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ORIGINAL

VR-Edupanc: Development of a Virtual Reality-Based Digital Game Learning Model for Civic Education in Elementary Schools

VR-Edupanc: Desarrollo de un modelo de aprendizaje de juegos digitales basado en realidad virtual para la educación cívica en escuelas primarias

Gilang Maulana Jamaludin[1], Muhammad Japar[1], Mohammad Syarif Sumantri[1]

[1]Universitas Negeri Jakarta. Jakarta, Indonesia.

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Corresponding Author: Gilang Maulana Jamaludin

ABSTRACT

Introduction: this research focuses on the development and initial evaluation of the VR-Edupanc application, a Virtual Reality-Assisted Digital Game-Based Learning learning medium to support the understanding of Pancasila values in elementary school students. This application was developed as a solution to overcome the still abstract and less interesting learning in Pancasila Education.
Method: this research uses the Research and Development method by adapting the Dick and Carey learning design model which is limited to the formative evaluation stage. The research process includes product design, expert validation, and limited trials on students. Validation was carried out by two material experts, two media experts, and one linguist using a Likert scale instrument, while the user response test involved nine fifth-grade students through a small group evaluation.
Results: the results showed that the VR-Edupanc application was categorized as very feasible, with an average validation score of 90,6 % from material experts, 89,3 % from media experts, and 85,3 % from linguists. Student responses also showed a very feasible category with an average score of 90,1 %, especially in the aspect of increasing student motivation, engagement, and understanding in Pancasila learning. Thus, the VR-Edupanc application has been declared to meet the eligibility criteria as an interactive learning medium that provides an immersive learning experience.
Conclusions: however, this research is still limited to the formative evaluation stage, so further research is needed to test its practicality and effectiveness on a broader scale.

Keywords: Virtual Reality; Digital Game-Based Learning; Pancasila Education; Interactive Learning Media; Elementary School.

RESUMEN

Introducción: esta investigación desarrolla VR-Edupanc, un medio de aprendizaje basado en Realidad Virtual - Aprendizaje Digital Asistido por Juegos, con el objetivo de mejorar la comprensión de los valores de Pancasila por parte de los estudiantes de primaria. Esta innovación está diseñada para abordar el aprendizaje que tiende a ser abstracto, poco interactivo y aún no es capaz de fomentar la participación activa de los estudiantes en la Educación de Pancasila.
Método: la investigación utiliza un enfoque de Investigación y Desarrollo con el modelo Dick and Carey, limitado hasta la etapa de evaluación formativa. Las etapas de la investigación incluyen el diseño del producto, la validación por expertos y las pruebas limitadas a través de la evaluación de grupos pequeños. Los participantes consistieron en dos expertos en contenido, dos expertos en medios y un experto en lenguaje como validador, así como nueve estudiantes de quinto grado en la etapa de prueba. El instrumento de evaluación utilizó una encuesta de escala Likert y se analizó de forma descriptiva cuantitativa para determinar el nivel de viabilidad del producto.

Resultados: VR-Edupanc es considerado muy apropiado para la enseñanza. Los expertos en contenido validaron con un promedio del 90,6 %, los de medios con un 89,3 % y los de lenguaje con el 85,3 %. Los alumnos también respondieron con un promedio del 90,1 %, lo que los colocó en la categoría de muy viable, sobre todo en cuanto a interactividad, motivación y entendimiento de los principios de Pancasila. VR-Edupanc demostró ser viable como medio de aprendizaje interactivo e inmersivo para apoyar la comprensión y la internalización de los valores de Pancasila en los estudiantes de primaria.
Conclusiones: se necesita realizar una investigación adicional para probar la practicidad y la efectividad a mayor escala.

Palabras clave: Realidad Virtual; Aprendizaje Basado en Juegos Digitales; Educación Pancasila; Medios de Aprendizaje Interactivos; Escuela Primaria.

