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DEVELOPMENT OF THE RUANGVERSE INTERACTIVE WEBSITE BASED ON PROJECT-BASED LEARNING AND DEEP LEARNING TO ENHANCE STUDENTS' UNDERSTANDING OF SOLID GEOMETRY CONCEPTS

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ABSTRAK

Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi kelayakan website interaktif RuangVerse yang mengintegrasikan Project-Based Learning (PjBL) dan prinsip Deep Learning pada pembelajaran bangun ruang untuk mendukung pemahaman konsep matematis peserta didik. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan model ADDIE yang meliputi tahap analisis, desain, pengembangan, implementasi, dan evaluasi. Partisipan penelitian terdiri atas tiga validator ahli (ahli materi, ahli media, dan ahli bahasa), tiga guru matematika, serta 33 peserta didik kelas VII SMPN 1 Bayah. Data dikumpulkan melalui lembar validasi, angket respons guru dan peserta didik, serta tes pemahaman konsep. Hasil penelitian menunjukkan bahwa website RuangVerse memperoleh skor validitas sebesar 91% yang termasuk dalam kategori sangat valid. Hasil penilaian kepraktisan menunjukkan skor sebesar 99% dari guru dan 90% dari peserta didik yang keduanya berada pada kategori sangat praktis. Selain itu, pemahaman konsep matematis peserta didik mengalami peningkatan setelah menggunakan RuangVerse yang ditunjukkan oleh skor rata-rata N-Gain sebesar 0,89 yang termasuk dalam kategori tinggi. Temuan ini menunjukkan bahwa RuangVerse berpotensi mendukung peningkatan pemahaman konsep bangun ruang melalui pengalaman belajar yang interaktif, berbasis proyek, dan bermakna. Oleh karena itu, RuangVerse dapat menjadi media pembelajaran matematika yang inovatif untuk mendukung pembelajaran yang aktif dan kontekstual di era digital.

Kata kunci: pembelajaran berbasis proyek, pembelajaran mendalam, pemahaman konsep matematis, website interaktif

ABSTRACT

This study aimed to develop and evaluate the feasibility of the RuangVerse interactive website, which integrates Project-Based Learning (PjBL) and Deep Learning principles for learning solid geometry to support students' conceptual understanding. This study employed a Research and Development (R&D) approach using the ADDIE model, consisting of the analysis, design, development, implementation, and evaluation stages. The research participants included three expert validators (content, media, and language experts) and 33 seventh-grade students at SMPN 1 Bayah. Data were collected using validation sheets, teacher and student response questionnaires, and a conceptual understanding test. The results showed that the RuangVerse website achieved a validity score of 91%, indicating that it was highly valid for learning use. The practicality assessment yielded scores of 99% from teachers and 90% from students, both categorized as very practical. Furthermore, students' conceptual understanding improved after using RuangVerse, as reflected by an average N-Gain score of 0.89, which falls into the high category. These findings indicate that RuangVerse has the potential to support the improvement of students' conceptual understanding of solid geometry through interactive, project-based, and meaningful learning experiences. Therefore, RuangVerse can serve as an innovative mathematics learning medium that supports active and contextual learning in the digital era.

Keywords: deep learning, interactive website, project-based learning, understanding of matchematical concepts

INTRODUCTION

21st-century mathematics education requires students to have a deep conceptual understanding, rather than merely memorizing formulas (Husna & Arifin, 2025). Conceptual understanding in mathematics is a crucial skill that must be developed in mathematics education so that students can actively engage in the learning process, understand concepts deeply rather than merely memorizing formulas, and effectively solve the mathematical problems they encounter (Agustini & Pujiastuti, 2020). Conceptual understanding serves as a fundamental basis for mathematical thinking and problem-solving, as students with strong conceptual understanding are better able to retain, reconstruct, and apply previously learned concepts when solving mathematical problems and addressing real-life situations (Yanti et al., 2022). Therefore, mathematics must be studied thoroughly, especially in the face of 21st-century challenges (Pujiastuti et al., 2020). However,

in practice, mathematics instruction is still dominated by conventional, teacher-centered methods, resulting in students' incomplete grasp of concepts. This situation leads to low levels of mathematical conceptual understanding among students, particularly in abstract geometry topics such as three-dimensional shapes (Irhadtanto et al., 2025). Research on misconceptions regarding three-dimensional shapes indicates that students still make errors in understanding the concepts of surface area, volume, and the relationships between the elements of three-dimensional shapes due to instruction that focuses on memorizing formulas and a lack of conceptual visualization (Nurlatif et al., 2020).

The study of three-dimensional shapes requires a high level of visualization skills because it involves three-dimensional objects that are difficult to grasp through conventional learning (Adnyana, 2025). Furthermore, it is noted that this necessitates the use of instructional media capable of presenting interactive visualizations to help students understand concepts more concretely. The development of technology-based learning media has been proven to help students better understand mathematical concepts and increase student engagement in the learning process (Aminullah & Irwansya, 2024). Research on the development of website-based mathematics learning media by Suryawan & Permana (2020) shows that the use of web-based media can improve the quality of learning and help students understand mathematical concepts more effectively.

Advances in digital technology offer significant opportunities for developing interactive and flexible website-based learning media; such media allow for the integration of various features—such as instructional videos, animations, simulations, and interactive assessments—that can enhance students' learning experiences (Ubaydullaeva et al., 2024). Research on the development of Google Sites-based mathematics learning media using the ADDIE model indicates that web-based media can increase students' interest in learning and help them understand mathematics material considered difficult (Ramdan et al., 2025). Furthermore, the development of web-based learning modules also indicates that web-based media can increase student engagement in mathematics learning and provide a more engaging and flexible learning experience (Fawaid et al., 2025). The results of this study also indicate that the web-based learning media developed

using the ADDIE model is valid and suitable for use in mathematics education, thereby having the potential to optimize the quality of learning.

In addition to the use of technology-based learning media, instructional models also play a crucial role in enhancing the understanding of mathematical concepts (Anggraini, 2023). One learning model that can improve conceptual understanding is Project-Based Learning (PjBL) (Anjarwati et al., 2020). Project-based learning provides students with the opportunity to build knowledge through direct experience and contextual problem-solving (Dinta et al., 2025). Recent research on the integration of technology in Project-Based Learning indicates that the use of technology in PjBL can enhance students' learning experiences and deepen their conceptual understanding (Yani et al., 2024).

