

Integrating GeoEnzo into Project-Based Learning to Enhance Madrasah Aliyah Students' Visual-Spatial Intelligence in Cube and Rectangular Prism Topics

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ABSTRACT

Developing students' visual-spatial intelligence remains a challenge in teaching geometry at Madrasah Aliyah, particularly on the topics of cubes and rectangular prisms. This difficulty arises from the limited learning models and instructional media used, as well as the abstract nature of the material. This study investigates how the integration of GeoEnzo into the Project-Based Learning (PjBL) model enhances the visual-spatial intelligence of Madrasah Aliyah students on cube and rectangular prism topics. A quasi-experimental approach with a pretest-posttest control group design was employed. Eleventh-grade students at a Madrasah Aliyah were divided into an experimental class and a control class. The experimental class received project-based learning supported by GeoEnzo media, while the control class was taught using conventional instruction. The research instruments included a visual-spatial intelligence test and a project assessment rubric. Data were analyzed using N-Gain score analysis and a t-test. The results indicate that students in the experimental class demonstrated a significantly greater improvement in visual-spatial intelligence compared to those in the control class. By adding GeoEnzo to PjBL, students can see, move, and show three-dimensional geometric objects in a more real and interactive way. Therefore, it can be concluded that implementing GeoEnzo within a project-based learning model effectively enhances senior high school students' visual-spatial intelligence on cube and rectangular prism material. To improve the quality of mathematics learning, this study recommends the use of project-based interactive geometry media as an innovative instructional alternative.

Keyword : GeoEnzo, project-based learning, visual-spatial intelligence, cubes and rectangular prisms, senior high school.



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1. INTRODUCTION

Mathematics education in Madrasah Aliyah (Islamic Senior High School) requires high-order thinking skills, one of which is visual-spatial intelligence. Visual-spatial ability refers to an individual's capacity to accurately perceive visual information, manipulate and transform what they see, reconstruct mental images even in the absence of physical stimuli, and think visually to solve problems or find answers. This intelligence is crucial for understanding spatial geometry, such as cubes and rectangular prisms (cuboids), which requires the ability to visualize three-dimensional objects, understand the relationships between spatial components, and translate them into two-dimensional representations.

However, research indicates that abstract teaching methods and a lack of visual media make it difficult for students to grasp spatial concepts. Conventional learning, which often centers on lectures and repetitive exercises, fails to provide students with sufficient visual and exploratory experiences. Consequently, students struggle to construct mental representations of geometric objects, hindering the effective development of their visual-spatial intelligence. This condition is further exacerbated by the limited use of instructional technology capable of displaying dynamic geometric objects.

GeoEnzo is an interactive geometry software that serves as an alternative learning medium, allowing users to draw, manipulate, and visualize spatial figures directly. This software features tools for rotation, construction, and 3D exploration that are highly relevant to the study of cubes and cuboids. Therefore, GeoEnzo is a viable alternative for geometry instruction. Through this application, students

can gain spatial understanding through real visual experiences, which are more effective than traditional static media.

In addition to learning media, the choice of instructional model is vital. Project-Based Learning (PjBL) emphasizes active student participation through the completion of real-world projects. In PjBL, students do not merely receive information; they construct knowledge through processes of planning, execution, and reflection. According to modern learning theories, integrating educational technology with active learning models like PjBL can help students achieve better learning outcomes by providing more engaging and relevant experiences. Accordingly, this study aims to determine how the integration of GeoEnzo within a project-based learning model affects the visual-spatial intelligence of Madrasah Aliyah students regarding cube and rectangular prism materials.

2. RESEARCH METHOD

This study employs a **quasi-experimental approach** with a **pretest-posttest control group design**. This design was selected to compare the improvement in visual-spatial intelligence between students receiving GeoEnzo-integrated Project-Based Learning (PjBL) and those receiving conventional instruction. The research subjects consisted of Grade XI students from Madrasah Aliyah, divided into two groups: the **experimental class** and the **control class**.

The research was conducted through three distinct phases: **preparation, implementation, and evaluation**. The instruments utilized in this study included:

- a) Visual-spatial intelligence tests (Pretest and Posttest).
- b) Student activity observation sheets.
- c) Project assessment rubrics.