INTRODUCTION

With the tremendous potential of virtual reality (VR) to raise learning standards, the swift advancement of digital technology has sparked a revolution in the field of education. The potential of virtual reality (VR) can enhance students' conceptual comprehension[1] facilitate collaborative learning environments,[2] and increase students' emotional engagement during learning.[3] Additionally, VR can significantly enhance students' critical thinking and problem-solving abilities,[4] as well as their involvement with and perception of the course materials.[5,6] This suggests a paradigm shift, where technology is not only an adjunct to education but a transformative instrument that alters pedagogical frameworks and educational experiences.[7] This emphasises the necessity of cautious implementation and support systems when incorporating virtual reality (VR) into teaching.

In light of this, VR-assisted Digital Game-Based Learning (DGBL) techniques are emerging as a viable means of overcoming obstacles in traditional education. VR's capacity to close the gap between contemporary learners and traditional education.[8] Learning materials are better understood and retained when VR is used to build engaging learning environments within a DGBL framework.[9] Significant participation,[10,11] an active learning environment, and improved access to educational resources[12] are some of its benefits. Students' self-directed learning efforts,[13] learning motivation,[14] perceptions of immersion, self-efficacy, and overall accomplishment[15] are all improved by the incorporation of interactive games into virtual reality. As a result, instructors must receive professional development that equips them with the necessary tools to incorporate virtual reality into their lesson plans.[16] This can result in learning experiences that are both effective and engaging, catering to the diverse needs of students.[17] This holds for Pancasila schooling as well as all other topics.

National identity is significantly influenced by Pancasila learning, a component of citizenship and character education. Fostering responsible citizens,[18] and enhancing a deeper understanding of Pancasila ideals[19,20] requires the inculcation of good values, ethics, and civic character. By fostering national identity, promoting respect for diversity, and upholding dedication to national sovereignty, educators play a crucial role in shaping the present generation.[21] To achieve the objectives of Pancasila and Citizenship education, effective pedagogical techniques are essential.[22] According to [23], incorporating digital platforms into Pancasila education can enhance accessibility and foster a deeper understanding of their civic responsibilities. However, several pedagogical obstacles frequently affect Pancasila learning in elementary schools, including the use of abstract material, low student attention, and teacher-centred, repetitive teaching strategies. Deep comprehension and appreciation of Pancasila ideals are not adequately fostered by traditional learning techniques that emphasise memorisation.

There is still a research gap in applying DGBL to value-based subjects like Pancasila, especially at the elementary school level, even though numerous prior studies have shown how effective it is at improving learning outcomes in science and technology,[24,25,26] chemical reaction exploration,[27] political education,[28] physical education and sports training,[29,30] and digital content.[31] There is currently relatively little research on the combined use of VR and DGBL in Indonesian value education. Therefore, this study developed and application called VR-Edupanc, and aims to assess the feasibility and initial user responses of integrating virtual reality (VR) into a Digital Game-Based Learning (DGBL) Model for Pancasila instruction in primary schools. Through interactive and immersive digital learning experiences, the research aims to (1) improve students' comprehension of Pancasila concepts and (2) strengthen the internalisation of national values as a means of appreciating and implementing Pancasila values in daily life. It is anticipated that this study will provide empirical support for the potential of virtual reality and digital game-based technology as innovative educational tools that can help develop children's cognitive abilities and character at a young age.

METHOD

Type of study

This research product is an R&D (Research and Development) project, more focused on the design process and formative evaluation of a prototype VR-Edupanc as a learning media for Pancasila values based on Virtual Reality. This development is framed within the ID model of Dick and Carey,[32] in this case, was used only until the formative evaluation phase (learning objectives identification, instructional analysis, product design, expert validation, and small-scale trials). The experiment was conducted from January to April 2025 in Majalengka Regency, West Java, at a local trial site, SDN Padasuka III.

Population and Sample

The population of this study comprised all fifth-grade students of an elementary school in Majalengka Regency who had received Pancasila Education, as well as experts with related expertise in the subject areas, such as competencies in Pancasila Education, educational technology, and language. There were no respondents available to choose at random, since this research was product-oriented and the researcher required staff with a certain level of expertise and characteristics. Five validators were selected from this population to validate the media and content, and nine fifth graders from SDN Padasuka III participated in small-group testing to assess the usability and attractiveness of the VR-Edupanc application. Determination of the Sample The sample decision included inclusion, exclusion, and exit criteria to ensure data validity and the feasibility of the evaluation process. Tables 1 and 2 present the sampling method and inclusion, exclusion, and exit criteria.