In addition to Project-Based Learning, the Deep Learning approach has recently gained considerable attention in educational practice. In the context of education, Deep Learning refers to a learning approach that emphasizes meaningful, mindful, and joyful learning experiences through concept exploration, reflection, and knowledge application (Rahayu et al., 2025). Unlike surface learning, which focuses primarily on memorization, Deep Learning encourages students to construct knowledge actively, connect new concepts with prior understanding, and apply their learning to authentic situations (Diputera et al., 2024). The implementation of Deep Learning generally involves activities such as exploration, conceptual understanding, reflection, and knowledge transfer, all of which aim to develop higher-order thinking skills and deeper conceptual understanding (Ulumiyah & Pratama, 2025). Project-Based Learning (PjBL) is closely aligned with the principles of Deep Learning because it provides students with opportunities to engage directly in solving contextual and real-world problems, thereby fostering critical, analytical, and reflective thinking skills (Maharshall & Nindiasari, 2025). Through project-based activities, students can connect mathematical concepts with real-world situations and develop problem-solving abilities while constructing meaningful understanding. Therefore, integrating Deep Learning principles into technology-based mathematics instruction has the potential to optimize students' conceptual understanding and learning outcomes (Siregar et al., 2025).

Several previous studies have developed website-based learning media using the ADDIE model and obtained valid and practical results. Research on the development of web-based learning media for mathematics instruction indicates that the developed media can enhance student interactivity in the learning process (F. S. W. Laksana & Fiangga, 2022). Additionally, another study developed web-based learning media using VR and found that web-based media can significantly improve students' learning motivation and learning outcomes Su et al. (2022).

However, research that simultaneously integrates interactive websites, Project-Based Learning, and Deep Learning in the context of solid geometry remains limited, as most previous studies have focused solely on the development of web-based learning materials or have applied the Project-Based Learning model without comprehensive technological integration. Furthermore, research specifically developing website-based geometric learning media using a Deep Learning approach is also rarely found, even though the integration of interactive digital media with project-based learning models and deep learning approaches has the potential to provide a more meaningful learning experience and optimally enhance students' understanding of mathematical concepts. Based on this gap, this study developed RuangVerse, an interactive website based on Project-Based Learning and Deep Learning for solid geometry content, utilizing Canva AI to ensure it is visually appealing, interactive, and easily accessible. The novelty of this study lies in the systematic integration of these three components into a single learning medium, equipped with interactive content features, contextual projects, reflection, and evaluation to enhance students' deep understanding of mathematical concepts.

RESEARCH METHOD

This study is a Research and Development (R&D) project aimed at developing an interactive website called RuangVerse based on Project-Based Learning (PjBL) and Deep Learning for the topic of three-dimensional shapes. The development model used in this study is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Cahyadi, 2019). The subjects in this study consisted of expert validators and product users.

The expert validators included one material expert, one media expert, and one language expert whose purpose was to assess the validity of the developed website. The material expert was a mathematics teacher with experience in mathematics instruction and curriculum implementation. The media expert was a mathematics teacher with expertise in instructional media development and the integration of educational technology in learning. Meanwhile, the language expert was a teacher who was competent in evaluating language accuracy, readability, and the appropriateness of language use in educational materials. These validators were selected purposively based on their expertise and experience relevant to the development of the RuangVerse interactive website.

The product users consisted of 33 seventh-grade students (N = 33) and three mathematics teachers at SMPN 1 Bayah. The students participated in the implementation phase and provided responses regarding the practicality of the website, while the teachers completed the practicality questionnaire to evaluate the usability and suitability of RuangVerse for classroom learning. This study focused on testing the validity, practicality, and potential effectiveness of the developed RuangVerse website. To evaluate the improvement in students' conceptual understanding, this study employed a One-Group Pretest–Posttest Design. Students were given a pretest before using the RuangVerse website and a posttest after the learning intervention. The difference between the pretest and posttest scores was analyzed using the N-Gain score to determine the improvement in students' conceptual understanding after using the developed website. The following research procedure uses the ADDIE model, which consists of five stages.

Tabel 1. One-Group Pretest–Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Description: O_1: Pretest of students' conceptual understanding; X: Learning using the RuangVerse interactive website; and O_2: Posttest of students' conceptual understanding

The research design is represented as $O_1 - X - O_2$, where O_1 denotes the pretest, X denotes the learning intervention using the RuangVerse website, and O_2 denotes the posttest. This design was used to measure the improvement in students'

conceptual understanding after the implementation of the developed learning media.

Analysis

In this phase, a learning needs analysis is conducted to identify issues related to the geometry curriculum. The analysis covers student needs, the curriculum, student characteristics, and the subject matter. The results indicate that students require interactive and engaging learning materials to help them understand geometric concepts more concretely and deeply.

Design

This phase involved designing the RuangVerse website based on Project-Based Learning and Deep Learning, designing the website's interface, developing spatial geometry materials, and creating project-based learning activities. Additionally, research instruments were developed during this phase, including an expert validation form, a teacher feedback questionnaire, and a student feedback questionnaire. The RuangVerse website was developed with the help of Canva AI to create an attractive, interactive, and easily accessible interface for students. The website's features are designed to support students' conceptual understanding through interactive materials, 3D visualizations of geometric shapes, project-based activities, quizzes, learning reflections, and assessments.

Development

The development phase was carried out in accordance with the established design, including the creation of the RuangVerse website, the development of spatial geometry materials, and the integration of Project-Based Learning into worksheets and the Deep Learning approach. The resulting products were then validated by subject matter, media, and language experts to assess their suitability, and subsequently revised based on the validators' recommendations.

Implementation

This phase was conducted through a pilot study involving seventh-grade students at SMPN 1 Bayah. The students used the RuangVerse website to learn about three-dimensional shapes and then completed a feedback questionnaire. Next, the teachers also tested the RuangVerse website and completed a teacher feedback questionnaire. The data collected was analyzed to assess the website's ease of use,

appeal, and practicality. Additionally, the students took pre- and post-tests to measure improvements in their conceptual understanding.

