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VISUAL ARTS INTEGRATION ON GEOMETRY ACHIEVEMENT FOR SPECIAL EDUCATION PUPILS

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ABSTRACT

This study aimed to investigate the effect of visual arts integration on the acquisition of conceptual knowledge in geometry among pupils with special educational needs (SEN). Recognizing the imperative to provide effective instructional strategies tailored to the diverse needs of students with SEN, this research investigates the potential of visual arts integration as a pedagogical approach. While extant literature has highlighted the benefits of visual arts integration in fostering engagement and comprehension, limited empirical inquiry has focused specifically on its influence on conceptual knowledge acquisition in geometry among students with SEN. The study employed a quasi-experimental quantitative design, involving twelve Year Two SEN pupils from a primary school in Negeri Sembilan. The intervention comprised integrating visual arts into the geometry curriculum, and a pre-test and post-test was conducted to measure pupils' geometry achievement according to Van Hiele's theory. The results indicated a statistically significant positive effect of visual arts integration on pupils' performance, as evidenced by their enhanced understanding and mastery of the concept of geometry in three-dimensional shapes. These outcomes corroborate the efficacy of visual arts integration as an instructional strategy for facilitating geometry learning among students with SEN. In conclusion, this study provides a rigorous empirical foundation for advocating the adoption of visual arts integration within the geometry curriculum for students with SEN. These findings have far-reaching implications, transcending the immediate context, as they underscore the potential of visual arts integration to augment conceptual knowledge acquisition in geometry, effectively addressing the distinctive learning requirements of students with SEN. Future research endeavors should investigate the longitudinal effects and broader applications of visual arts integration across diverse academic domains and educational settings.

Keywords: visual arts integration, geometry achievement, special educational needs (SEN), Van Hiele.

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INTRODUCTION

Geometry, renowned for its abstract concepts and reliance on spatial reasoning, poses significant challenges for pupils with special educational needs (SEN) (Serin, 2018). In Malaysia, where geometry holds a fundamental position within the mathematics curriculum and is introduced at an early stage in elementary school (Yunus et al., 2019), it is crucial to identify effective instructional strategies that cater specifically to the unique learning requirements of pupils with SEN.

The acquisition of foundational mathematical skills, such as counting, calculating, and problem-solving, plays a pivotal role in shaping pupils' perception and engagement with mathematics, particularly for those with SEN (Abarca, 2023). However, repeated failures in these early experiences can lead to frustration, demotivation, and academic setbacks. This challenge is particularly pronounced for students diagnosed with Attention Deficit Hyperactive Disorder (ADHD) or those who struggle with sustained focus and engagement. Consequently, there is an urgent need for innovative approaches that can address these obstacles and promote substantial academic achievement.

Visual arts integration has emerged as a highly promising pedagogical strategy with the potential to enhance engagement and improve academic performance among pupils with SEN. By integrating visual arts into geometry instruction, pupils can develop their visual imaginative abilities by connecting abstract mathematical concepts with real-life experiences (Schoevers et al., 2020). Despite the documented benefits of visual arts integration, it often remains undervalued due to curriculum constraints and the dominance of traditional mathematical textbooks that impede creative practices. Furthermore, limited research has explicitly examined the effects of visual arts integration on geometry achievement in the context of pupils with SEN.

Alongside this gap in research, the present study aims to explore the efficacy of visual arts integration in promoting geometry achievement among pupils with SEN. The primary objective is to assess the impact of visual arts integration on conceptual understanding, spatial reasoning, and overall geometry performance within this specific population. By investigating the potential of visual arts integration, this study seeks to contribute to the existing body of knowledge on effective instructional strategies for special education pupils in the field of mathematics education.

The significance of this research lies in its capacity to inform educational practices and provide equitable learning opportunities for pupils with SEN. The findings have the potential to guide educators in designing inclusive instructional approaches that foster engagement, comprehension, and remarkable academic success in geometry for special education pupils.

