

Developing Panca-AR for Scenario-Based Civic Reasoning and Peer Deliberation in Elementary Pancasila Education

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Received: August 19, 2026

Accepted: October 9, 2026

Online Published: October 13, 2026

doi:10.11114/jets.v15i1.9210

URL: <https://doi.org/10.11114/jets.v15i1.9210>

Abstract

Augmented reality (AR) in elementary education has been used predominantly to visualize and contextualize academic content, while its potential to support scenario-based civic reasoning and peer deliberation remains underexplored. This study developed and evaluated Panca-AR, a marker-based AR application for Grade 5 Pancasila Education. Using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model, a needs analysis involving 10 Grade 5 teachers informed design requirements related to contextual learning, interactive visualization, civic content, and classroom feasibility. Panca-AR was structured around Pancasila as a foundational civic framework and three applied scenario domains: Gotong Royong, Digital Ethics, and Kebhinekaan. Prototype development was followed by independent content, language, and media expert appraisal and expert-informed revision before classroom implementation. Fifty Grade 5 students from two intact classes completed an individual pre-test (T0), participated in Panca-AR learning activities and a 15-minute structured peer-deliberation session, and subsequently completed an individual post-test (T1). The pre-test and post-test used separate scenario-based forms developed from the same assessment blueprint. Overall scenario-based civic performance increased from 62.33 (SD = 17.99) at pre-test to 93.67 (SD = 5.21) at post-test. The distribution of within-participant difference scores satisfied the normality assumption, and a paired-samples t-test indicated a statistically significant increase in performance, $t(49) = 12.75$, $p < .001$, Cohen's $d_z = 1.80$. Student responses indicated high acceptance, while structured classroom observation documented scenario interpretation, perspective exchange, peer participation, consequence consideration, civic reason-giving, and collaborative reflection during peer deliberation. The findings indicate substantial immediate improvement on the scenario-based civic tasks across the integrated instructional sequence. Because the study used a one-group pre-test-post-test design and combined AR-supported scenarios with reflection and peer deliberation, the observed change should not be interpreted as an isolated causal effect of Panca-AR.

Keywords: augmented reality, civic reasoning, peer deliberation, Pancasila Education, elementary education, situated learning

1. Introduction

Pancasila Education in Indonesian elementary schools carries a broader responsibility than transmitting knowledge about national symbols, constitutional principles, or prescribed civic values. At the primary level, civic education is expected to help children interpret social situations, recognize competing responsibilities, and make judgments about how civic values should guide everyday conduct. This orientation is consistent with broader conceptions of citizenship education that position civic learning as the development of judgment, participation, responsibility, and engagement with social difference rather than the acquisition of declarative knowledge alone (Arthur et al., 2008). More recent international frameworks similarly conceptualize civic, global citizenship, and sustainability education as overlapping domains concerned with participation, responsibility, and learners' capacity to respond to social issues (Damiani & Fraillon, 2025).

The need to move beyond declarative civic learning is increasingly important because children encounter questions of cooperation, exclusion, cultural difference, responsible communication, and participation across both face-to-face and digitally mediated environments. Contemporary global citizenship education therefore places growing emphasis on

critical reflection, ethical engagement, and the ability to engage constructively with difference (Bosio & Waghid, 2025). It also requires educational experiences that connect global and civic principles with situations in which learners can inquire, interpret, and act rather than simply reproduce normative statements (Leite, 2022). At the primary level, this orientation places particular demands on pedagogy because teachers must make complex civic issues accessible while enabling children to encounter multiple perspectives in developmentally appropriate ways (van Werven et al., 2023).

These expectations are also connected to broader educational commitments toward peaceful, inclusive, and socially responsible societies. Education associated with Sustainable Development Goal 16 increasingly emphasizes the role of schooling in developing dispositions related to justice, peaceful interaction, responsibility, and strong social institutions (Kowkas et al., 2024). Similar work connecting quality education with peace, justice, and reduced inequalities highlights the importance of learning experiences that make global competencies understandable through concrete narratives and socially meaningful situations (Salmon et al., 2024). For Pancasila Education, the central pedagogical issue is therefore not whether students can identify desirable civic values, but whether they can apply those values when confronted with situations requiring interpretation and judgment.

This issue is particularly relevant for contemporary elementary learners, whose learning environments are increasingly visual, interactive, and digitally mediated. Research on Generation Alpha suggests that interactive and game-oriented learning environments can support participation when technological features are meaningfully aligned with learning activities rather than used primarily for entertainment (Fernando & Premadasa, 2024). From a learning-design perspective, such alignment is critical because effective educational technology depends on the relationship among learner characteristics, instructional activities, technological affordances, and intended outcomes (Schmidt & Huang, 2022). Consequently, introducing digital technology into Pancasila Education is insufficient unless the technology changes what students are required to do cognitively and socially.

Augmented reality (AR) offers a potentially useful response because it can connect digital information with physical or recognizable real-world contexts. By superimposing visual, textual, or three-dimensional elements onto the learner's environment, AR can reduce the distance between abstract educational content and contextual experience. A systematic review of AR in education identified benefits associated with visualization, interaction, motivation, and contextualization while also showing that these benefits depend substantially on pedagogical implementation (Akçayır & Akçayır, 2017). More recent reviews similarly describe AR as a flexible educational environment capable of integrating spatial visualization, interaction, simulation, and contextual information across subject areas (Kamińska et al., 2023). Its educational potential therefore lies not simply in making learning visually novel, but in creating forms of interaction that would be difficult to reproduce through conventional materials (Koumpouros, 2024).

