THE EFFECTIVENESS OF MULTISENSORY APPROACH ASSISTED BY VISUAL ANIMATION MEDIA AND QR QUIZIZZ ASSESSMENT ON MATHEMATICAL CONCEPTUAL UNDERSTANDING OF STUDENTS WITH DYSCALCULIA

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Abstract

Low conceptual understanding of geometry among students with mild intellectual disabilities remains a challenge in special needs mathematics education. Observations at SLB Negeri Slawi indicate that most students have difficulty grasping abstract mathematical concepts, particularly in geometry, due to the dominance of conventional teaching methods and limited use of interactive learning media. This study aims to examine the effect of implementing a multisensory approach assisted by visual animation media and QR Quizizz assessment on students' mathematical conceptual understanding. The research employed a quantitative approach with a quasi-experimental method using a post-test only control group design. The sample consisted of 16 students from Class C, Phase D (Junior High School level) selected through purposive sampling, divided equally into experimental and control groups. Data were collected through QR Quizizz-based tests and documentation, then analyzed using a proportion test, independent t-test, and simple linear regression. The results showed that 88% of students in the experimental class achieved the minimum mastery criterion (≥75). The regression equation was $\hat{Y} = 36{,}9285 + 0{,}5357$ '[-X with a coefficient of determination (R^2) of 0.5129, indicating that 51.29% of students' conceptual understanding was influenced by the multisensory approach, while the remaining percentage was influenced by other factors. The t-test results indicated a positive and significant difference between the experimental and control groups. These findings suggest that integrating a multisensory approach with visual animation media and QR Quizizz assessment is effective in enhancing mathematical conceptual understanding among students with dyscalculia.

Keywords: Multisensory approach, QR Quizizz, visual animation, mathematical conceptual understanding, special needs education

1 INTRODUCTION

Education is a fundamental right for all citizens and is guaranteed by the Indonesian government. This is affirmed in Article 5 of the National Education System Law, which states that: (1) all citizens have equal opportunities and the right to quality education; (2) citizens with physical, emotional, mental, and/or social conditions have the right to special education services; (3) those with extraordinary intelligence or special talents also have the right to education tailored to their potential (Ningsih, K.N., 2020:1).

Special education, as regulated in Law No. 20 of 2003 on the National Education System, Article 50, aims to develop attitudes, personality, talents, as well as the mental and physical abilities of students as a whole so that they can achieve optimal development according to their respective capacities (Lutfi et al., 2022:188). In the context of inclusive education as well as in Special Schools (SLB), the role of education is crucial in developing the potential, abilities, and independence of students.

One important aspect of basic education is mathematics, which makes a significant contribution to logical thinking, problem-solving, and daily life skills. According to Soedjadi (in Andriyani et al., 2020:297), mathematics is the science related to logical structures, facts, and problems of space and form. The abstract concepts inherent in mathematics, particularly in geometry, require strong visualization and spatial understanding skills. For students with intellectual disabilities, specific learning difficulties, or developmental disorders, understanding mathematical concepts requires a more contextual, concrete, and multisensory approach.

The multisensory approach, introduced by Grace M. Fernald and Gillingham-Stillman, integrates four types of senses simultaneously visual, auditory, kinesthetic, and tactile designed to engage multiple sensory channels of learners so they can actively participate in the learning process more comprehensively and effectively (Surtikayati & Ritonga, 2023:54).

Visual animation media has been proven to have a positive effect on understanding geometric concepts because of its interactive nature and ability to capture students' attention, helping them understand the material more quickly (Andriyani et al., 2022:302). In addition, the development of educational technology has brought interactive, digital-based platforms such as QR Quizizz, which can be used as an effective technology-based assessment tool to evaluate students' understanding interactively and enjoyably (Asria et al., 2021:2). Research by Qur'ani & Hamsar (2024:201–202) shows that technology-based assessments such as QR Quizizz increase students' motivation and learning outcomes.

