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<https://journal-gehu.com/index.php/gehu> Effectiveness of Transparent Concrete Media for
Geometry Learning in Improving Junior High School Students' Understanding of Surface
Area Dinar Nirmalasari¹, Halvitri Nurul Hidayah², Claudia Salsabila³ 1,2,3Universitas
Sultan Ageng Tirtayasa, Banten, Indonesia Article Info ABSTRACT Article history:

Received 2025-11-10 Revised 2025-11-19 Accepted 2025-12-28 Mastery of the concept
of surface area in solid figures remains a challenge for junior high school students,
particularly in linking threedimensional representations with their corresponding nets. This
study aimed to examine the effectiveness of transparent solid figures as concrete learning
media in improving students' understanding of surface area concepts. Conducted at
SMPIT Al Mubarak, Serang City, during the 2025/2026 academic year, the study employed
a quantitative method using a one-group pretest–posttest experimental design. Thirty
ninth-grade students were selected through accidental sampling based on accessibility and
availability. A concept comprehension ¹ test was administered before and after the
treatment, and data were analyzed descriptively and inferentially. Results indicated that
students' surface-area comprehension improved significantly following the use of
transparent concrete instructional media. The mean pretest score of 81.43 increased to
100 on the posttest. The Wilcoxon Signed-Rank Test revealed a significance value of
0.000 (<0.05), and the N-Gain score of 1.00 was categorized as high, confirming that
transparent solid media were highly effective in enhancing students' conceptual
understanding of surface area. Keywords: Concrete Media Geometry Learning
Effectiveness Surface Area This is an open-access article under the CC BY-SA

license. Corresponding Author: Dinar Nirmalasari ⁹ Faculty of Teacher Training and
Education, Universitas Sultan Ageng Tirtayasa Email: dinar.nirmalasari@untirta.ac.id 1.

INTRODUCTION 21st-century education requires students to master competencies that
extend beyond factual knowledge, emphasizing critical thinking, creativity, conceptual
understanding, and the ability to apply knowledge in real-life contexts [1]. In mathematics

learning, conceptual mastery is measured not only through computational skills but also through the depth **1** of students' understanding of the meaning behind each mathematical procedure [2]. Ideally, mathematics instruction should emphasize thinking processes **8** that help students discover relationships between concepts rather than focusing solely on final calculation results [3].

<https://doi.org/10.58421/gehu.v5i1.813> 284 Geometry, as a key branch of mathematics, plays a crucial role in developing visual and conceptual thinking skills. Through geometry learning, students are encouraged **1** to understand the relationships between shapes and space and to enhance their spatial visualization abilities [4]. However, studies consistently show that students often face difficulties when learning geometric concepts, especially topics related to three-dimensional figures and their surface areas. These challenges arise because students struggle to visualize 3D objects abstractly [5]. Procedural and symbolic learning approaches also contribute to students' tendency to memorize formulas without understanding their conceptual foundations [6]. **1** As a result, they frequently develop misconceptions when asked to explain the origin of surface area formulas or relate them to nets of solid figures [7]. Therefore, appropriate learning media are needed to provide students with concrete experiences that support the construction of clear conceptual understanding. Constructivism posits that learners actively build knowledge through interaction with their environment and through direct experiences [8]. **7** In the context of geometry learning, this theory can be implemented by incorporating tangible media that allow students to manipulate objects, examine relationships among the components of geometric solids, and derive surface-area concepts through hands-on exploration [9]. Concrete media function as a link connecting real-life experiences with abstract mathematical concepts, thereby enhancing students' conceptual understanding [10]. Evidence from previous **2** research indicates that incorporating concrete learning media into geometry lessons has a positive impact on students' motivation, interest, and conceptual mastery [11]. One relevant development is transparent concrete spatial media,