Evidence regarding learning outcomes is also broadly favorable, although it requires careful interpretation. Meta-analytic research has found positive effects of AR-supported learning while demonstrating considerable variation according to instructional context, learner characteristics, and implementation design (Garzón & Acevedo, 2019). Similar findings in science education indicate that AR can support academic achievement, but its benefits depend on how augmented content is integrated into instruction rather than arising automatically from the technology itself (Kalemkuş & Kalemkuş, 2023). A broader meta-analysis of experimental and quasi-experimental studies likewise reinforces the importance of pedagogical configuration in determining the outcomes associated with AR-supported learning (Chang et al., 2022).

However, the dominant educational function of AR remains strongly representational. Many applications use augmentation to display objects, spatial relationships, scientific structures, or procedural information that would otherwise be difficult to observe. In chemistry education, for example, AR and three-dimensional visualization have been used to make abstract molecular and scientific representations more accessible to learners (Abdinejad et al., 2021). Such applications demonstrate an important strength of AR, but they are generally organized around content whose correctness or structure can be visually represented. Civic education presents a different instructional problem because socially appropriate judgments cannot always be reduced to recognition of a single object, process, or factual relationship.

Civic learning requires students to interpret situations in which values acquire meaning through context. Situated learning provides an important theoretical basis for this distinction because knowledge is understood as inseparable from the activities and social situations in which it is used (Brown et al., 1989). Applied to elementary Pancasila Education, cooperation, responsibility, inclusion, and respect are therefore more than concepts to be defined. Students need opportunities to encounter these principles within recognizable situations and determine what they imply for action. AR becomes pedagogically significant when it helps construct such situations rather than merely augmenting the visual appearance of civic content.

A complementary rationale comes from moral-development theory. Kohlberg and Hersh (1977) emphasized that moral

learning involves engagement with situations requiring learners to consider competing considerations, consequences, social expectations, and reasons for action. In the present study, this perspective is used pedagogically rather than diagnostically. Panca-AR does not attempt to classify elementary learners into stages of moral development. Instead, the framework informs the construction of civic scenarios in which students interpret socially consequential situations and consider alternative responses. Previous research showing that AR-supported behavioral simulation can stimulate moral imagination further suggests that augmented environments can support ethical and social reasoning rather than factual visualization alone (Sari et al., 2021).

Within Indonesia, AR has begun to enter Pancasila and citizenship education. Android-based AR media have been developed to support Pancasila and Citizenship Education learning, demonstrating the feasibility of integrating augmented content into this curricular domain (Hutagalung & Rachman, 2023). At the elementary level, AR-based Pancasila learning has also been associated with critical reasoning and learning outcomes (Corneliesta et al., 2025). These studies establish an important foundation, but less attention has been given to instructional designs in which AR-supported civic scenarios are organized around decision-making, consequences, reflection, and structured peer deliberation.

This is the first gap addressed here. Displaying cooperation, digital responsibility, or diversity is not equivalent to asking students what should be done when collective action is difficult, a peer is excluded, or online communication causes harm. Panca-AR therefore positions Pancasila as the normative foundation for three applied domains, Gotong Royong, Digital Ethics, and Kebhinekaan, and uses a recurring sequence of context interpretation, response selection, consequence consideration, reflection, and value reinforcement.

A second gap concerns the social dimension of civic reasoning. Civic judgment is rarely developed exclusively through isolated individual cognition. Citizenship also involves explaining positions, encountering disagreement, considering alternative perspectives, and evaluating reasons offered by others. Educational AR research indicates that instructional outcomes vary according to the pedagogical approach surrounding the technology, with collaborative configurations representing an important dimension of AR-supported learning (Garzón et al., 2020). For civic education, however, the relevant process extends beyond generic collaboration. Students need opportunities to explain how they interpret civic situations, compare possible responses, encounter alternative judgments, and provide reasons for their own positions.

A third gap concerns evaluation. Expert appraisal, usability, acceptance, and post-intervention achievement reveal different aspects of an educational technology but do not establish whether applied civic performance changes across an integrated instructional sequence. The present study therefore combined formative design evidence with individual pre-test and post-test assessment, student acceptance, structured observation, and teacher perspectives while keeping those evidence sources conceptually distinct.

Developing such an intervention also requires alignment between identified educational needs, theoretical foundations, technological design, implementation, and evaluation. The ADDIE framework provides an appropriate developmental structure because it integrates Analysis, Design, Development, Implementation, and Evaluation while allowing instructional requirements to be progressively translated into technological and pedagogical features. Contemporary research on dynamic ADDIE models emphasizes that the framework is most useful when evidence from learners, instructional contexts, and formative evaluation informs subsequent design decisions rather than when its phases are treated as a rigid production sequence (Li & Sun, 2024). Earlier applications likewise demonstrate the usefulness of ADDIE for systematically translating educational requirements into designed instructional content and procedures (Wiphasith et al., 2016).

Accordingly, Panca-AR was designed as a marker-based situated learning environment in which Grade 5 students interpreted Pancasila values through contextual civic decisions and peer discussion. Its proposed contribution is not AR visualization itself, but the integration of augmented scenarios, individual judgment, consequence reflection, and deliberation within one elementary civic-learning architecture.