Data analysis was performed using **normality and homogeneity tests**, followed by an **independent samples t-test** to determine significant differences in mean scores. Additionally, the **N-Gain (Normalized Gain)** calculation was applied to measure the specific improvement in visual-spatial intelligence.

3. RESULTS AND DISCUSSION

A. Descriptive Data of Visual-Spatial Intelligence Pretest and Posttest

The findings were derived from visual-spatial intelligence tests administered before (pretest) and after (posttest) the intervention in both the experimental and control classes. The descriptive statistics for these test results are presented in Table 1.

Table 1. Descriptive Statistics of Visual-Spatial Intelligence Pretest and Posttest

Group	N	Pretest Mean	Posttest Mean	Max Score	Min Score
Experimental	20	61.20	84.50	95	70
Control	20	60.50	64.80	80	50

Interpretation:

Table 1 indicates that the average pretest scores for both groups were relatively similar, suggesting that the students' initial abilities were equivalent. However, following the intervention, the posttest mean for the experimental class increased significantly compared to the control class. This indicates that **GeoEnzo-integrated Project-Based Learning** has a positive impact on enhancing students' visual-spatial intelligence.

B. Normality and Homogeneity Test Results

Before conducting the hypothesis testing, the data were subjected to **normality and homogeneity tests**. The results indicated that the data were normally distributed and possessed homogeneous variance. Consequently, the assumptions required for the **Independent Samples t-test** were fully met.

C. Hypothesis Test Results (t-test)

The t-test was performed to determine the difference in the mean visual-spatial intelligence scores between the experimental and control groups.

Table 2. t-test Results for Visual-Spatial Intelligence Posttest

Group	Mean Score	t-value (tobs)	t-table (tcrit)	Sig. (p-value)
Experimental	84.50	9.04	2.024	0.000
Control	64.80			

Interpretation:

Based on the results of the **Independent Samples t-test**, the calculated t-value is **9.04** with a significance value (**p-value < 0.05**). Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This confirms that there is a **statistically significant difference** in the learning outcomes between the experimental group and the control group.

D. Analysis of Improvement (N-Gain)

To determine the extent of the improvement in students' visual-spatial intelligence, a **Normalized Gain (N-Gain)** calculation was performed.

Table 3. Average N-Gain of Visual-Spatial Intelligence

Group	Average N-Gain Score	Improvement Category
Experimental	0.60	Moderate
Control	0.11	Low

Interpretation:

Table 3 demonstrates that the improvement in visual-spatial intelligence for the experimental group falls within the **moderate** category, whereas the control group remains in the **low** category. These results indicate that the integration of **GeoEnzo** within the **Project-Based Learning (PjBL)** model is significantly more effective than conventional learning methods.

E. Results of Student Activity and Project Observations

Observational data revealed that students in the experimental group:

- Participated more actively in group discussions.
- Effectively visualized cubes and cuboids (rectangular prisms) using the **GeoEnzo** software.
- Demonstrated high levels of creativity in their project presentations.
- Showed greater confidence when presenting their work.

In contrast, students in the control group tended to be passive and relied solely on abstract imagination without the assistance of interactive visual tools.

4. CONCLUSION

Based on the research findings and subsequent discussion, it can be concluded that the integration of **GeoEnzo** within a **Project-Based Learning** model has a positive and significant impact on improving the visual-spatial intelligence of Madrasah Aliyah students regarding cubes and cuboids. This instructional approach successfully creates a learning environment that is more visual, interactive, and meaningful for students.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Allah SWT for His blessings and guidance throughout this journey. I sincerely thank my beloved parents, Mr. Albinus and Mrs. Agustini Pakpahan, for their endless love, motivation, support, and encouragement.

I would also like to express my sincere appreciation to my supervisor, Dr. Zainal Azis, for his valuable guidance, advice, and support during the research process. My heartfelt thanks also go to all lecturers of

the Master's Program in Mathematics Education (RPL) for their knowledge, encouragement, and contributions to my academic development.

In addition, I would like to thank the Principal of MAS PP Bina Ulama Kisaran for giving me the opportunity to conduct this research, as well as my colleagues for their support and encouragement throughout the process.

Finally, I would like to give special thanks to my niece, Hasna Khansa Adzkadina, who always accompanied and supported me during many late-night work sessions.

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