Evaluation

This stage is conducted to assess the quality of the product based on expert validation, feedback from educators, and feedback from students. The evaluation involves analyzing data on validity and practicality to determine the website's suitability, which is then used as the basis for final revisions to ensure that RuangVerse is both valid and practical for use in mathematics education.

The instruments used were concept comprehension assessments designed to evaluate improvements in student learning outcomes before and after using the RuangVerse website. The following instruments were used in the pretest and posttest.

Table 2. Indicators of Conceptual Understanding

No	Indicators of Conceptual Understanding
1	Restate concepts that have been learned
2	Classify objects according to the concepts learned
3	Provide examples and non-examples of a concept
4	Apply concepts to problem-solving
5	Relate one concept to another

Kilpatrick (2001) as cited in (Julanda et al., 2023)

The data analysis techniques used in this study include qualitative and quantitative data analysis. Qualitative data were obtained from the suggestions and comments of expert validators, as well as responses from educators and students. These data were analyzed descriptively to inform the revision and refinement of the developed product. Quantitative descriptive analysis was used to evaluate the developed instructional materials based on their validity, practicality, and effectiveness. The following is the formula for expert validation analysis and its assessment criteria, which refer to Oktavia, Ardiawan, & Haryadi (2024).

$$P_v = \frac{x}{x_{max}} \times 100\% \quad (1)$$

Description: P_v: respondent's total score; x_{max}: maximum score

Table 3. Expert Validation Criteria

Validity Percentage	Validity Criteria
$81\% - 100\%$	Very Valid
$61\% - 80\%$	Valid

$41\% - 60\%$	Fairly Valid
$21\% - 40\%$	Invalid
$0\% - 20\%$	Very Invalid

Next, practicality was assessed based on the results of questionnaires completed by educators and students, using a formula and categories of practicality based on Oktavia, Ardiawan, & Haryadi (2024), as follows.

$$P_p = \frac{x}{x_m} \times 100\% \quad (2)$$

Description: P_p: practicality percentage; x: total score obtained; x_m: maximum total score.

Table 4. Product Practicality Criteria

Practicality Percentage	Practicality Criteria
$81\% - 100\%$	Very Practical
$61\% - 80\%$	Practical
$41\% - 60\%$	Moderatly Practical
$21\% - 40\%$	Impractical
$0\% - 20\%$	Very Impractical

Next, effectiveness was assessed based on pretest and posttest results calculated using a formula, which were then interpreted according to criteria referenced from Hake (2002) in Oktavia, Ardiawan, & Haryadi (2024) as follows.

$$N - Gain = \frac{x_{post} - x_{pre}}{x_i - x_{pre}} \quad (3)$$

Description: x_{post}: posttest score; x_{pre}: pretest score; x_i: ideal score

Table 5. N-Gain Score

N-Gain Score	Effectiveness Criteria
$n - gain \geq 0{,}7$	High
$0{,}7 > n - gain \geq 0{,}3$	Moderate
$n - gain < 0{,}3$	Low

Table 6. Product Effectiveness Criteria

Effectiveness Percentage	Effectiveness Criteria
$> 76\%$	Effective
$56\% - 75\%$	Fairly Effective
$40\% - 55\%$	Less Effective
$< 40\%$	Ineffective

RESEARCH RESULTS AND DISCUSSIONS

This research resulted in an interactive website called RuangVerse. The following is a discussion of the development stages, which utilized the ADDIE model.

Analysis

During the analysis phase, preliminary findings indicated that students still struggle with learning three-dimensional geometry, primarily due to their limited ability to visualize three-dimensional shapes, making it difficult for them to fully grasp the concepts. Additionally, the learning process, which remains conventional, results in students being less actively engaged in learning activities. From a curriculum perspective, the school has implemented the Merdeka Curriculum, which emphasizes student-centered learning and encourages the use of technology. However, in reality, the use of technology in teaching three-dimensional shapes has never been implemented.

Given these challenges, there is a need for an educational innovation that can help students visualize three-dimensional shapes in a more concrete and engaging way. Therefore, an interactive website called RuangVerse has been developed. This platform is expected to increase students' interest in learning, simplify the process of visualizing three-dimensional shapes, and strengthen students' understanding of mathematical concepts, thereby ensuring that learning objectives are optimally achieved.

Design

During the design phase, the researchers began developing the concept for the RuangVerse interactive website to meet learning needs. The design process involved creating prompts with the help of Canva AI to generate the desired website design. The prompts covered the website's content structure, including the presentation of materials, worksheets, sample questions, quizzes, and other supporting features. This process was repeated until a design was achieved that aligned with the learning objectives.

Next, the researchers developed assessment instruments to evaluate the suitability of the developed product. These instruments included a validation questionnaire for experts—comprising media experts, language experts, and subject

matter experts—as well as questionnaires for educators and students. In addition, a test instrument was also developed to measure students' conceptual understanding, aligned with the conceptual understanding indicators from Kilpatrick (2001) as cited in Julanda et al., (2023), as shown in Table 1.

Development

During the development phase, the website design was implemented as a tangible product in the form of the RuangVerse interactive website. The researchers began developing the website's content in accordance with the previous design, including the creation of spatial geometry materials, worksheets, sample problems, and interactive quizzes accessible to students. Each component is systematically designed to be user-friendly and to support the learning process. Here is a preview of the RuangVerse interactive website that has been developed.