The study aimed to (1) identify teachers' instructional and implementation needs; (2) translate Pancasila values, those needs, and the theoretical framework into a scenario-based AR design refined through expert appraisal; (3) examine pre-test to post-test change in scenario-based civic performance across Gotong Royong, Digital Ethics, and Kebhinekaan; and (4) examine student acceptance and classroom process evidence associated with Panca-AR and structured peer deliberation.

2. Method

2.1 Research Design

This study employed a research and development design using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model as the overarching framework for developing and evaluating Panca-AR. ADDIE was selected because it provides a systematic structure for linking instructional needs, design decisions, prototype

development, classroom implementation, and evaluation while allowing evidence generated at one phase to inform decisions in subsequent phases (Li & Sun, 2024; Wiphasith et al., 2016). Rather than treating ADDIE as a rigid production sequence, the present study used the model as an iterative development framework in which teacher-identified needs informed the instructional architecture, specialist appraisal informed prototype revision, and classroom implementation provided evidence concerning student performance, acceptance, and learning processes.

Within the Implementation and Evaluation phases, a one-group pre-test-post-test design was used to examine within-participant change in scenario-based civic performance. The design was selected because the primary evaluative question concerned whether the same students demonstrated different levels of performance before and after completing the instructional sequence. The sequence consisted of an individual pre-test, learning with Panca-AR, structured peer deliberation, and an individual post-test. The pre-test and post-test used separate forms developed from the same assessment blueprint rather than identical item sets. Because no separate comparison group was included, the design was used to examine immediate within-student change across the integrated instructional sequence rather than to estimate an isolated causal effect of Panca-AR, scenario practice, or peer deliberation.

The study was conducted from May to July 2026 at a public elementary school in North Jakarta, Indonesia. Grade 5 students were selected because they are positioned within Phase C of the Indonesian national curriculum, which encompasses Grades 5 and 6 at the elementary level. The *Capaian Pembelajaran* (Learning Outcomes) for Pendidikan Pancasila established by the Indonesian Ministry of Primary and Secondary Education emphasizes the development and application of Pancasila values within students' social and civic contexts (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2025). This curricular positioning, combined with the developmental appropriateness of concrete and visually supported learning experiences, made Grade 5 suitable for scenario-based civic activities requiring students to interpret social situations, consider alternative responses, examine consequences, and connect their judgments with Pancasila values.

Three participant groups contributed to analytically distinct phases of the study. Ten teachers who taught Grade 5 participated in the needs analysis because they were directly familiar with the curriculum, learner characteristics, instructional practices, and technological conditions of the target classrooms. Three independent university lecturers participated in prototype appraisal: a Pancasila and Civic Education lecturer from Universitas Cenderawasih, an Indonesian Language Education lecturer from Universitas Mulawarman, and an Educational Technology lecturer from Universitas Negeri Jakarta. Fifty Grade 5 students from two intact classes at the same school, with 25 students in each class, participated in classroom implementation and the pre-test-post-test evaluation. Thus, teachers informed design requirements, specialists supported prototype refinement, and students provided evidence concerning implementation and learning. The overall development and evaluation sequence is summarized in Figure 1.

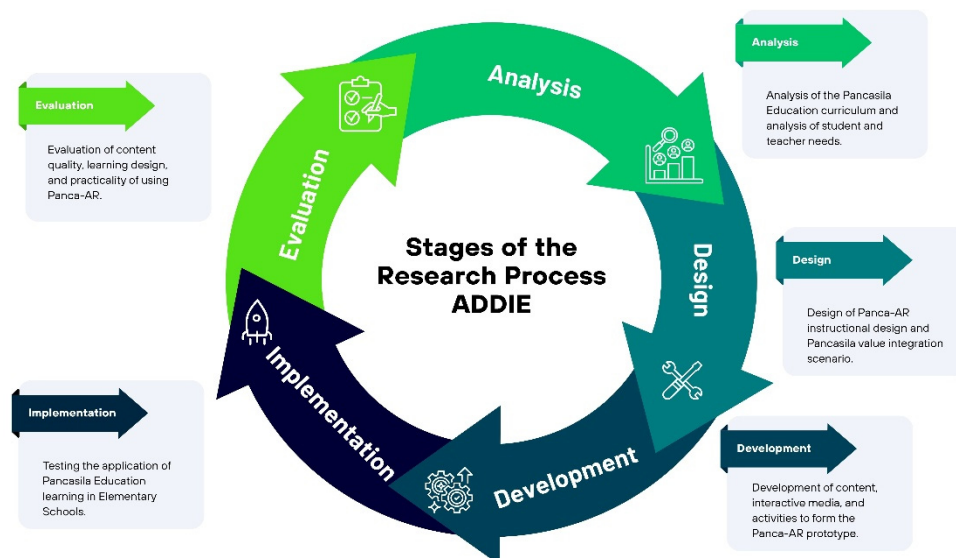


Figure 1. ADDIE-Based Development and Evaluation Process of Panca-AR

Source: Author's work

2.1.1 Analysis

The Analysis phase identified the instructional, content, media, and implementation requirements relevant to the development of Panca-AR. Particular attention was given to contextual learning needs and technological feasibility

because the instructional value of AR depends partly on whether its features can be accommodated within the conditions of the intended classroom environment. This consideration is particularly relevant in primary-school contexts where teacher readiness, accessibility, infrastructure, and implementation complexity can influence the practical use of AR-supported learning (Alalwan et al., 2020; Criollo-C et al., 2021).