Several previous studies have demonstrated the effectiveness of each medium separately, such as the study by Rahmanda et al. (2024:29), which showed that a multisensory approach can improve understanding of geometry in students with intellectual disabilities, and Wardany & Ulfa (2022:24), which showed that gamification using QR Quizizz increases students' learning motivation in inclusive classrooms. However, few studies have combined both in an integrated approach and tested them quantitatively.

Therefore, this study aims to examine the effectiveness of combining visual animation media and QR Quizizz assessments in improving students' geometric concept understanding quantitatively at SLB Negeri Slawi.

2 METHODOLOGY

This research employed a **quantitative approach** with a **quasi-experimental design** in the form of a *post-test only control group design*. The study population comprised students of SLB Negeri Slawi in the even semester of the 2024/2025 academic year, specifically those in Class C, Phase D (Junior High School level). The sample consisted of 16 students, divided equally into the experimental class and the control class, selected using purposive sampling based on initial assessment results and learning needs.

Table 1 Research Design

Group	Treatment	*Post-test*
Experiment	X_1	Y_1

Notes :

X_1: Treatment given with a multisensory approach

Y_1: Post-test after treatment of experiment group

The independent variable in this study was the implementation of a multisensory approach combined with visual animation teaching aids and QR Quizizz assessments. The dependent variable was students' mathematical conceptual understanding of plane figures, measured after the intervention. Controlled variables included the learning material (focused on basic concepts of plane figures), the same teacher to ensure instructional consistency, proportional time allocation for each learning phase, and identical classroom facilities to prevent environmental differences from affecting the results.

The study population comprised all students in Class C Phase D at SLB N Slawi (Slawi State Special Needs School) during the second semester of the 2024/2025 academic year, totaling 25 students. The research sample was Cluster Group 5 consisting of 8 students, selected using cluster random sampling. This selection was based on previous STS (Summative Term Assessment) data indicating the need for improvement in this class's mathematics learning outcomes, the fact that they had never experienced multisensory learning with visual animation aids and QR Quizizz assessments, and logistical considerations enabling effective research implementation.

Data were collected through several techniques: observation to monitor student interactions and identify learning barriers, and documentation to gather data from activity records and learning materials. The primary instrument used was an achievement essay test. After being piloted in Cluster Group 1, the essay test instrument was evaluated for feasibility through item validity testing, reliability testing, difficulty index analysis, and discrimination index analysis.

Table 2 Results of the Instrument Trial for Learning Achievement

	Validity	Difficulty Level	Discrimination Index	Conclusion
1	Valid	Medium	Very Good	Used
2	Valid	Medium	Very Good	Not Used
3	Valid	Medium	Very Good	Used
4	Valid	Medium	Very Good	Not Used
5	Valid	Medium	Very Good	Used
6	Valid	Medium	Very Good	Not Used
7	Valid	Medium	Very Good	Used
8	Valid	Medium	Very Good	Not Used

After being tested in class group 1, the essay test instrument was evaluated for its feasibility through item validity, reliability, difficulty index, and discrimination index analyses. The reliability test results showed a reliability value of $r_{11} = 0.901$, indicating that the test was reliable. Based on the analysis of the learning achievement test items used in this study, items number 1,2, 3, 4, 5, 6,7, and 8 were declared valid and usable. However, only 4 questions were used for the post-test (questions number 1, 3, 5, and 7) to optimize time efficiency in completing the test.

3 RESULTS

Based on the results of the study, the observation data on students' learning activeness over three meetings are presented as follows:

Table 2. Observation Results of Students' Learning Activeness

Session	Result	Category
Session-1	83%	Very Good
Session-2	83%	Very Good
Session-3	88%	Very Good
Session-4	86%	Very Good
Average	85%	Very Good

According to Table 2, the observation results indicate that in the first session, the percentage obtained was 83%, falling into the "Excellent" category; in the second session, the percentage reached 83%, classified as "Excellent"; in the third session, the percentage was 88%, also in the "Excellent" category; and in the fourth session, the percentage was 86%, again in the "Excellent" category. The average score of 85% demonstrates that students' learning engagement in multisensory approach instruction using visual animation media falls into the "Excellent" category.