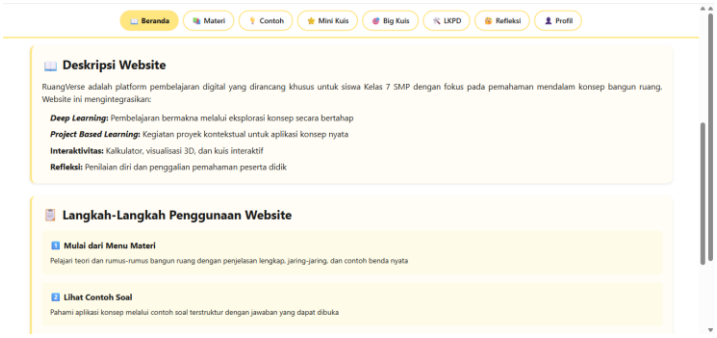

Figure 1. RuangVerse Home Menu View

Figure 2. Course Materials Menu

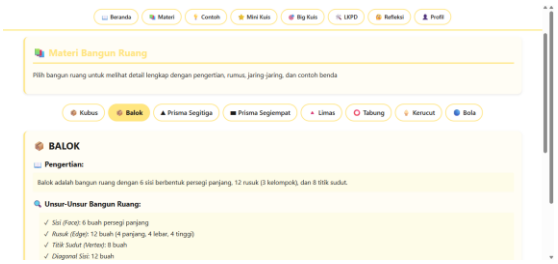

Figure 1 shows the home menu screen in RuangVerse, which includes learning objectives, a website description, instructions for using the website, and icebreaker questions. Next, Figure 2 shows the 3D shapes menu, which consists of cubes, rectangular prisms, prisms, pyramids, cylinders, cones, and spheres. Each section includes definitions, elements of the shapes, formulas, net diagrams, 3D visualizations, and examples of objects for each shape.

Figure 3. Sample Questions

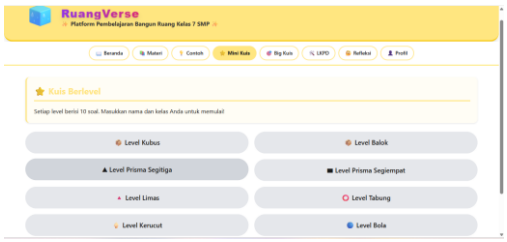

Figure 4. Mini Quiz View

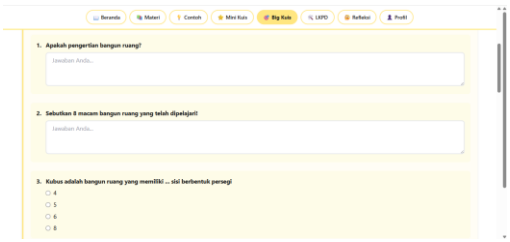

Figure 5. Big Quiz View

Figure 3 shows a sample question screen containing various sample questions covering the entire solid geometry curriculum. Figure 4 shows a mini-quiz screen consisting of 10 questions in each solid geometry category. Figure 5 shows a big quiz screen containing 20 questions covering the entire solid geometry curriculum, with question types including fill-in-the-blank, multiple choice, and true or false.

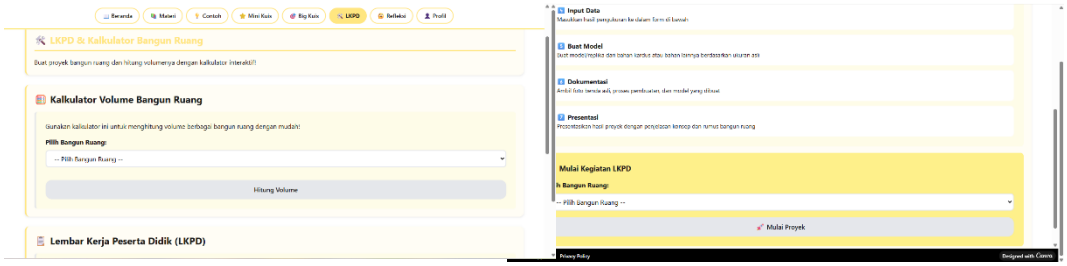

Figure 6. LKPD Menu View

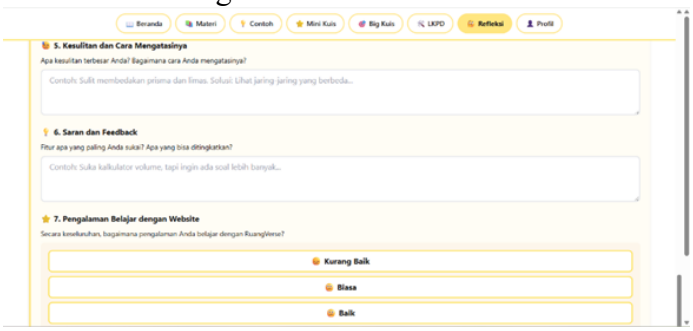

Figure 7. Reflection Menu View

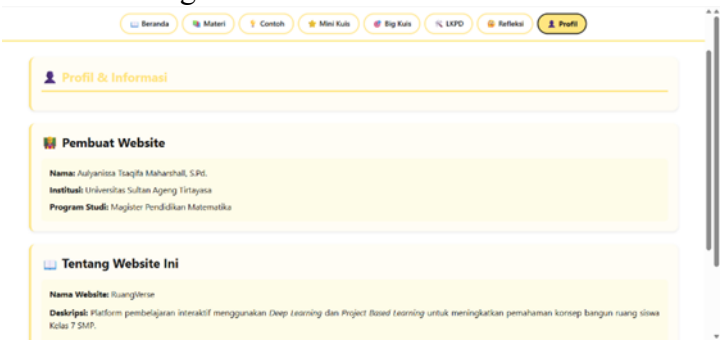

Figure 8. Profile Menu View

Figure 6 shows the LKPD menu, which includes a 3D geometry calculator and project-based activities. Figure 7 shows the reflection menu, which is used to assess students' responses while using RuangVerse and their level of understanding of 3D geometry concepts. Figure 8 shows the profile menu, which contains information about the website's creator, a description of the website, the supervising instructor, and the technology development team behind the RuangVerse website.

Next, the developed product was validated by experts—including media experts, language experts, and subject matter experts—to assess the website's suitability from various perspectives. The validation results were used as the basis for making improvements and refinements to the product. Revisions were made until the RuangVerse interactive website was deemed suitable for use in learning.

Below are the validation results from media experts, subject matter experts, and language experts regarding the RuangVerse website.

Table 7. Product Validation Results by Experts

Validator	Validity Percentage	Validity Criteria
Media Expert	91%	Very Valid
Material Expert	90%	Very Valid
Language Expert	92%	Very Valid
Overall Validator Results	91%	Very Valid

The results of the RuangVerse product validation by experts indicate that the developed media has a very high level of suitability. The assessment by media experts yielded a score of 91%, indicating that the website's design, navigation, and technical aspects are excellent and user-friendly. Furthermore, the validation results from content experts reached 90%, meaning that the spatial geometry content presented aligns with the curriculum, is accurate, and supports the achievement of learning objectives. Meanwhile, validation by language experts yielded a score of 92%, indicating that the language used on the website is clear, communicative, and easily understood by students. Overall, the average validation score from the three experts is 91%, meeting the "highly valid" criteria, so the RuangVerse product is deemed suitable for use in education.