Teacher needs were examined using a 20-item four-point response questionnaire organized into four dimensions, with five items in each dimension. Two open-ended questions were additionally used to obtain information concerning thematic priorities and desired application features. The needs assessment served a formative rather than an outcome function. Requirements concerning contextual learning informed the use of familiar school, social, and digital situations; thematic priorities informed the applied civic domains; and preferences for visualization, simulation, and interactive activities informed the marker-based AR and scenario structure.

Table 1. Teacher Needs-Analysis Instrument and Design Function

Dimension	Main aspects assessed	Instrument	Design function
Learning Needs	Interactive instruction, visual and digital learning, contextual examples, student participation, learner diversity	5 indicators, 4-point scale	Informed contextual, interactive, and participatory civic-learning activities
Media Needs	AR-supported attention, visualization of social situations, accessible technology, contextual learning media	5 indicators, 4-point scale	Informed marker-based AR and accessible visual interaction
Content Needs	Kebhinekaan, Digital Ethics, Gotong Royong, Pancasila reflection, citizenship character	5 indicators, 4-point scale	Informed the thematic and civic-content structure of Panca-AR
Implementation Needs	Teacher willingness, classroom feasibility, school support, relevance of educational technology	5 indicators, 4-point scale	Informed classroom feasibility and low-complexity implementation requirements

2.1.2 Design

The Design phase translated the needs-analysis findings into the instructional and technological architecture of Panca-AR. AR was treated as a learning environment rather than as an isolated visualization feature. Contextual scenarios, augmented objects, student decisions, consequences, reflective prompts, and value reinforcement were therefore designed as interconnected components. This orientation is consistent with educational AR research emphasizing that augmented representations are most meaningful when embedded within explicit instructional activities rather than treated as the learning objective itself (Gargrish et al., 2020). Immersive technologies have also been used to organize ethically consequential learning scenarios, supporting their use for context-dependent decision situations rather than only factual or procedural visualization (Permanasari et al., 2022).

Panca-AR comprised a foundational Pancasila domain and three applied domains. The foundation connected the five principles to tolerance, empathy, anti-bullying, dignity, unity, deliberation, social justice, cooperation, and concern for others; Gotong Royong, Digital Ethics, and Kebhinekaan then operationalized those values in recognizable situations.

Across the three applied domains, students first encountered a contextualized civic situation or social conflict, then considered alternative responses, made an individual decision, examined likely consequences, reflected on the implications of their choice, and received reinforcement of the underlying civic value. Situated learning informed the placement of civic concepts within recognizable school, interpersonal, and digital situations (Brown et al., 1989; Lave & Wenger, 1991). A Kohlberg-informed perspective guided the construction of decision points involving alternative actions, interpersonal expectations, consequences, fairness, and reasons for action (Kohlberg & Hersh, 1977). Kohlberg's framework was used pedagogically rather than diagnostically; students were not classified into stages of moral development.

Table 2. Instructional Architecture and Assessment Alignment of Panca-AR

Component / Domain	Main civic focus	Instructional role	Assessment role
Pancasila	Tolerance, empathy, dignity, unity, deliberation, social justice, cooperation	Foundational civic-value orientation and conceptual reinforcement	Not scored as a separate performance domain
Gotong Royong	Cooperation, social care, shared responsibility, collective action	Applied scenario-based civic learning	4 scenario-based items
Digital Ethics	Digital empathy, responsible communication, anti-bullying, respectful online conduct	Applied scenario-based civic learning	4 scenario-based items
Kebhinekaan	Tolerance, inclusivity, empathy, social respect, unity in diversity	Applied scenario-based civic learning	4 scenario-based items

2.1.3 Development

During Development, the design became Prototype V1, a marker-based application with a main menu, marker scanning, three-dimensional objects, contextual information, scenarios, and navigation.

Prototype development was followed by independent specialist appraisal. The content specialist examined curriculum alignment, conceptual accuracy, scenario relevance, developmental appropriateness, integration, and reflection of civic values. The language specialist examined linguistic accuracy, clarity, Grade 5 appropriateness, terminology, consistency, communicativeness, and sentence structure. The media specialist examined visual quality, layout, navigation, marker detection and stability, narration, software functionality, and score recording. Each specialist used a 10-item four-point appraisal instrument. Expert appraisal was treated as formative evidence rather than as a numerical product-validity claim. Written recommendations were incorporated into Prototype V1, producing Prototype V2 as the version used in classroom implementation (Oberdörfer et al., 2021).

Table 3. Expert Appraisal Procedure During Panca-AR Development

Expert domain	Main aspects assessed	Instrument	Development decision
Content	Curriculum alignment, conceptual accuracy, scenario relevance, developmental appropriateness, integration, value reflection	10 indicators, 4-point scale	Suitable without revision / suitable after revision / unsuitable
Language	Accuracy, Grade 5 appropriateness, clarity, terminology, consistency, communicativeness, sentence structure	10 indicators, 4-point scale	Suitable without revision / suitable after revision / unsuitable
Media	Visual quality, layout, navigation, marker detection and stability, narration, software functionality, score recording	10 indicators, 4-point scale	Suitable without revision / suitable after revision / unsuitable

2.1.4 Implementation

Fifty students participated across two intact Grade 5 classes. The research team facilitated the sessions with classroom teachers present; both classes received the same instructions, devices, materials, duration, and assessment procedures.