To achieve these objectives, the report is organized as follows. First, the theoretical framework and prior research on visual arts integration and geometry achievement for pupils with SEN will be thoroughly reviewed. Subsequently, the research methodology and study design will be described in detail. The results of the study will be meticulously presented, followed by an in-depth analysis and discussion of the findings. Finally, the report will conclude with implications for practice, recommendations for future research, and a concise summary of the key outcomes.

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instructional strategies for special education pupils in the field of mathematics education.

Objectives of the Study

The objective of the study is to determine the effectiveness of visual arts integration on Year Two SEN pupils' geometry achievement.

Hypotheses of the Study

H_{01}: There is no significant difference in the overall mean scores of pre-test and post-test geometry achievement for the control group pupils.

H_{02}: There is no significant difference in the overall mean scores of pre-test and post-test geometry achievement for the treatment group pupils.

H_{03}: There is no significant difference in the mean scores of conceptual knowledges of geometry between the control group and treatment group.

Scope and Limitations of the Study

The study aims to investigate the effectiveness of visual arts integration on the acquisition of geometry skills, particularly in the identification of three-dimensional shapes nets. Hence, it is important to acknowledge that the scope of this study is limited to geometry and cannot be generalizable to other topics of education.

Moving on, the study is subjected to several limitations that should be considered when interpreting the results. To illustrate, the sample size is limited to only twelve Year Two SEN pupils in one public primary school located in Seremban, Negeri Sembilan. Consequently, the results may lack external validity and cannot be generalizable to other schools or regions in Malaysia. The small sample size also limits the statistical power of the analysis and the ability to draw strong conclusions.

LITERATURE REVIEW

According to Mariappan et al. (2023), there has been a global trend towards inclusive education for SEN pupils in recent years, driven by the Salamanca Statement and Framework for Action on Special Needs Education (1994). This shift towards inclusivity is also evident in Malaysia, where the Persons with Disabilities Act 2008 emphasizes the provision of suitable assistance to ensure the full and equitable participation of special needs children in education. As a result, there has been a significant increase in the enrolment of SEN pupils in the Individualized Education Program (IEP), highlighting the collective commitment to educational inclusivity.

Geometry poses unique challenges for SEN pupils due to its abstract nature and reliance on spatial reasoning. Extensive research has consistently shown that SEN students often face difficulties in understanding geometric concepts, leading to disengagement, low self-esteem, and anxiety (Lowe, 2016; Serin, 2018). Consequently, it is imperative to identify effective instructional strategies that cater to their specific learning needs (Yunus et al., 2019). Visual arts integration, with its potential therapeutic qualities, has emerged as a promising approach to support SEN students and enhance their geometry achievement (Lowe, 2016; Nutov, 2021; Mariappan et al., 2023). By incorporating activities such as modeling and hands-on projects, visual arts integration offers a multimodal and interactive learning experience. This pedagogical approach aims to establish connections between abstract geometric concepts and real-life experiences, thereby fostering deeper conceptual understanding and engagement among SEN pupils (Schoevers et al., 2020).

While the benefits of visual arts integration have been well-documented in general education settings, there is a noticeable gap in the literature concerning its specific impact on geometry achievement among SEN pupils. Limited research has directly examined the effectiveness of visual arts integration, particularly in the context of geometry, for this particular population. Consequently, further investigation is warranted to fill this research gap and provide valuable insights into effective instructional strategies tailored to the unique learning requirements of special education pupils. The primary objective of this study is to explore the effectiveness of visual arts integration on conceptual understanding and geometry achievement for SEN pupils. By addressing this research gap, the study aims to contribute to the existing body of knowledge by providing evidence-based insights into instructional strategies that can enhance geometry learning outcomes for SEN pupils.

Theoretical Framework

This study examines the interplay between the Van Hiele theory, Gardner's multiple intelligence theory, and Vygotsky's scaffolding theory in relation to geometry achievement among special education needs (SEN) learners.