which has been declared valid and practical in previous development studies. This media is designed from transparent acrylic material that can be opened and rearranged, allowing students to directly see the relationship between the constituent sides and the surface area [12]. Unlike previous studies using opaque or virtual media, this study introduces transparent acrylic-based manipulatives that allow students to visualize the internal structures of 3D solids directly, offering a more comprehensive spatial learning experience. This study aims 1 to evaluate the effectiveness of transparent concrete geometry media in improving junior high school students' conceptual understanding of surface area. The findings are expected to reinforce the theoretical foundations of experiential learning and provide practical guidance for mathematics teachers on using manipulative materials to create learning environments that are more interactive and conducive to deeper understanding. 2. 2 METHOD This study employed a quantitative method using a one-group pretest–posttest experimental design [13]. This design was selected 1 to evaluate the effectiveness of transparent concrete media in enhancing students' understanding of surface area concepts by comparing their scores before and after the intervention [14]. The one-group pretest– posttest design is often employed in educational research to evaluate the improvement in learning outcomes within a single group, without a comparison group [15].

<https://doi.org/10.58421/gehu.v5i1.813> 285 The research procedure consisted of three main stages. The initial phase involved administering a pretest to identify students' baseline understanding of the surface area of solid figures. The second phase consisted of a treatment session during which students participated in learning activities using transparent concrete spatial models (such as cubes, blocks, prisms, pyramids, cylinders, and cones) made from acrylic. These activities allowed students to explore and connect three-dimensional forms with their corresponding nets. The final phase included a posttest designed to evaluate the improvement in students' conceptual comprehension after the intervention. Two validators, a mathematics education lecturer and a mathematics teacher,

reviewed the content validity and appropriateness of the concrete media visualization used. Table 1 presents the research design. Table 1. One-Group Pretest–Posttest Experimental Design Pretest Treatment Posttest $O_1 X O_2$ Description: O_1 = Pre-intervention test result X = Learning using transparent concrete spatial media O_2 = Post-intervention test result The research was carried out in the even semester of the 2025/2026 academic year at SMP IT Al Mubarak in Serang City, Banten. The research population consisted of all ninth grade students at the school, and a sample of 30 was selected via convenience sampling. This technique was selected for its practicality ² in terms of accessibility, participant availability, and classroom teachers' willingness to support the learning intervention. The selection aimed to ensure smooth coordination during the treatment process and to reflect the typical mathematics learning situation at the junior high school level. Data analysis employed both descriptive and inferential statistical techniques. The descriptive analysis summarized the score distribution, sample size, minimum and maximum scores, mean, and standard deviation. Before conducting the inferential analysis, the pretest and posttest scores were assessed for normality using the Shapiro–Wilk test [16]. If the data met the normality assumption (sig. > 0.05), the analysis proceeded with a paired t-test to assess the significance of the difference between the pretest and posttest scores [17]. If the data did ¹⁰ not meet the normality assumption ($p \leq 0.05$), the Wilcoxon Signed-Rank test was employed as the nonparametric procedure [18]. The hypothesis for ¹ this study was stated as follows: H_a : The use of transparent concrete media is effective in improving students' understanding of surface area concepts. H_0 : The use of transparent concrete media is not effective in improving students' understanding of surface area concepts. Interpretation is conducted by comparing the obtained significance value with the 0.05 significance level. If the significance value is < 0.05, it indicates a meaningful difference between the pretest and posttest scores, leading to the acceptance of the alternative hypothesis (H_a) and the rejection of the null hypothesis (H_0). Conversely, if the significance

<https://doi.org/10.58421/gehu.v5i1.813> 286 value is ≥ 0.05 , it shows that no significant difference exists; therefore, 4 the null hypothesis (H_0) is accepted, and the alternative hypothesis (H_a) is rejected [19]. The effectiveness of the treatment is further examined by calculating the Normalised Gain (N-Gain), which is determined using the following formula: $g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$ (1) The classification of N-Gain values used to interpret 2 the level of improvement is presented in Table 2. Table 2. Classification of N-Gain N-Gain Value Criteria $g \geq 0,70$ $0,30 \leq g < 0,70$ $g < 0,30$ High Medium Low 3. 1 RESULTS AND DISCUSSION 3.1. Results This study investigated the effectiveness of transparent concrete media in enhancing students' comprehension of surface-area concepts. Data on student learning outcomes were collected through pretest and posttest assessments administered to 30 participants. Overall, the results indicate a substantial improvement in students' understanding following the intervention, as shown through descriptive, normality, and inferential analyses. A summary of the descriptive statistics for both tests is presented in Table 3. Table 3. Descriptive Statistics