Each class completed one approximately 90-minute session: individual pre-test (T0); guided use of Prototype V2 to scan markers, explore augmented content, interpret scenarios, consider choices and consequences, complete embedded quizzes, and reflect; a 15-minute peer-deliberation phase; and individual post-test (T1).

During peer deliberation, each class was divided into five groups of approximately five students. The research team facilitated the discussions using consistent prompts across groups, while classroom teachers accompanied the implementation. Students were asked to explain their interpretations of the civic situations, compare possible responses, discuss the consequences of alternative actions, and provide reasons for their judgments. The purpose of the deliberative phase was not to produce a single group answer, and no group score was assigned. Instead, peer interaction provided an opportunity for perspective exchange and reason-giving before students returned to individual assessment. This procedure is consistent with research indicating that immersive learning experiences may extend beyond direct interaction with technological interfaces through the classroom interactions organized around them (Cheng & Tsai, 2019).

2.1.5 Evaluation

Evaluation integrated four evidence sources: individual pre-test and post-test performance as the primary outcome, student acceptance and usability responses, researcher observation of deliberation, and teacher interviews about engagement, relevance, and feasibility.

The sources retained distinct functions: acceptance was not treated as learning, observation documented rather than scored deliberation, and interviews provided implementation evidence rather than an effectiveness measure. Interviews were conducted in Indonesian; quotations were translated into English and lightly edited for clarity without altering meaning.

2.2 Measures and Data Analysis

2.2.1 Scenario-Based Civic Performance

Scenario-based civic performance was assessed individually at T0 and T1 across Gotong Royong, Digital Ethics, and Kebhinekaan. Pancasila provided the unscored foundational framework.

Each applied domain was represented by four scenario-based multiple-choice questions with four response options (A–D), producing a total of 12 items at each assessment occasion. The items addressed students' interpretation of civic situations, recognition of the social issue involved, selection of an appropriate response, understanding of likely consequences, and reflection on the underlying civic value. The research team developed separate pre-test and post-test forms from the same assessment blueprint. The two forms were designed as blueprint-aligned measures of scenario-based civic performance, with comparable domain coverage, targeted indicators, four-option response format, cognitive demand, and scoring principles, while avoiding simple repetition of an identical item set. The content specialist in Pancasila and Civic Education

reviewed the assessment blueprint and item content for alignment with the targeted civic indicators, developmental appropriateness, conceptual accuracy, and intended cognitive demand before classroom use.

The assessment was designed to examine students' performance at the domain and overall levels across the instructional sequence. Accordingly, the pre-test and post-test scores were interpreted as performance on comparably structured, blueprint-aligned civic tasks. Because the post-test followed exposure to scenario-based activities and embedded quizzes within Panca-AR, the resulting scores were interpreted as immediate performance on aligned civic tasks rather than as evidence of stable civic disposition or long-term transfer.

Domain scores were converted to a 0–100 scale, and the overall score was their arithmetic mean. The scores were used to represent scenario-based civic performance and were not interpreted as measures of moral-development stages.

2.2.2 Student Acceptance and Perceived Usability

An eight-item four-point questionnaire measured visual attractiveness, ease of use, AR visualization, language and material clarity, scenario usefulness, enjoyment, and willingness to reuse Panca-AR. Item and overall means were converted to percentages of the maximum score and analyzed descriptively because the indicators represented complementary user-experience dimensions.

2.2.3 Supporting Process Evidence

A structured observation sheet was prepared before classroom implementation to document six intended processes during peer deliberation: scenario interpretation, perspective exchange, peer participation, consequence consideration, civic reason-giving, and collaborative reflection. These indicators were aligned with the instructional objectives of the deliberative phase. During the group discussions, the researcher recorded whether the intended processes were observed and supplemented the structured record with brief field notes on relevant interactional examples. The observation evidence was used descriptively to establish whether the deliberative phase involved the intended forms of social interaction rather than mere physical group placement. It was not converted into an independent quantitative learning score and was not used to infer the separate effect of peer deliberation. Following classroom implementation, participating teachers took part in a brief semi-structured interview addressing student engagement, the perceived relevance of Panca-AR, and classroom feasibility. Interview responses were interpreted descriptively as complementary implementation evidence rather than as a formal qualitative outcome measure.

2.2.4 Statistical Analysis

Teacher-needs and student-response data were summarized descriptively using means and percentages. Expert appraisal was reported qualitatively through the issues identified and the revisions undertaken, rather than through numerical validation percentages. Pre-test and post-test scenario-based civic performance was summarized using means and standard deviations. Consistent with the blueprint-aligned assessment design, inferential analysis focused on overall scenario-based civic performance, while domain-level scores were interpreted descriptively. Because the same 50 students completed both assessment occasions, inferential analysis focused on within-participant differences. A difference score was calculated for each student as T1 minus T0.

2.3 Ethical Considerations

Formal school permission and institutional authorization preceded the study. Participation was voluntary, student assent was obtained, procedures were coordinated with teachers, and only aggregated results are reported.

3. Results and Discussion

Results follow the ADDIE phases so that needs function as design evidence, appraisal as formative development evidence, pre-test-post-test results as immediate performance evidence, and student and teacher responses as implementation evidence.

3.1 Analysis: Teacher Needs and Instructional Requirements

Teachers reported high needs across Learning ($M = 3.80$, 95.0%), Media ($M = 3.78$, 94.5%), Content ($M = 3.86$, 96.5%), and Implementation ($M = 3.96$, 99.0%); the overall mean was 3.85 (96.25%).