The Van Hiele theory, proposed by van Hiele in 1986, offers a comprehensive framework comprising five levels of geometric thinking (Kania et al., 2022). For this study, particular emphasis is placed on the initial level (L0) of visualization, which involves the learners' ability to recognize, name, and classify geometric shapes based solely on visual attributes (Prashanthan & Nonis, 2022). By employing the Van Hiele theory, this study aims to explore the progression of SEN learners' geometric thinking and identify factors influencing their advancement through the initial level (Yi, et al., 2020).

Gardner's multiple intelligence theory, advanced by Howard Gardner in 1983, posits that individuals possess diverse and independent intelligences (Gardner & Hatch, 1989). In this study, the integration of visual arts activities activates linguistic or logical-mathematical intelligence and places particular emphasis on spatial intelligence (Novitasari, et al., 2020). This approach seeks to facilitate a deeper comprehension of geometry among SEN learners, considering their varied learning styles.

Vygotsky's scaffolding theory, firmly grounded in the Zone of Proximal Development (ZPD) and sociocultural context, assumes a pivotal role in this research. Scaffolding, as a structured learning approach, provides tailored support to SEN learners by breaking down complex tasks into manageable steps (Wright, 2018). Through the implementation of scaffolding techniques, this study aims to foster a supportive learning environment that alleviates anxiety and empowers SEN learners to explore geometric concepts at their own pace, with the guidance of teachers or peers (Taber, 2018).

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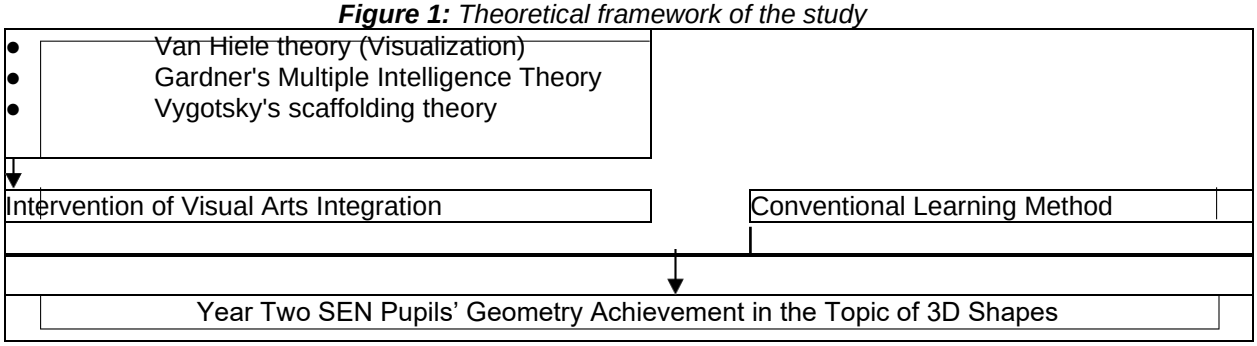
Figure 1: *Theoretical framework of the study*



METHODOLOGY

This study employed a quasi-experimental non-equivalent pretest-posttest control group design to investigate the impact of visual arts integration on the geometry learning outcomes of Year Two SEN pupils. A quasi-experimental design was used because the study was conducted in a real-world setting where random assignment of participants to the groups was not feasible. This design allows for the evaluation of causal relationships between variables while controlling for potential confounding factors. To ensure internal validity, a variety of factors such as teachers, topics, study duration, and extraneous inputs were kept constant between the groups (Maharani et al., 2020b). For instance, the teachers selected for the control and experimental groups were carefully chosen based on their comparable levels of experience and expertise in teaching geometry, ensuring that any variations in outcomes can be attributed to the intervention rather than teacher proficiency. Additionally, both groups consisted of teachers who possessed a strong familiarity with special educational needs (SEN) students, guaranteeing that differences in outcomes stemmed from the teaching approach rather than variations in handling SEN students. The methodology section provides a detailed account of the procedures implemented in this study.

Participants

The participants consisted of twelve year Two SEN pupils randomly selected from a primary school in Seremban, Negeri Sembilan. The participants were divided into two groups: the control group (n=6) and the treatment group (n=6). In the control group, instruction was delivered using PowerPoint presentations, focusing on three-dimensional shapes in geometry. On the other hand, the treatment group received instruction through visual arts integration, which involved incorporating visual arts activities to enhance their understanding of three-dimensional shapes.