However, the language expert suggested adding prompt questions at the beginning of the learning materials to stimulate students' critical thinking and activate their prior knowledge before studying the content. Prior to the revision, the learning materials presented explanations of solid geometry concepts directly without any introductory prompt questions. Based on this recommendation, the materials were revised by incorporating prompt questions at the beginning of each topic to encourage students to reflect on their prior experiences, generate initial ideas, and engage more actively with the learning content. The comparison between the product before and after revision is presented in Figure 9 and Figure 10.

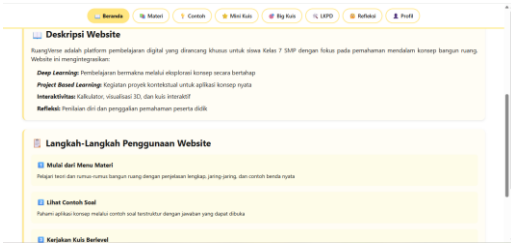

Figure 9. RuangVerse Display Before the Addition of Prompt Questions

Figure 10. RuangVerse Display After the Addition of Prompt Questions

Implementation

During the implementation phase, the developed product was pilot-tested on a limited scale with seventh-grade students at SMPN 1 Bayah. The students used the RuangVerse interactive website to learn about three-dimensional shapes and then completed a feedback questionnaire to evaluate the practicality of the medium. In addition, teachers also tested RuangVerse and completed a teacher feedback questionnaire.

Table 8. Results of the Survey on Educators' and Students' Perceptions of the Product's Practicality

Respondent	Practicality Percentage	Practicality Criteria
Teachers	99%	Very Practical
Students	90%	Very Practical

Table 8 shows the results of the questionnaires completed by educators and students. The educator questionnaire yielded a practicality score of 99%, which falls within the "very practical" category. Although the score was very high, it did not reach the maximum value because several indicators were rated as "good" rather than "very practical." In particular, the items "The RuangVerse interactive website supports learning through group projects" and "The RuangVerse interactive website helps students collaborate within their groups" each received a "good" rating from one respondent. These results indicate that, while the developed website was perceived very positively overall, there were still aspects identified as having room for improvement. Therefore, the practicality score reflects the respondents' actual evaluations rather than a perfect assessment. Meanwhile, the student questionnaire yielded a practicality score of 90%, which was also categorized as "very practical." The assessment covered aspects of appearance, ease of use, the implementation of

Project-Based Learning and Deep Learning, support for conceptual understanding, and learning motivation. Overall, these findings indicate that RuangVerse is practical and easy to use in the learning process.

The effectiveness of the RuangVerse interactive website was evaluated through students' pretest and posttest scores on conceptual understanding of solid geometry. Before conducting the N-Gain analysis, descriptive statistics were examined to provide an overview of students' performance before and after the implementation of the developed website. The descriptive statistics of the pretest and posttest scores are presented in Table 9.

Table 9. Descriptive Statistics of Pretest and Posttest Scores

Test	*N*	Mean	Std. Deviation	Score Minimum	Score Maximum
Pretest	33	51.06	16.85	15	75
Posttest	33	94.54	6.88	80	100

Based on Table 9, the mean score increased substantially from 51.06 on the pretest to 94.54 on the posttest. Furthermore, the minimum score increased from 15 to 80, while the maximum score increased from 75 to 100. The standard deviation also decreased from 16.85 to 6.88, indicating that students' scores became more homogeneous after the learning intervention. These findings suggest that students demonstrated a better understanding of solid geometry concepts after learning using the RuangVerse interactive website.

To determine the magnitude of the improvement in students' conceptual understanding, the N-Gain score was calculated. The results of the N-Gain analysis are presented in Table 10.

Table 10. N-Gain Score Result

	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain Score	33	.50	1.00	.8932	.13737
N_Gain Score (%)	33	50.00	100.00	89.32	13.737

As shown in Table 10, the average N-Gain score obtained was 0.89, which falls into the high category. Furthermore, the effectiveness percentage reached 89.32%, indicating that the developed website met the criteria of effective learning

media. These results demonstrate that the RuangVerse interactive website effectively improved students' understanding of solid geometry concepts. The substantial improvement may be attributed to the integration of Project-Based Learning (PjBL), Deep Learning principles, and interactive website features that facilitate meaningful learning experiences and active student engagement.

Evaluation

During the evaluation phase, a comprehensive assessment of the quality of the RuangVerse product was conducted based on expert validation results, teacher feedback, and student feedback. The validation results indicated that RuangVerse met the criteria for "highly valid," while the results of the teacher and student feedback surveys indicated that it met the criteria for "highly practical." These findings confirm that the developed website meets the standards of suitability in terms of content, design, and use in learning.

The evaluation was conducted through an analysis of validity and practicality data to ensure the quality of the product. Although several suggestions for improvement were made, revisions were implemented, resulting in a more optimal final product. Consequently, RuangVerse has been deemed suitable for use as a mathematics learning tool for three-dimensional shapes, as it meets the criteria for validity and practicality and is capable of effectively supporting the learning process. You can access RuangVerse at: https://bit.ly/RuangVerseEd

DISCUSSION

Based on the results of the above analysis, the development of the RuangVerse interactive website—based on PjBL and Deep Learning—for conceptual understanding of three-dimensional shapes using the ADDIE model indicates that the resulting product is feasible, practical, and effective for use in mathematics education. During the analysis phase, it was found that students still experience difficulties in learning three-dimensional shapes, particularly in visualizing three-dimensional objects. This finding aligns with Nurhikmayati (2017) research, which states that three-dimensional geometry material is abstract and thus requires strong visualization skills, and that limitations in visualization are the primary cause of students' learning difficulties.