Table 4. Teacher Needs and Their Translation into Panca-AR Design Requirements

Dimension	Mean	Percentage	Design implication
Learning Needs	3.80	95.0%	Contextual, interactive, and participatory civic-learning activities
Media Needs	3.78	94.5%	Marker-based AR and visual representation of recognizable social situations
Content Needs	3.86	96.5%	Applied civic content involving Gotong Royong, Digital Ethics, and Kebhinekaan
Implementation Needs	3.96	99.0%	Classroom-feasible implementation with relatively simple technological procedures
Overall	3.85	96.25%	Strong overall requirement for contextual and technology-supported Pancasila learning

The pattern reflected more than enthusiasm for digital media. Teachers prioritized contextual examples, participation, applied civic content, visualization, and feasible procedures. These findings formatively informed familiar school and digital situations, marker-based AR, and the three applied domains rather than serving as evidence of effectiveness.

The traceability from need to feature supports pedagogical alignment, a central condition for effective AR design (Akçayır & Akçayır, 2017; Garzón et al., 2020). Table 4 specifies this translation.

3.2 Design: Translating Pancasila Values into Scenario-Based Civic Learning

Design translated these requirements into an architecture in which Pancasila provided the normative foundation and Gotong Royong, Digital Ethics, and Kebhinekaan provided applied contexts. This arrangement reflects situated learning, whereby knowledge acquires meaning through its uses and activities (Brown et al., 1989; Lave & Wenger, 1991).

The foundational domain linked the five principles with tolerance, empathy, anti-bullying, dignity, unity, deliberation, social justice, cooperation, and care. Marker-based representations and contextual explanations oriented students to these values before the applied scenarios, embedding visualization within meaningful activity (Akçayır & Akçayır, 2017; Garzón et al., 2020).

Figure 2 illustrates the augmented Garuda Pancasila and contextual explanation introducing the five principles and their everyday civic meaning. This foundational orientation preceded the applied domains.



Figure 2. Panca-AR Foundational Pancasila Domain

All three applied domains used the same sequence: recognize a situation and civic issue, consider responses, decide, examine consequences, reflect, and reconnect the judgment to Pancasila values. The structure used morally consequential situations to support judgment rather than classify developmental stages (Kohlberg & Hersh, 1977).

Kebhinekaan addressed diversity, inclusion, empathy, and respect through the exclusion of a culturally different classmate. Choices and feedback directed attention to inclusion, mutual respect, and unity in diversity (Figure 3), grounding abstract values in an interpersonal context.



Figure 3. Panca-AR Kebhinekaan Scenario-Based Learning Environment

Digital Ethics presented a group-chat conflict involving harmful or exclusionary communication. Students interpreted the interaction, selected a response, considered consequences, and reflected on respectful communication, privacy, and unverified information (Figure 4). The domain framed digital participation as an ethical and civic practice, not merely a technical skill (Bosio & Waghid, 2025; Damiani & Fraillon, 2025).

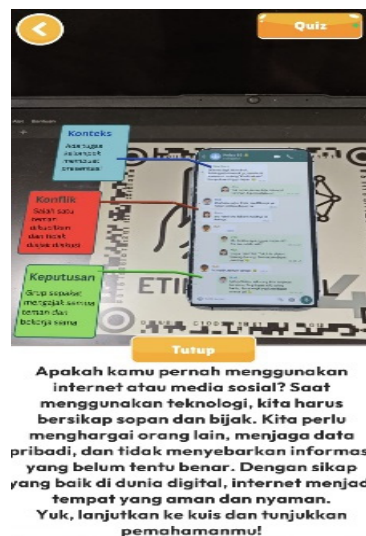


Figure 4. Panca-AR Digital Ethics Scenario-Based Learning Environment

Gotong Royong presented a school environmental problem involving shared responsibility. Students considered whether to contribute, remain passive, or disengage, then connected individual action with collective welfare (Figure 5). The familiar social practice made mutual cooperation concrete within the situated-learning framework (Brown et al., 1989; Lave & Wenger, 1991).



Figure 5. Panca-AR Gotong Royong Scenario-Based Learning Environment

Across domains, AR supported a recurring movement from recognition to interpretation, decision, consequence awareness, and reflection. Its value therefore depended on integration with instructional activity rather than visual novelty (Garzón & Acevedo, 2019; Chang et al., 2022).

The conceptual contribution is the shift from displaying civic content to structuring civic reasoning. Situated scenarios made values actionable, while alternatives and consequences elicited judgment. Panca-AR thus connected augmented representation with individual decisions, reflection, and subsequent peer deliberation.

3.3 Development: Prototype Construction and Expert-Informed Refinement

Development converted the design into Prototype V1, including the opening interface, menu, scanning, three-dimensional representations, contextual information, scenarios, reflection, and navigation.

Independent content, language, and media specialists then identified concrete revisions rather than merely assigning a validity score (Table 5).

Table 5. Expert Appraisal and Prototype Refinement

Expert domain	Main issue identified	Revision undertaken
Content	Need for stronger contextualization and clearer correspondence between scenarios and civic values	Contextual examples were strengthened and connections between situations and relevant Pancasila values were clarified
Language	Need for greater consistency in terminology, wording, and Grade 5 readability	Terminology, sentence construction, instructions, and wording were refined
Media	Need for refinement of visual presentation, typography, narration, interface characteristics, and marker functionality	Visual elements, typography, narration, interface presentation, and marker responsiveness were revised

Content review strengthened links between scenarios and Pancasila values; language review improved Grade 5 readability and consistency; media review refined presentation, narration, interface, and marker responsiveness. These changes produced Prototype V2, the only classroom version.