Instrument

In this study, a pre-posttest instrument was utilized as the primary instruments for assessing changes in students' geometry achievement. The pre-test was administered prior to the intervention to establish the participants' baseline knowledge of geometry, specifically focusing on their ability to identify basic shapes and three-dimensional shape nets. Subsequently, a post- test was conducted after the intervention to measure participants' geometry achievement. The tests were designed in accordance with the Mathematics Curriculum and Assessment Standard Document (*DSKP*) and aligned with the year two mathematics textbook (2017) and activity book (2017). The researchers collaborated with their supervisor and an experienced mathematics teacher to carefully craft 10 questions for each test. The scores obtained from the tests were scaled to a range of 0 to 100 for data analysis using IBM SPSS (Statistical Package for the Social Sciences) software.

Validity and Reliability of the Instrument

The Pre-test and Post-test instruments used in this study underwent content validity evaluation by an expert panel comprising mathematics, language, and test construction specialists. Their expertise ensured the alignment of the instruments with the study's objectives. Adjustments were made to the test format, question structure, and mathematical terminology based on the panel's feedback and reference to the Year Two Mathematics Curriculum and Assessment Document.

To assess reliability, a pilot study was conducted, and data were analyzed using the Cronbach's alpha reliability coefficient in SPSS (Creswell & Creswell, 2018). The coefficient of 0.800 indicates excellent reliability and high consistency of the instrument's results. Hence, the instruments effectively measure the mastery and achievement of the two respondent groups in the area of 3D shape with a high level of reliability.

Table 1: *Cronbach's alpha reliability coefficient test*

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.800	.801	10

Ethical Considerations

This study adheres to rigorous ethical principles, encompassing informed consent, participant confidentiality, and data protection. Special attention is given to safeguarding the rights and welfare of vulnerable individuals, such as SEN pupils. All data collected will be securely stored and utilized exclusively for research purposes, ensuring anonymity and compliance with privacy regulations. The research will be conducted with utmost integrity, respecting participants' rights, and the findings will be objectively reported, prioritizing confidentiality.

Data Analysis

The collected quantitative data from the pre-test and post-test measures will undergo rigorous statistical analysis. Descriptive statistics such as means, standard deviations and frequencies will summarize participants' performance, while inferential statistics such as dependent and independent t-tests will assess significant differences in geometry achievement between the control and treatment groups. The analysis will be conducted using IBM SPSS software, ensuring accuracy and reliability. Throughout the process, attention will be given to data integrity, adherence to statistical assumptions, and interpretation of findings in relation to the research objectives.

Experimental Procedure

The experimental procedure spanned three days in regular classroom settings, with rigorous control measures implemented for internal and external validity. It began with a pre-test administered to all participants, accompanied by clear instructions for comprehension and compliance. The intervention involved the control group receiving conventional learning and the treatment group receiving visual arts integration instruction on the following day. A post-test was administered on the final day to assess geometry learning achievements. To ensure fairness, the control group also received the same treatment after the experiment. This systematic procedure aimed to comprehensively evaluate the impact of the intervention on participants' geometry learning outcomes in a controlled environment.

RESULTS AND FINDING

Based on the sample size of the study, the normality of the data was assessed using the Shapiro-Wilk normality test, a recommended method for sample sizes below 50 (Ghasemi & Zahediasl, 2012). The results of this analysis, presented in Table 2, provide valuable insights into the distributional characteristics of the collected data. Specifically, the significant values obtained for the pre-test and post-test data in both groups were .916 and .991, respectively. As all the significant values exceeded the threshold of 0.05, indicating a lack of statistical significance, it can be concluded that the data exhibited a normal distribution.

Table 2: *Data Normality Test of Students' Geometry Achievement as a Whole*

Test	Shapiro-Wilk		
	Statistics	**df**	**Sig.**
Pre-test	.970	12	.916
Post-test	.982	12	.991

The descriptive statistics in Table 3 reveal a significant improvement in geometry scores for both the control and treatment groups. The control group's mean score increased from 41.17 in the pre-test to 63.33 in the post-test, while the treatment group's mean score rose from 55.00 to 85.00. These findings highlight a noteworthy enhancement in geometry achievement regardless of the instructional approach employed.