Table 1. Population and Sample

Respondent Group	Population	Sample	Sampling Techniques	Description
Expert Validator	All experts in Pancasila, educational technology, and relevant language	5 people (2 material experts, 2 media experts, 1 language expert)	Purposive sampling	≥5 years of experience, understanding of digital media development standards
Elementary School Students	All fifth-grade elementary school students in Majalengka Regency	9 fifth-grade students at Padasuka III Elementary School	Purposive sampling	Selected based on teacher recommendations and ability to follow VR instructions

Table 2. Inclusion, Exclusion, and Exit Criteria

Criteria	Expert Validator	Fifth Grade Students
Inclusion	≥5 years of experience in the field of expertise Understands digital learning media standards	Registered as fifth grade students Have participated in Civics learning Able to follow instructions on how to use VR
Exclusion	Did not complete the assessment instrument	Did not complete the assessment instrument or trial session
Exit	The instrument was not completed completely	Did not complete the VR session due to technical difficulties or physical conditions (vertigo, severe vision impairment)

Research Variables

There were three groups of factors in this study:

Cognitive Variables: Understanding of the Pancasila Concept

It was assessed using a cognitive test questionnaire that included questions on knowledge of Pancasila as the state ideology and the meaning of its values in the life of the nation.

Affective Variables/Internalisation of Values: Internalisation of National Values

Assessed in terms of attitudes and behaviours reflecting Pancasila values, e.g., tolerance, discipline, responsibility, camaraderie. We selected this variable because it is not commonly used in VR research and requires observer-specific behavioural indicators.

Qualitative Behavioural Variables. The following performance criteria were measured using observation sheets at the time of learning

a. Group behaviour attitudes of tolerance.
b. Self-control on time allocation and task finished.
c. Responsibility in learning activities.

Instrument

The research instruments were developed according to the expertise of each validator. Expert validation instruments were used to assess the suitability of the content, media, and language of the VR-Edupanc application, as described in table 3. Each instrument used a 1-5 Likert scale, ranging from 1 (Very inappropriate) to 5 (Very appropriate). Meanwhile, user response questionnaires were used to assess usability, attractiveness, clarity of instructions, and learning motivation in using the application (table 4).

Table 3. Expert Validation Instruments

Validator	Aspects Evaluated	Number of Items
Content Experts	Accuracy of content, alignment with learning objectives and outcomes, relevance, adequacy of depth, references	16
Media Expert	Presentation and design quality, accessibility, interactivity	24
Language Expert	Clarity of language, compliance with Indonesian language rules, consistency of terms/icons, support for objectives	10

Table 4. User Response Instrument

Aspect	Indicators	Number of Items
Alignment with Learning Objectives	Content relevance, support for Pancasila values, focus on learning objectives, contribution to achievement of outcomes	4
Clarity of Instruction	Ease of navigation, clarity of instructions, system responsiveness	4
Impact on Learner	Visual appeal, engagement, interactive experience	4
feasibility	Increased interest in Pancasila learning, willingness to reuse, encouragement for self-study	5

Data Collection Process

The research procedure was divided into three main stages. First, the product planning and development phase involved developing visualizations and content embodying Pancasila values, complemented by quizzes, puzzles, and video-based storytelling. Second, the expert validation phase involved five expert validators based on their expertise. The experts provided quantitative assessments and qualitative input as a guide for product revisions. Third, a limited trial phase was conducted through a small group evaluation involving nine fifth-grade students. After the trial, user feedback was collected to evaluate the learning experience, ease of use, and app appeal.