RuangVerse is designed as an integrated technology-based learning platform that combines course materials, worksheets, practice problems, and interactive quizzes into a single, systematic platform. Each component is designed to support the learning process: course materials serve as the foundation for conceptual understanding, worksheets encourage active engagement through project-based activities, practice problems help reinforce understanding, and interactive quizzes provide both assessment and feedback for students. Technology-based media allows abstract concepts, such as three-dimensional shapes, to be presented more concretely through engaging and dynamic visualizations. This aligns with the research by Jundu, Jehadus, Nendi, Kurniawan, & Men (2019), which states that interactive learning media can enhance understanding of mathematical concepts and make students more active in learning, as it helps them grasp various mathematical concepts more easily. Furthermore, Etyarisky & Marsigit (2022) also state that students' understanding of mathematical concepts in the experimental class was higher than in the control class, thus confirming that interactive multimedia learning is effective in improving students' ability to understand mathematical concepts.

Furthermore, RuangVerse has met the criteria for suitability in terms of content, presentation, and language use, making it suitable for use in learning with only minor revisions required. This aligns with various studies on the development of technology-based learning media, which indicate that products that have undergone expert validation are generally suitable for use and capable of optimally supporting the learning process (Januarisman & Anik Ghufron, 2016). The use of RuangVerse in learning demonstrates high practicality, indicating that well-designed interactive media tends to be easy to use, engaging, and capable of enhancing student engagement and motivation (Auria et al., 2025).

The use of RuangVerse was effective in improving students' conceptual understanding. This finding is supported by the increase in students' mean score from 51.06 on the pretest to 94.54 on the posttest. Furthermore, the average N-Gain score reached 0.89, which falls into the high category, while the effectiveness percentage reached 89.32%, indicating that the developed website met the criteria of effective learning media. This finding is consistent with the research by Etyarisky

& Marsigit (2022), which states that interactive multimedia in geometry instruction can significantly improve conceptual understanding.

The effectiveness of RuangVerse in improving students' conceptual understanding may be attributed to several key features embedded within the website. Among these features, the learning materials component appears to contribute most significantly to students' spatial visualization. The materials present three-dimensional solid geometry objects in an interactive 3D format that can be rotated and viewed from multiple perspectives. Through this feature, students are able to observe the structure and characteristics of geometric solids directly rather than relying solely on mental imagination. This is particularly important because difficulties in visualizing three-dimensional objects are one of the main obstacles faced by students when learning solid geometry. By allowing students to manipulate and examine objects from different angles, the website helps bridge the gap between abstract geometric concepts and concrete visual representations, thereby facilitating deeper conceptual understanding.

In addition, the integration of Deep Learning principles supports meaningful learning through concept exploration, reflection, and knowledge application. The prompt questions, worksheets, and interactive activities encourage students to think critically, reflect on their understanding, and connect new knowledge with prior experiences. Furthermore, the website allows students to access learning materials independently while receiving immediate feedback through quizzes, creating a more active and student-centered learning environment..

The project activities embedded within RuangVerse also contributed significantly to students' conceptual understanding. The projects were designed as a continuous learning process rather than a single assignment. Initially, students were asked to observe and identify objects in their surrounding environment that represented various solid geometry shapes. Through this activity, students recognized that mathematical concepts are closely related to objects encountered in everyday life. They then analyzed the dimensions of these objects and used the calculator feature available in RuangVerse to determine their surface area and volume.

The project activities continued through group discussions and the construction of solid geometry models based on the objects they had identified. These experiences enabled students to connect abstract mathematical concepts with concrete representations. As a result, students gained a clearer understanding of the practical application of solid geometry concepts, particularly in recognizing real-world examples of geometric solids and understanding how concepts such as volume and surface area are applied in everyday situations. Therefore, the project activities facilitated meaningful learning by enabling students to construct knowledge through direct experience and authentic contexts.

Soal Nomor 4

Sebuah kotak berbentuk balok memiliki panjang 10 *cm, lebar* 8 *cm, dan tinggi* 5 *cm.*

a) Hitung volume kotak tersebut!

b) Jika kotak tersebut akan diisi air, apakah 0,3 *liter air cukup untuk mengisinya?*

Jelaskan alasanmu.

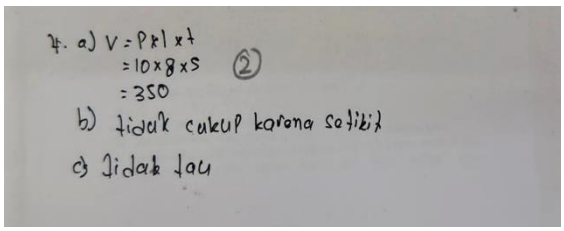

Figure 10. Student responses - Pretest

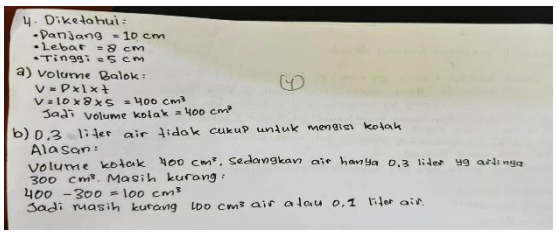

Figure 11. Student responses - Prosttest

Figure 11. shows that students were able to solve the problems using a systematic approach and correctly apply concepts of three-dimensional shapes to problem-solving. Students did not merely rely on formulas; they were also able to identify the appropriate concepts and use them to solve the given problems. This indicates that students have met the indicators of conceptual understanding, particularly in applying mathematical concepts to problem-solving in an accurate and structured manner.

The interactive features of RuangVerse provide students with the opportunity to learn independently, explore the material, and receive immediate feedback through the available quizzes, thereby increasing student engagement and

motivation. This demonstrates that RuangVerse is not only relevant to the learning needs of the digital age but also effective in helping students gain a deeper understanding of mathematical concepts. Overall, RuangVerse supports a more active and meaningful learning process through interactive visual presentations, thereby encouraging student engagement while serving as an effective solution to overcome difficulties in understanding abstract material.

CONCLUSIONS

Based on the results of this research and development study, it can be concluded that the RuangVerse interactive website, developed using the ADDIE model and integrating Project-Based Learning (PjBL) and Deep Learning principles, is valid, practical, and capable of supporting improvements in students' conceptual understanding of solid geometry. The improvement was reflected in the increase in students' learning outcomes and the high N-Gain score achieved after the implementation of the website. The interactive 3D visualizations, project-based activities, and meaningful learning experiences provided by RuangVerse helped students connect abstract mathematical concepts with real-life situations.