Comparing the post-test mean scores, pupils who received visual arts integration instruction outperformed their peers in the control group. Notably, the control group exhibited a decrease in

standard deviation from 15.626 in the pre-test to 14.72 in the post-test, indicating a reduced variability in achievement levels among high- and low-achieving pupils within control group. Meanwhile, the treatment group exhibited a notable reduction in standard deviation, which decreased from 18.974 to 13.038. This decrease suggests a trend toward increased consistency in the data points within the treatment group's results. These findings contribute to the growing body of evidence supporting the efficacy of visual arts integration in improving geometry achievement. By incorporating visual arts elements into instruction, positive academic outcomes can be achieved.

Table 3: *Descriptive Statistics of Students' Geometry Achievement as a Whole*

Pupils	**Mean Score**		**Standard Deviation**		***N***
	Pre	**Post**	**Pre**	**Post**	
Control	41.17	63.33	15.626	14.720	6
Treatment	55.00	85.00	18.974	13.038	6

Moving on, paired sample t-tests were conducted to examine the mean score disparity between the Pre-test and Post-test for all groups, and the findings are presented in Table 4 and Table 5.

Table 4: *Paired sample t-test for control group in pre-test and post-test*

Control Group	**Mean**	**Std. Deviation**	**t-value**	**Sig. (2-tailed)**
Pre-test	41.17	15.626	-5.99	.002
Post-test	63.33	14.720		

Table 5: *Paired sample t-test for treatment group in pre-test and post-test*

Treatment Group	**Mean**	**Std. Deviation**	**t-value**	**Sig. (2-tailed)**
Pre-test	55.00	18.974	-8.783	<.001
Post-test	85.00	13.038		

Regarding the assessment of homogeneity of variance using Levene's Test, the result in Table 7 indicates a significant value of .696, which is larger than the conventional threshold of .05. This suggests that equal variance can be assumed, meeting the assumption of homogeneity of variance. Subsequently, the independent t-test is calculated for control group and treatment group.

Table 7: *Independent sample t-test for control group and treatment group*

Group		**Levene's Test for Equality of Variance**		**T-test for Equality of Means**			
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**
Post test	Control	.161	.696	-2.699	10	.022	-21.667
	Treatment						

DISCUSSIONS, RECOMMENDATIONS AND CONCLUSIONS

The present study successfully investigated the effectiveness of visual arts integration on Year Two SEN pupils' geometry achievement. The findings revealed a substantial improvement in the performance of SEN pupils, underscoring the positive impact of integrating visual arts in geometry learning.

To illustrate, analysis of the control group (Table 4) revealed a noteworthy increase in mean scores from the pre-test (M=41.17) to the post-test (M=63.33), surpassing the 50% pass mark. This observation was further validated by the paired sample t-test, revealing a statistically significant difference (t=-5.990, p=.002 < .05) and leading to the rejection of the null hypothesis (H_{01}). These results suggest that the conventional teaching method had impact on SEN pupils' geometry achievement.

In contrast, the treatment group displayed higher mean scores in the post-test (M=85) compared to the pre-test (M=55) (Table 5), providing robust evidence that visual arts integration fosters improved conceptual understanding and higher achievement among pupils. The paired t-tests yielded a strong and statistically significant t-value of -8.783 with a p-value of <.001 (< .05), leading to the rejection of the null hypothesis (H_{02}). Consequently, a significant discrepancy in the overall mean scores of pre-test and post-test geometry achievement is apparent for the treatment group. These findings robustly underscore the potency of visual arts integration in effecting substantial advancements in pupils' geometry achievement, further emphasizing its effectiveness in comparison to the conventional teaching approach observed in the control group.