The revision cycle demonstrates ADDIE's iterative character: pedagogical intentions and technological functionality were progressively aligned through formative feedback (Oberdörfer et al., 2021).

3.4 Implementation: Change in Scenario-Based Civic Performance

All 50 students completed T0, Panca-AR activities, 15 minutes of peer deliberation, and T1 under the standardized procedure. Results therefore represent the complete instructional sequence, not an isolated component.



Figure 6. Classroom Implementation of Panca-AR During Marker-Based Augmented Reality Learning

Source: Author's documentation

Overall performance increased from $M = 62.33$ ($SD = 17.99$) at T0 to $M = 93.67$ ($SD = 5.21$) at T1, a mean gain of 31.33 points. The 50 difference scores did not significantly depart from normality, Shapiro-Wilk $W = .977$, $p = .442$, supporting the paired-samples t-test (Table 6).

Table 6. Overall Scenario-Based Civic Performance at Pre-Test and Post-Test

Assessment	M	SD	Mean change	95% CI of change	t(49)	p	Cohen's dz
Pre-test (T0)	62.33	17.99					
Post-test (T1)	93.67	5.21	31.33	[26.39, 36.27]	12.75	< .001	1.80

Post-test performance was significantly higher, $t(49) = 12.75$, $p < .001$, with a 95% confidence interval for improvement of 26.39 to 36.27 points and a very large within-participant effect, Cohen's $dz = 1.80$.

The improvement is consistent with meta-analytic evidence that AR can support learning when integrated with structured pedagogy (Garzón & Acevedo, 2019; Chang et al., 2022) and extends that observation to socially consequential elementary civic scenarios.

The effect magnitude nevertheless requires restraint. A one-group design cannot establish that Panca-AR caused the change. The sequence combined augmented scenarios, embedded quiz practice, repeated content, reflection, and deliberation; blueprint-aligned testing may also have produced familiarity with domains and scenario logic. The estimate should therefore be read as immediate change within a closely aligned instructional and measurement context, not an isolated AR effect.

Domain-Specific Performance

All domains improved: Gotong Royong from 59.00 to 84.00, Digital Ethics from 63.00 to 98.00, and Kebhinekaan from 65.00 to 99.00 (Table 7).

Table 7. Descriptive Performance Across the Three Applied Civic Domains

Applied domain	Pre-test mean	Post-test mean	Descriptive change
Gotong Royong	59.00	84.00	+25.00
Digital Ethics	63.00	98.00	+35.00
Kebhinekaan	65.00	99.00	+34.00

Improvement was not confined to one domain, although Gotong Royong remained lower and the other domains approached the scale maximum.

Near-maximum post-test scores in Digital Ethics and Kebhinekaan suggest a possible ceiling effect, indicating that the current multiple-choice format may have had limited capacity to differentiate students at higher performance levels. These scores should therefore not be interpreted as evidence of complete or stable civic competence. Future assessment development should incorporate more ambiguous or conflicting civic scenarios, competing value considerations, and open-ended justification tasks that require students to explain the reasoning underlying their judgments. Such formats may provide greater discrimination of higher-order civic reasoning and reduce ceiling effects in subsequent evaluations. The lower Gotong Royong score may reflect greater difficulty in judgments about individual contribution and collective responsibility, although differences in item difficulty remain an alternative explanation.

3.5 Implementation Process: Peer Deliberation and Civic Reason-Giving

Structured observation documented discussion after Panca-AR and before T1. Students explained situations, compared responses, considered social consequences, and justified judgments; groups neither received a collective score nor had to reach consensus.

Table 8. Observed Processes During Structured Peer Deliberation

Observed dimension	Classroom evidence
Scenario interpretation	Students restated and explained the civic situations using their own words
Perspective exchange	Students compared their preferred responses with those proposed by peers
Peer participation	Students invited or encouraged other group members to contribute
Consequence consideration	Students discussed how different responses could affect other people or the group
Civic reason-giving	Students provided reasons for why particular responses were considered more appropriate
Collaborative reflection	Students reconsidered aspects of their initial interpretation after hearing alternative perspectives

The observed interpretation, perspective exchange, participation, consequence consideration, reason-giving, and reflection (Table 8) indicate deliberation rather than mere physical grouping. Its civic relevance lies specifically in exchanging perspectives and reasons.

Discussion also enacted the fourth Pancasila principle's emphasis on deliberation and respect for opinions. It socially extended the reasoning initiated by the scenarios, consistent with situated participation and research on social interaction around immersive environments (Brown et al., 1989; Lave & Wenger, 1991; Scavarelli et al., 2021).

Because deliberation and Panca-AR were delivered within one sequence, observation cannot identify a separate deliberation effect; it shows only that the intended processes occurred.

3.6 Evaluation: Student Acceptance and Teacher Perspectives

Evaluation distinguished user perceptions from learning evidence. Table 9 reports positive responses across all eight acceptance and usability indicators.