This study contributes theoretically to the development of technology-enhanced mathematics learning by demonstrating the integration of PjBL and Deep Learning principles within a web-based learning environment. Practically, RuangVerse can serve as an alternative learning medium for teaching abstract mathematical concepts, particularly solid geometry.

This study was limited to a small-scale implementation involving 33 seventh-grade students from a single school and employed a one-group pretest–posttest design. Therefore, future studies are recommended to conduct broader trials involving schools with different characteristics and larger sample sizes. In addition, further development of RuangVerse can be carried out for other mathematics topics and evaluated using experimental or quasi-experimental research designs.

REFERENCES

Adnyana, I. M. S. (2025). Pengembangan Media Pembelajaran Interaktif Berbasis Android Untuk Visualisasi Bangun Ruang Pada Mahasiswa PGSD Semester III STKIP Agama Hindu Amlapura. *Pendas: Jurnal Ilmiah Pendidikan Dasar*,

10(4), 256–265. https://doi.org/https://doi.org/10.23969/jp.v10i04.39115

Agustini, D., & Pujiastuti, H. (2020). Analisis Kesulitan Siswa Berdasarkan Kemampuan Pemahaman Matematis dalam Menyelesaikan Soal Cerita Pada Materi SPLDV. *Media Pendidikan Matematika*, *8*(1), 18–27. https://ojspanel.undikma.ac.id/index.php/jmpm/article/view/2568

Aminullah, & Irwansya. (2024). Analisis Efektivitas Penggunaan Teknologi dalam Pembelajaran Matematika. *JagoMIPA: Jurnal Pendidikan Matemaika Dan IPA*, *4*(4), 678–687. https://doi.org/https://doi.org/10.53299/jagomipav4i4.721

Anggraini, S. (2023). Learning Concepts Learning Approach Modelsin Improving Students' Understanding of Mathematical Concepts. *EDUCTUM: Journal Research*, *2*(5), 136–139. https://doi.org/https://doi.org/10.56495/ejr.v2i5.416

Anjarwati, S., Pujiastuti, H., & Ihsanudin. (2020). Pengembangan Pocket Book Digital Berbasis *Project Based Learning* Menggunakan GeoGebra Untuk Meningkatkan Pemahaman Konsep Matematis Siswa SMP. *Wilangan: Jurnal Inovasi Dan Riset Pendidikan Matematika*, *3*(2), 111–118. https://doi.org/http://dx.doi.org/10.62870/wjirpm.v3i2.13414

Auria, A., P, D. A. R., Simbolon, N. W., Wulan, E. N., & Sasalia, S. (2025). Pengembangan Penggunaan Media 3D SketchUp dalam Mendukung Pembelajaran Matematika yang Efektif. *Jurnal BasicEdu*, *9*(4), 956–965. https://doi.org/https://doi.org/10.31004/basicedu.v9i4.10014ISSN 2580-1147(Media Online)

Cahyadi, R. A. H. (2019). Pengembangan Bahan Ajar Berbasis *ADDIE Model*. *Halaqa: Islamic Education Journal*, *3*(1), 35–43. https://doi.org/10.21070/halaqa.v3i1.2124

Dinta, S. A., Putri, A., Afina, Fadilasari, N. S., & Andriesgo, J. (2025). Analisis Literatur Tentang Strategi Kurikulum Pembelajaran Berbasis Proyek dalam Penguatan Keterampilan Siswa. *Irfani*, *21*(2), 428–445. https://doi.org/https://doi.org/10.30603/irfani.v21i2.6548

Diputera, A. M., Zulpan, & Eza, G. N. (2024). Memahami Konsep Pendekatan *Deep Learning* dalam Pembelajaran Anak Usia Dini yang *Meaningful*, *Mindful*, dan *Joyful*: Kajian Melalui Filsafat Pendidikan. *Bunga Rampai Usia Emas (BRUE)*, *10*(2), 108–120. https://doi.org/https://doi.org/10.24114/jbrue.v10i2.65978

Etyarisky, V., & Marsigit. (2022). The Effectiveness of Interactive Learning Multimedia with a Contextual Approach to Student ' s Understanding Mathematical Concepts. *Al-Ishlah: Jurnal Pendidikan*, *14*(3), 3101–3110. https://doi.org/10.35445/alishlah.v14i3.941

Fawaid, Faulina, R., & Sari, D. I. (2025). Pengembangan E-Modul Berbasis Etnomatematika Pada Materi Bangun Ruang Sisi Datar. *Journal Numeracy*, *12*(1), 51–66. https://doi.org/https://doi.org/10.46244/numeracy.v12i1.3092

Husna, W., & Arifin, F. (2025). Penerapan Media Geoboard untuk Meningkatkan Pemahaman Konsep Bangun Datar Siswa Kelas IV SD. *EDUKASI TEMATIK: Jurnal Pendidikan Sekolah Dasar*, *6*(2), 128–134. https://doi.org/https://doi.org/10.59632/edukasitematik.v6i2.518

Irhadtanto, B., Cuhanazriansyah, M. R., & Pratama, A. (2025). Revitalisasi Pembelajaran Bangun Ruang melalui Kolaborasi Kontekstual RME dan

STEAM. *POLINOMIAL: Jurnal Pendidikan Matematika*, *4*(3), 595–604. https://doi.org/https://doi.org/10.56916/jp.v4i3.2130

Januarisman, E., & Anik Ghufron. (2016). Pengembangan Media Pembelajaran Berbasis Web Mata Pelajaran Ilmu Pengetahuan Alam Untuk Siswa Kelas VII. *Jurnal Inovasi Teknologi Pendidikan*, *3*(2), 166–182. https://doi.org/https://doi.org/10.21831/jitp.v3i2.8019

Julanda, R., Medika, G. H., Rahmat, T., & Firmanti, P. (2023). Pengaruh Pendekatan *Scaffolding* Terhadap Pemahaman Konsep Matematika Siswa. *Journal of Education and Science*, *1*(2), 81–90. https://doi.org/https://doi.org/10.57255/edusains.v1i2.953