This study was conducted at SLB N Slawi (Slawi State Special Needs School) with 8 students from Cluster Group 5 during the second semester of the 2024/2025 academic year. Over four sessions, a multisensory approach combined with visual animation aids in the form of geometric puzzles was implemented in teaching plane figures. The collected data included quantitative data from Mid-Semester Summative Assessment (MSSA) scores and post-intervention cognitive learning test scores, along with qualitative data from observations and documentation during the learning process.

Table 3 Descriptive Statistics of STS Scores and Post-test Scores

	STS Score	Post-test Score
N	8	8
Mean	80	83
Median	79.5	82
Mode	79	80
Std. Dev.	3.464	5.182
Minimum	75	75
Maximum	84	91

The results show an increase in the mean score from 80.00 to 83.00, an improvement of 3.00 points. The median increased from 79.5 to 82, indicating that the majority of students improved their learning outcomes. The standard deviation also increased from 3.464 to 5.182, reflecting greater variability in the posttest results due to some students achieving a maximum score of 91.

The obtained data were then analyzed using simple linear regression. The results of the simple linear regression analysis show that the regression equation obtained is:

a. The constant (a) of 36.9285 indicates that if there is no learning activeness (X = 0), the mathematical conceptual understanding score would be 36.9285.

b. The regression coefficient (b) of learning activeness variable is 0.5357, meaning that if the multisensory approach assisted by visual animation media and QR Quizizz assessment increases by 1, the students' learning activeness will increase by 0.5357.

The basis for decision-making (hypothesis testing) in the simple linear regression analysis is as follows:

F_{value}	F_{table}	Result
6,318	5,987	$6,3182 > 5,987$ $F_{value} > F_{table}$

t_{value}	t_{table}	Result
2,513	2,440	$2,513 > 2,440$ $t_{value} > t_{table}$

Based on the linearity test results using a one-way ANOVA at a 5% significance level ($\alpha = 0.05$), the calculated $F_{value} = 6,318$ dan $F_{table} = 5,987$ maka $F_{value} > F_{table}$, it can be concluded that there is a linear relationship between students' learning activeness in instruction using a multisensory approach assisted by visual animation media and QR Quizizz assessments, and their mathematical conceptual understanding.

At the same significance level, the calculated $t_{value} = 2,513$ dan $t_{table} = 2,440$; then $t_{value} > t_{table}$, H_0 is rejected. This indicates that students' learning activeness in instruction using a multisensory approach assisted by visual animation media and QR Quizizz assessments has a significant effect on their mathematical conceptual understanding.

The obtained coefficient of determination was 0.5129. This means the independent variable (learning activeness in the multisensory approach assisted by visual animation and QR Quizizz assessments, X) contributes 51.29% to the variance in the dependent variable (mathematical conceptual understanding, Y), while the remaining 48.71% is influenced by other variables not examined in this study.

This finding aligns with the study conducted by Rahmanda, A. R., Widajati, W., & Widyastuti, E. (2024), which demonstrated that the use of multisensory media enhances the understanding of plane figures among children with intellectual disabilities. Prasaja et al. (2022:78) explain that visual animations help children with dyscalculia understand abstract concepts through clear graphical representations.

4   CONCLUSIONS

There is a significant effect of learning activeness through the multisensory approach assisted by visual animation media and QR Quizizz assessments on mathematical conceptual understanding, as represented by the simple linear regression equation Ŷ = 36.9285 + 0.5357X. The analysis reveals that 51.29% of the variation in mathematical conceptual understanding can be explained by learning activeness through the multisensory approach with visual animation media and QR Quizizz assessments, while the remaining percentage is influenced by other factors beyond the scope of this study. Therefore, these findings are expected to contribute more broadly to the development of mathematics learning strategies across various educational levels.

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