In this intervention period, students attained higher score, with a mean score of 82, higher than the mean score in the baseline-1.

Susilana (2008) explains that one of the central purposes of learning media is providing a concrete fundamental of thinking, reducing the possible linguistic error. Therefore, the MIS media was selected in the 1-10 summation learning to provide a more concrete media facilitating the learning process. The use of this concrete MIS learning media was expected to enhance the 1-10 summation skills of fourth-grade intellectually disabled students.

This study examines the effects of mathematical intelligence stick media on the 1-10 summation skills of students with mild intellectual disabilities. The students' summation skills were observed to increase, as shown from their obtained scores in the baseline-1 and intervention periods. In baseline-1, students' scores ranged between 50 to 60%, while in the intervention, their scores were between 80 to 100%, showing the positive effects of MIS on the mathematics learning process. Besides, the average obtained score was also increased, as the mean score in baseline-1 was 52, while the mean in the intervention session was 82. A 30% change in level was observed between the first intervention session and the last baseline-1 session. These findings signify a relatively significant improvement after the intervention.

In addition, the obtained overlap percentage was 0. Sunanto et al. (2005:119) explain that a lower overlap percentage represents better effects of the intervention on the target behavior. Thus, this finding affirms that the increasing mild intellectually disabled students' summation skills are induced by the use of mathematical intelligence stick media.

The 1-10 summation skills of the students with mild intellectual disabilities increase after the intervention. Additionally, the obtained students' scores were also influenced by their fluctuated mood and concentration, which are affected by their surrounding environment. Therefore, the teachers should have excellent patience to help these students with intellectual disabilities attain maximum scores.

Similar results have been obtained by a study conducted by Hidayat (2014) on the effects of ice cream stick media on increasing the numeracy skills of five-grade students with intellectual disabilities. That study also reveals a higher post-test average score (8.8) than the pretest score (3.4). Sekarani (2015) has also carried out a study on the effects of Cuisenaire sticks on the numeracy skills of six-grade students with intellectual disabilities, showing an enhanced students' numeracy skills. The Cuisenaire sticks are similar with MIS, but the Cuisenaire sticks have number on its end, while MIS has separated number block. Therefore, according to our findings and previous studies, stick media can enhance students' numeracy skills.

Another study carried out by Wardani (2012) investigates the use of dekak-dekak (abacus) and sticks on the first-grade elementary school students' mathematics learning results, showing significantly different learning results from the use of dekak-dekak and sticks. Essentially, the use of mathematical intelligence sticks is similar to the use of dekak-dekak and sticks. However, as the mathematical intelligence sticks are easier to be hold, colorful, and equipped with number blocks, the media is more attractive and better facilitates students' numeracy learning than the other two media.

The mathematical intelligence sticks media provides attractive learning that enhances students' learning levels. By using this media, students have a better understanding of the summation learning materials. Besides, this media helps students to comprehend abstract mathematics materials.

Conclusion

According to our analysis results, we conclude that the mathematical intelligence sticks can enhance the 1-10 summation skills of the students with mild intellectual disabilities. It is confirmed through their obtained high score after the intervention. Thus, the mathematical intelligence sticks carry effects on the 1-10 summation skills of students with intellectual disabilities. The effects were observed from the increasing students' scores obtained after the intervention session, with a 30% increase in summation skills.

Suggestions

Following our research results, we recommend that teachers use mathematical intelligence sticks as learning media in the 1-10 summation learning. Besides, the teachers were also suggested to expand their creativity to find innovative learning means to help the learning process of students with intellectual disabilities.

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