Data Analysis

Data analysis was conducted using descriptive quantitative methods. Assessment scores from experts (material, media, language) and students (small group evaluation) were collected using a Likert-based instrument with a 1–5 scale, with the following categories: 1 = Very Inadequate, 2 = Inadequate, 3 = Fairly Adequate, 4 = Adequate, and 5 = Very Adequate. The scores obtained from each indicator item were summed and then the average (mean) value was calculated based on the number of items per indicator. Next, the mean value was converted into a percentage using the formula:

Interpretation of percentage results is based on the following eligibility criteria:

Table 5. Eligibility criteria

Mean Range	Category
4,21 – 5,00	Very Feasible
3,41 – 4,20	Feasible
2,61 – 3,40	Quite Feasible
1,81 – 2,60	Less Feasible
1,00 – 1,80	Not Feasible

Research Ethics

This research has been approved by the Ethics Committee of the institution where it is being conducted. Formal consent was obtained from the school headmaster of SDN Padasuka III. Assent was obtained from all

students, and written consent was obtained from parents or guardians. Participation was not mandatory, and withdrawal was possible at any time without penalty. All participants' identities and information were kept private.

RESULTS

Results of VR-Edupanc Product Development

The product developed in this research is the VR-Edupanc (Virtual Reality-Assisted Digital Game-Based Learning for Pancasila Education) application, designed as an interactive learning medium by combining Pancasila values content and virtual reality technology. Through this application, students can gain a more immersive and engaging learning experience. The Pancasila values material is presented interactively and contextually to help students understand the meaning of each principle. In addition, a virtual classroom simulation is available that creates a learning atmosphere similar to a real classroom. The application also features educational games such as VR Quiz in the form of 3D-based multiple-choice questions and VR Puzzle in the form of an activity to arrange Pancasila symbols and the Garuda bird. To strengthen contextual understanding, interactive video questions are presented that illustrate examples of the application of Pancasila values in the school environment and society. Automatic score feedback supports all learning activities, enabling students to directly assess their learning achievements. The audio of the song "Garuda Pancasila" plays at the beginning of the application, fostering students' nationalism before they begin learning.

Application Interface Display

To clarify the development results, some of the app's interface is shown in the following image.

Figure 1. VR-Edupanc App Preview

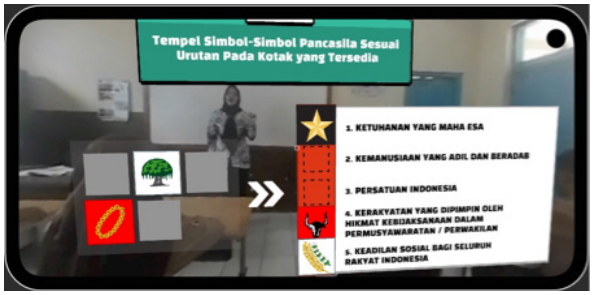

Figure 2. VR Puzzle Feature Display in the App

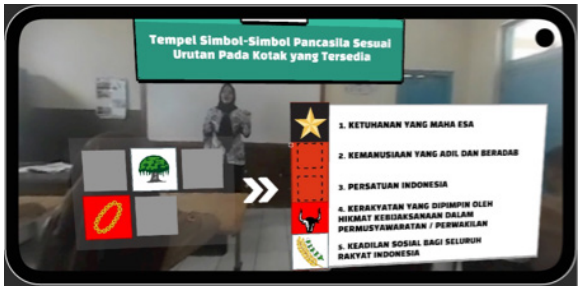

Figure 3. Score Earning System Display

Expert Validation Results

Product validation was carried out by five experts, consisting of two subject matter experts, two media experts, and one linguist. The assessment was carried out using a Likert scale instrument of 1-5. The results of the assessment are summarized in the following table.

The results of validation by material experts on the VR-Edupanc application are presented in table 6. This validation includes content accuracy, suitability to the curriculum, clarity of learning objectives, depth of material, and adequacy of references.