N	Minimum	Maximum	Mean	Std. Deviation	Variance	Pretest	30	70	90	81.43	8.645
645	74.737	100	100	100	0	0	0	0	0	0	0

According to Table 3, the average pretest score of students was 81.43 with a standard deviation of 8.645, while the average posttest score reached 100 with a standard deviation of 0, indicating no variation in the final results. This suggests that all students achieved maximum scores after receiving learning treatment using transparent concrete media. Thus, the descriptive analysis indicates a strong improvement in learning outcomes following the intervention. Prior to conducting inferential analysis on the pretest and posttest scores, a normality assessment was performed using the Shapiro-Wilk test, considering that the total number of participants was fewer than 50. 2 The outcomes of this normality test are summarized in Table 4.

and Posttest Kolmogorov-Smirnova Shapiro-Wilk Statistic df Sig. Statistic df Sig. Pre Test
204 30 .003 .842 30 .000 Post Test .313 30 .000 .754 30 .000 a Lilliefors Significance

Correction **5** Based on the results in Table 4, it is evident that the significance values
(Sig.) for both the pretest and posttest are 0.000, **11** which is less than 0.05. This means
that the data on student learning outcomes before and after the treatment are not normally

distributed. Consequently, a nonparametric Wilcoxon Signed-Rank Test was employed to
examine **2** the difference between pretest and posttest scores rather than a parametric
paired t-test. The Wilcoxon test results are shown in Table 5. Table 5. Wilcoxon Signed-

Rank Test Results	Ranks	N	Mean Rank	Sum of Ranks	Posttest - Pretest	Negative Ranks
0a	.00	.00	Positive Ranks	30b	15.50	465.00
			Ties	0c	Total	30

posttest < pretest b. Posttest > Pretest c. Posttest = Pretest Test Statisticsa Posttest -
Pretest Z -4.819b Asymp. Sig. (2-tailed) <.000 a. Wilcoxon Signed Ranks Test b.

Based on negative ranks. **5** Based on the Wilcoxon test results in Table 5, a Z value of
-4.819 was obtained with a significance value ($p < 0.001$). This finding confirms a
significant difference between the students' pretest and posttest scores. Every student

showed higher scores after instruction with transparent concrete media, indicating that the
media effectively enhanced **1** their understanding of surface area concepts. The N-Gain
score was computed to assess the extent of students' learning improvement, and the

results are summarized in Table 6. Table 6. The N-Gain score results

Respond (1-30)	Spre	SPost	Score	N-Gain	Mean	81.43	100	1.00
As shown in the results presented in Table 6, the mean N-Gain score was 1.00, which is categorized as high according to the interpretation standards outlined in Table 2. This result suggests that								

incorporating transparent solid media greatly improves students' comprehension **1** of
surface area in three-dimensional shapes. All students showed optimal

<https://doi.org/10.58421/gehu.v5i1.813> 288 learning improvement, achieving
maximum scores after **2** the application of this learning media. 3.2. Discussion Cognitive
Effect **1** The results of this study indicate that transparent concrete media are highly

effective in enhancing the understanding of grade IX students of the surface area of solid figures at Al Mubarak Islamic Junior High School. Analytical findings showed a rise in students' mean performance, improving from a pretest score of 81,43 to a posttest score of 100. The Wilcoxon Signed-Rank Test yielded a significance value of 0.000 (< 0.05), indicating that the difference between the pretest and posttest scores was statistically significant. These results confirm that transparent concrete geometry media had a measurable and meaningful impact on students' conceptual understanding of surface area concepts [16].

Constructivist Validation The use of concrete media in mathematics instruction enables students to participate actively through hands-on learning. Through transparent models, students can directly observe the shapes, dimensions, and relationships among the faces of three-dimensional objects, enabling deeper comprehension of surface-area concepts [17]. This aligns with Bruner's theory, which emphasizes the progression from enactive to iconic and symbolic representation when learning abstract mathematical ideas [18]. In this study, students naturally progressed from concrete manipulation to symbolic generalization through the use of transparent media.