Additionally, the independent t-test demonstrated a significant difference in the mean scores between the post-test of the control and treatment groups (Table 7), with a significant value of .022 (< .05), rejecting the null hypothesis (H_{03}). This suggests that the integration of visual arts in geometry learning led to a substantial improvement in SEN pupils' geometry achievement.

In summary, this study provides robust evidence supporting the positive impact of visual arts integration on Year Two SEN pupils' geometry achievement. The treatment group demonstrated significantly higher post-test scores compared to the control group, highlighting the efficacy of visual arts integration in enhancing conceptual understanding and achievement in geometry. These findings align with previous research emphasizing the potential of visual arts integration to improve academic outcomes, particularly for SEN pupils, surpassing traditional instructional methods (Fuss, 2015; Lowe, 2016). By incorporating visual teaching aids, students develop a deeper conceptual understanding through direct observation and manipulation of 3D shapes and their nets. These results further reinforce the conclusions drawn by Aida et al. (2019), underscoring the substantial benefits of visualization techniques in geometry education. The consistent alignment of these findings with existing research provides strong empirical support for the positive impact of visual arts integration on students' geometry achievement.

Limitations and Future Research

Despite the significant findings, it is crucial to acknowledge the limitations and potential flaws inherent in the present study design and methods, particularly with regard to SEN pupils. Addressing these limitations in future research will contribute to a more nuanced understanding of the relationship between visual arts integration and academic outcomes among SEN pupils.

Firstly, the study's sample size was limited to Year Two pupils from a single public primary school in Negeri Sembilan, which may restrict the generalizability of the results to other schools or regions in Malaysia. Consequently, caution must be exercised when applying these findings to a broader population of SEN pupils. To enhance the external validity, future research should include a larger and more diverse sample of SEN pupils from various educational settings.

Moreover, the study design employed a pre-test/post-test comparison between a control group and a treatment group, enabling an assessment of the impact of visual arts integration. However, this design does not fully account for potential confounding variables or alternative explanations for the observed differences in achievement. A randomized controlled trial or longitudinal study design would provide more robust evidence of the causal relationship between visual arts integration and geometry achievement specifically among SEN pupils.

Additionally, the reliance on self-reported data from students' performance assessments may introduce measurement bias or subjectivity, which is particularly relevant when working with SEN pupils. To strengthen the validity and reliability of the findings, future studies could incorporate objective measures or employ multiple methods of data collection, such as teacher observations or standardized assessments tailored for SEN pupils.

Furthermore, it is important to note that factors such as socioeconomic status and teacher quality, which are known to impact academic performance among SEN pupils, were not explicitly addressed in this study. The omission of these influential variables may limit the internal validity and the ability to establish a direct causal relationship between visual arts integration and geometry achievement scores specifically for SEN pupils. Thus, future research should consider incorporating these factors to provide a more comprehensive understanding of the impact of visual arts integration on the geometry achievement of SEN pupils.

Conclusions

In conclusion, this study provides compelling evidence for the positive impact of visual arts integration on Year Two SEN pupils' geometry achievement. The findings underscore the efficacy of incorporating visual arts to enhance conceptual understanding and academic performance in geometry. By captivating students visually, visual arts integration immerses them in the subject matter and ignites a genuine passion for learning mathematics. Despite inherent limitations such as the constrained sample size and study design, the study's contributions to the field are substantial.

To advance this line of inquiry, future research should endeavor to undertake larger-scale investigations with diverse cohorts to bolster the generalizability of the results. Moreover, employing robust research designs and incorporating additional measurement tools would fortify the validity and reliability of the findings. These efforts would offer a more comprehensive understanding of the impact of visual arts integration on geometry education.

Overall, this study affirms the critical role of integrating visual arts into the curriculum to bolster the academic achievement of SEN pupils in geometry. It provides a compelling impetus for educators to diversify their pedagogical approaches, particularly when teaching geometry. By leveraging the power of visual arts, educators can cultivate an enriched learning environment that fosters deeper conceptual understanding and propels students' geometry proficiency. As such, this study serves as a catalyst for further exploration in this domain, inspiring future investigations and encouraging the adoption of innovative instructional strategies in mathematics education.

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