Table 6. Recapitulation of Material Expert Validation Results

No	Indicators	Mean 1-5	Percent	Category
1	Content Quality	4,60	92,0	Very Feasible
2	Curriculum Suitability	4,33	86,6	Very Feasible
3	Learning Objective Relevance	4,50	90,0	Very Feasible
4	Material Depth	4,62	92,4	Very Feasible
5	Reference Adequacy	4,50	90,0	Very Feasible
Total/ Average		4,51	90,60	Very Feasible

The results of the material expert validation show an overall average of 4,51 (90,6 %), categorized as Very Feasible. The indicator with the highest score was the adequacy of content depth aspect (92,4 %), indicating that the material content was deemed adequate in terms of depth. Overall, the application was deemed very suitable for use as a learning medium from a material perspective.

Table 7 presents the validation results from media experts who assessed aspects of VR presentation feasibility, accessibility, and interactivity.

Table 7. Recapitulation of media expert validation results

No	Indicators	Mean 1-5	Percent	Category
1	Virtual Reality (VR) Feasibility and Presentation	4,25	85,0	Very Feasible
2	Accessibility	4,60	92,0	Very Feasible
3	Interactivity	4,55	91,0	Very Feasible
Total/ Average		4,47	89,3	Very Feasible

Media expert validation results showed an average score of 4,47 (89,3 %) with a Very Feasible rating. The highest indicator was accessibility (92,0 %), indicating that the application is easy for students to access and use.

The results of the linguist validation of the linguistic aspects of the VR-Edupanc application are presented in table 8. The aspects assessed include language clarity, suitability of rules, use of terms, and alignment with learning objectives.

Table 8. Recapitulation of the results of the validation by language experts

No	Indicators	Mean 1-5	Percent	Category
1	Language Clarity	4,00	16	Very Feasible
2	Language Rule Compliance	4,40	22	Very Feasible
3	Use of Terms, Fonts, and Display Icons	4,67	28	Very Feasible
4	Language Alignment with Learning Objectives	4,00	16	Very Feasible
Total/ Average		4,27	85,3	Very Feasible

The overall average validation score from linguists was 4,27 (85,3 %), categorized as Very Feasible. The highest score was for the consistency of terms, letters, and icons indicator (93,4 %), indicating that the application is consistent in its terminology and symbols.

Table 9. recapitulation of user response test results

No	Indicators	Mean 1-5	Percent	Category
1	Goal orientation (focus on Pancasila objectives)	4,061	92,2	Very Feasible
2	Clarity of learning	4,53	90,6	Very Feasible
3	Impact on learners	4,64	92,8	Very Feasible
4	Practical feasibility	4,24	84,8	Very Feasible
	Total/ Average	4,51	90,1	Very Feasible

Student responses averaged 4,51 (90,1 %), categorized as Very Feasible. The indicator with the highest score was impact on learners (92,8 %), indicating that the VR-Edupanc application increased student motivation, engagement, and understanding of Pancasila values.

DISCUSSION

The findings of this study showed that the developed VR-Edupanc application, a Digital Game-Based Learning (DGBL) model for Pancasila learning in elementary schools based on Virtual Reality (VR), is well-suited for use. The expert validation showed very high feasibility in materials (90,6 %), media (89,3 %), and the language field (85,3 %), and students' responses testing also indicated a highly positive acceptance rate of 90,1 %. These findings suggest that combining VR and digital games could deliver more meaningful learning experiences for students. Especially if conceptual, abstract, like Pancasila. This is demonstrated by the assessment of material experts who emphasize the accuracy and relevance of content to learning outcomes, media experts who assess the presentation and interactivity of the application as adequate,[33] and linguists who emphasize the clarity and consistency of language use in supporting student understanding.[34]

The findings of this study showed that the developed VR-Edupanc application, a Digital Game-Based Learning (DGBL) model for Pancasila learning in elementary schools based on Virtual Reality (VR), is very well suited for use. The expert validation showed very high feasibility in materials (90,6 %), media (89,3 %), and the language field (85,3 %), and students' responses testing also indicated a highly positive acceptance rate of 90,1 %. These findings suggest that combining VR and digital games could deliver more meaningful learning experiences for students. Especially if conceptual, abstract, like Pancasila. These findings are consistent with international studies demonstrating VR's ability to enhance conceptual understanding. This finding is in line with various studies stating that the use of VR-based technology in learning can increase student engagement and motivation.[35,36,37,38,39] VR-Edupanc not only presents content but also provides an immersive learning experience as if students were in a real classroom, complete with the sound of the national anthem, quiz games, puzzles, video questions, and a feedback system that strengthens understanding. The integration of these various components makes the application not just a collection of separate features, but a complete and effective learning system.[40,41,42]