Support from Previous Research The effectiveness of transparent concrete media is further supported by previous studies, which show that manipulative and concrete instructional tools significantly enhance students' conceptual mastery and spatial reasoning in geometry [16]. These media facilitate students' visualization of planar relationships and volumetric structures within threedimensional figures [17], reinforcing the cognitive benefits observed in this study.

Spatial Visualization Enhancement Transparent spatial models help students overcome common challenges related to visualizing complex geometric structures. The models enable students to visualize interior and hidden surfaces, facilitating their understanding that surface area is determined by summing all visible and non-visible faces [19]. Such visual access strengthens spatial reasoning and enhances students' ability to interpret the relationships among surfaces in three-dimensional objects [19], [20].

Learning Gain Analysis The mean N-Gain score of 1.00 falls within the high category, indicating that the improvement in student understanding achieved through the

use of transparent concrete media was optimal. These findings are consistent with earlier research demonstrating that

<https://doi.org/10.58421/gehu.v5i1.813> 289 3 the use of concrete instructional media significantly increases motivation and improves learning outcomes in geometry [21], [22]. Affective Engagement Beyond cognitive outcomes, 2 the use of transparent concrete media also contributed to students' affective development. Students exhibited greater enthusiasm, motivation, and active participation during the learning process. The engaging and interactive nature of the media fostered a positive learning environment, increasing focus and involvement [23]. This aligns with Piaget's perspective that meaningful learning arises from direct interaction with concrete objects [24], and is further supported by Dale's cone of experience, which 7 emphasizes the importance of direct experience in enhancing the comprehension 14 of abstract concepts [25]. Pedagogical Implications 1 These findings suggest that integrating transparent media into geometry learning aligns with 21st-century learning principles by supporting inquiry-based instruction, critical thinking, collaboration, and student-centered practices. The media's visual and tactile characteristics make it highly relevant for contemporary mathematics classrooms seeking to enhance conceptual understanding through active learning. Scalability and Digital Adaptation Given its effectiveness, this innovation has strong potential to be scaled through teacher professional development, school-based workshops, and integration into instructional modules. Furthermore, transparent spatial media can be digitalized, such as 2 through augmented reality (AR) platforms or interactive 3D applications, to broaden access and support implementation in blended and virtual learning environments. 4.

CONCLUSION This study aimed 1 to evaluate the effectiveness of transparent concrete geometry media in enhancing junior high school students' conceptual understanding of surface area. The findings 3 demonstrated a substantial improvement in student learning outcomes, as reflected in the increase in the mean score from 81.43 (pretest) to 100 (Posttest). This gain 4 was statistically significant ($p = 0.000 < 0.05$) and supported by a

high N-Gain value of 1.00, indicating a strong conceptual improvement. Conceptually, the transparent media successfully helped students connect abstract geometric ideas with their concrete representations, enabling deeper understanding through direct exploration.

Pedagogically, ³ the use of transparent acrylic-based manipulatives serves as an effective instructional strategy in geometry learning. The media not only improved cognitive outcomes but also stimulated higher student motivation, participation, and engagement throughout ² the learning process. These results align with constructivist learning principles, showing that hands-on and visual experiences ⁸ play a crucial role in strengthening students' understanding of abstract mathematical concepts. Therefore, this media ¹⁴ can be considered a

<https://doi.org/10.58421/gehu.v5i1.813> 290 practical and beneficial tool for teachers seeking to implement active, contextual, and student-centered geometry instruction. Despite its promising ³ results, this study is limited by its implementation in a single school context and its focus on a single geometry topic: the surface area of solid figures. These limitations restrict the generalizability of the findings. Future research is recommended ¹ to examine the effectiveness of transparent geometry media across diverse schools, grade levels, and mathematical topics such as volume, nets, or geometric transformations. ¹³ Longitudinal studies are also needed to investigate the long-term impact on conceptual retention and students' visual-spatial abilities.

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