Jundu, R., Jehadus, E., Nendi, F., Kurniawan, Y., & Men, F. E. (2019). Optimalisasi Media Pembelajaran Interaktif dalam Meningkatkan Kemampuan Matematis Anak di Desa Popo Kabupaten Manggarai. *E-DIMAS: Jurnal Pengabdian Kepada Masyarakat*, *10*(2), 221–225. https://doi.org/https://doi.org/10.26877/e-dimas.v10i2.3353

Laksana, F. S. W., & Fiangga, S. (2022). The Development of Web-Based Chatbot as Mathematics Learning Media on System of Linear Equations In Three Variables. *MATHEdunesa*, *11*(1), 145–154. https://doi.org/https://doi.org/10.26740/mathedunesa.v11n1.p145-154

Maharshall, A. T., & Nindiasari, H. (2025). *From Surface to Deep*: Pembelajaran Berbasis *Deep Learning* dan PjBL untuk Penguatan Kemampuan Pemecahan Masalah Matematis. *FIBONACCI : Jurnal Pendidikan Matematika Dan Matematika*, *11*(2), 179–192. https://doi.org/https://dx.doi.org/10.24853/fbc.11.2.179-192

Nurhikmayati, I. (2017). Kesulitan Siswa Berpikir Abstrak Matematika dalam Pembelajaran Problem Posing Berkelompok. *KALAMATIKA:Jurnal Pendidikan Matematika*, *2*(2), 159–176. https://doi.org/https://doi.org/10.22236/KALAMATIKA.vol2no2.2017pp159-176

Nurlatif, L., Muchyidin, A., & Nursuprianah, I. (2020). Miskonsepsi Siswa Pada Pemahaman Konsep Bangun Ruang. *JRPM (Jurnal Review Pembelajaran Matematika)*, *5*(2), 72–86. https://doi.org/https://doi.org/10.15642/jrpm.2020.5.2.72-86

Oktavia, S., Ardiawan, Y., & Haryadi, R. (2024). Pengembangan Media Pembelajaran Berbasis Web Pada Bangun Ruang Sisi Datar terhadap Kemampuan Komunikasi Siswa SMP. *JagoMIPA: Jurnal Pendidikan Matemaika Dan IPA*, *4*(1), 236–247. https://doi.org/https://doi.org/10.53299/jagomipa.v4i2.559

Pujiastuti, H., Utami, R. R., & Haryadi, R. (2020). The development of interactive mathematics learning media based on local wisdom and 21st century skills: social arithmetic concept. *Journal of Physics: Conference Series*, *1521*(3), 1–7. https://doi.org/10.1088/1742-6596/1521/3/032019

Rahayu, C., Setiani, W. R., Yulindra, D., & Azzahra, L. (2025). Pendidikan Matematika Realistik Indonesia dalam Pembelajaran Mendalam (*Deep Learning*) Tinjauan Literatur. *Jurnal Pendidikan MatematikaUniversitas Lampung*, *13*(1), 9–25. https://doi.org/https://dx.doi.org/10.23960/mtk/v13i1.pp9-25

Ramdan, A. Y., Atiaturrahmaniah, & Watoni, M. (2025). Pengembangan Media

Pembelajaran Interaktif Berbasis Google Sites untuk Meningkatkan Hasil Belajar Matematika Kelas 5 SD Negeri 1 Pringgasela Selatan. *CJPE: CokroaminotoJuornal of Primary Education*, *8*(4), 1986–1999. https://doi.org/https://doi.org/10.30605/cjpe.8.4.2025.7088

Siregar, F. D., Adrianto, I., Azizi, M. F., & Aprillio, Y. (2025). Pengaruh Pendekatan *Deep Learning* Berbantuan Media PPT Interaktif Berbasis Geogebra terhadap Hasil Belajar Trigonometri Siswa. *JRPMS (Jurnal Riset Pembelajaran Matematika Sekolah)*, *9*(September), 95–104. https://doi.org/https://doi.org/10.21009/jrpms.092.10

Su, Y.-S., Cheng, H.-W., & Lai, C.-F. (2022). Study of Virtual Reality Immersive Technology Enhanced Mathematics Geometry Learning. *Frontiers in Psychology*, *13*, 1–8. https://doi.org/10.3389/fpsyg.2022.760418

Suryawan, I. P. P., & Permana, D. (2020). Media Pembelajaran Online Berbasis Geogebra sebagai Upaya Meningkatkan Pemahaman Konsep Matematika. *PRISMA*, *9*(1), 108–117. https://www.academia.edu/99883954/Media_Pembelajaran_Online_Berbasis_Geogebra_sebagai_Upaya_Meningkatkan_Pemahaman_Konsep_Matematika

Ubaydullaeva, S., Umurova, G., Botirova, S., Yakhshiev, A., Mavlyanova, U., Nazirova, S., Khalova, M., & Kim, O. (2024). Modular Web-based Learning Model to Address Underdeveloped ICT Infrastructure for Smart E-learning Education System. *Journal of Internet Services and Information Security (JISIS)*, *14*(4), 450–461. https://doi.org/10.58346/JISIS.2024.I4.028

Ulumiyah, D., & Pratama, M. A. (2025). Literasi Sains Siswa Sekolah Dasar Melalui Pendekatan Pembelajaran Mendalam (*Deep Learning*). *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *10*(04), 258–269. https://doi.org/https://doi.org/10.23969/jp.v10i04.35774

Yani, I. P., Ahzari, S., Asrizal, & Novitra, F. (2024). Technology Integration in the Project Based Learning Model: Bibliometric Analysis 2015-2024. *Pillars of Physics Education*, *17*(2), 143–149. https://doi.org/https://doi.org/10.24036/16204171074

Yanti, A. W., Kusumawardani, A. D. P., Rohmah, F. M., & Kulsum, U. (2022). Pemahaman Konsep Siswa Dalam Menyelesaikan Masalah Matematika Pada Materi Fungsi Kuadrat Menurut Teori Kilpatrick. *MUST:Journal of Mathematics Education, Science and Technology*, *7*(1), 30–49. https://doi.org/http://dx.doi.org/10.30651/must.v7i1.1093