In addition, the high ease-of-use rating (92 %) demonstrates that primary school children can easily use the application, and, despite common perception, VR is not a hard-to-use technology. This can be owed to the design nature of a simple interface, consistent icons, or understandable terminology, as presented in the linguist validation. Additional research also supports the importance of a user-friendly VR interface for VR to be effective with elementary-aged students. Conversely, the material depth, which received the highest score in expert validation, indicates that the Pancasila content was appropriate and can fulfil curriculum requirements in VR-Edupanc. The inclusion of real-life social scenarios (e.g., supporting actors for tolerance, cooperation, and discipline) grounds the values each principle encapsulates.

In addition to expert validation, limited student trials also demonstrated a very positive response. Students found the app easy to use, engaging, and able to enhance their learning enthusiasm. This demonstrates the acceptability of VR-DGBL in values-based learning, as it encourages active student engagement, facilitates independent learning, and fosters a more contextual and enjoyable learning experience.[43,44,45] Thus, VR-Edupanc can be seen as an innovative learning media that not only strengthens students' cognitive understanding of Pancasila values, but also supports character internalization through immersive digital experiences.[46,47]

The findings are far-reaching in their educational implications, particularly for revitalising Pancasila learning in Indonesia. The application of VR-Edupanc could serve as a reference point in efforts to enhance the quality of character education, which has long experienced ups and downs. In addition, the results of this application demonstrate that, even at the elementary school level, new technologies such as VR can be adopted in areas such as Majalengka. This opens the way for digital transformation in primary schools through a pertinent, sustainable, and easily replicable approach.

Although our results are encouraging, several limitations should be noted. Indeed, the duration over which these results can be sustained (long-term retention) and the long-term effects on student character development will require further inquiry. Second, the VR is still reliant on specific devices — not every school can access it without proper facilities. Third, the research population is limited to one area, namely Majalengka Regency, to generalise the results. Further studies may generalise more broadly across regions and employ randomised experimental designs to improve generalisability. Nonetheless, these limitations do not diminish the significance of this research, which presents a new, reputable, and relevant VR-based learning model for Pancasila education in elementary schools.

CONCLUSIONS

This research successfully developed the VR-Edupanc application as an innovative VR-DGBL-based learning medium that presents Pancasila values content in the form of an immersive and interactive learning experience.

The validation results from experts show that VR-Edupanc has accurate content quality, attractive media design, and clear and consistent language use, making it highly suitable for use in Pancasila Education learning in elementary schools. Limited trials also showed a positive response from students, particularly in terms of engagement, motivation, and ease of application use. This application has proven to support conceptual understanding and character building through technology-based learning experiences. However, this research is still limited to the formative evaluation stage, so further research is needed in the form of practicality testing and effectiveness testing on a wider scale to ensure the learning impact on student learning outcomes is significant.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Gilang Maulana Jamaludin.
Data curation: Gilang Maulana Jamaludin.
Formal analysis: Gilang Maulana Jamaludin.
Research: Gilang Maulana Jamaludin, M. Japar, Mohammad Syarif Sumantri.
Methodology: Gilang Maulana Jamaludin.
Project management: Gilang Maulana Jamaludin.
Resources: Gilang Maulana Jamaludin.
Software: Gilang Maulana Jamaludin.
Supervision: Gilang Maulana Jamaludin, M. Japar, Mohammad Syarif Sumantri.
Validation: M. Japar, Mohammad Syarif Sumantri.
Display: Gilang Maulana Jamaludin.
Drafting - original draft: Gilang Maulana Jamaludin.
Writing - proofreading and editing: M. Japar, Mohammad Syarif Sumantri.