Table 9. Student Acceptance and Perceived Usability of Panca-AR

Indicator	Mean	Percentage
Visual attractiveness	3.80	95.0%
Ease of use	3.64	91.0%
Usefulness of AR visualization	3.72	93.0%
Language clarity	3.70	92.5%
Material clarity	3.72	93.0%
Usefulness of scenario activities	3.68	92.0%
Enjoyment during learning	3.78	94.5%
Willingness to use Panca-AR again	3.62	90.5%
Overall	3.71	92.7%

The overall mean was 3.71 of 4 (92.7%). Visual attractiveness was highest ($M = 3.80$), followed by enjoyment ($M = 3.78$); willingness to reuse Panca-AR was lowest ($M = 3.62$) but remained positive. These ratings indicate acceptance, not learning improvement.

Teacher interviews clarified the perceived benefits and implementation conditions. Quotations were translated from Indonesian and lightly edited without changing their substantive meaning.

Teachers first emphasized attention and engagement:

"Students today are very familiar with digital devices, so learning with augmented reality can attract their attention more easily. Compared with conventional explanations, the use of AR makes the learning activity more interesting and encourages students to pay closer attention to the material."

They also viewed contextual visualization as important for translating abstract Pancasila values into recognizable experience:

"In Pancasila Education, students need clear illustrations and examples that are close to situations they experience in everyday life. If the material is presented only through text or verbal explanation, some students may find it difficult to imagine the situation. Panca-AR helps because students can see the situation more clearly, relate it to familiar experiences, and better understand how civic values are applied in practice."

These views echoed the contextual, interactive, and visual requirements identified before development, demonstrating continuity between needs and post-implementation perceptions.

However, teachers identified device availability as a practical constraint:

"The main challenge is access to devices because not every student has a smartphone that can be used for

learning. In regular classroom implementation, teachers may need to use their own devices or organize students into groups. During this activity, smartphones provided by the research team were used, which made the implementation much easier."

Research-provided smartphones reduced this barrier during the study, but routine classroom adoption requires device access to be treated as an implementation requirement rather than as a peripheral logistical concern. Depending on school conditions, feasible strategies may include shared-device arrangements, small-group use, teacher- or school-provided devices, and institutional support for device availability and connectivity. Thus, the practical feasibility of Panca-AR depends not only on technical simplicity but also on equitable and sustainable access to compatible devices.

3.7 Integrated Discussion Across the ADDIE Development Cycle

Across ADDIE, a traceable developmental chain connected teacher-identified needs to a Pancasila-based scenario architecture, specialist revisions, standardized implementation, individual performance assessment, observed deliberation, and user perspectives. This coherence distinguishes Panca-AR from an AR product evaluated only through validity and satisfaction scores.

The principal conceptual contribution is not the display of Pancasila objects. Panca-AR uses augmentation to situate civic problems within an architecture of interpretation, decision, consequences, reflection, and peer deliberation. It thereby extends established AR affordances for visualization and contextualization toward applied civic judgment (Akçayır & Akçayır, 2017; Garzón & Acevedo, 2019; Chang et al., 2022).

The results also suggest that the instructional sequence, rather than technology alone, is the relevant unit of interpretation. The observed gain followed augmented scenarios, quiz practice, reflection, and discussion, and the process evidence confirms that students exchanged perspectives and reasons. Accordingly, the pre-test and post-test results are interpreted as changes in blueprint-aligned scenario-based civic performance rather than as estimates of an underlying psychometric construct. Future component-comparison designs are needed to determine what AR, scenario practice, and deliberation each contribute.

Teacher evidence adds a material qualification. Scenario-based visualization may help elementary students grasp abstract civic concepts, but its affordances depend on access to devices, infrastructure, and teacher readiness (Alalwan et al., 2020). Device access should therefore be considered part of the implementation architecture of Panca-AR rather than a peripheral logistical issue. Shared-device arrangements, small-group implementation, and school-level support for device availability and connectivity may be necessary to ensure equitable and sustainable classroom participation.

Two limitations delimit the claims. First, 50 Grade 5 students from two intact classes at one school restrict generalizability. Second, the immediate post-test captures short-term aligned-task performance, not retention or transfer. Future studies should use multi-school samples, delayed post-tests, and unfamiliar transfer scenarios.

4. Conclusion

This study developed Panca-AR as a marker-based environment that positioned Pancasila as a foundational framework and operationalized its values through Gotong Royong, Digital Ethics, and Kebhinekaan. Its contribution is the use of AR to situate recognizable civic problems requiring interpretation, decisions, consequence consideration, reflection, and peer deliberation rather than simply display civic content.

Performance increased from 62.33 (SD = 17.99) to 93.67 (SD = 5.21), $t(49) = 12.75$, $p < .001$, Cohen's $d_z = 1.80$. This substantial immediate change concerns the integrated sequence of augmented scenarios, practice, reflection, and deliberation and should not be interpreted as an isolated causal effect of Panca-AR.

The single-school sample and immediate post-test limit generalizability, retention, and transfer claims. Multi-school studies with diverse students, delayed assessment, unfamiliar scenarios, and component comparisons are needed. Within these boundaries, Panca-AR offers a feasible architecture for connecting foundational Pancasila values with contextual civic reasoning and peer deliberation.

Acknowledgments

The authors are grateful to the participating elementary school, teachers, students, and expert validators for their cooperation and valuable contributions throughout the development and implementation of Panca-AR.

Author contributions

PCICD was responsible for conceptualization, methodology, investigation, formal analysis, data curation, writing the original draft, writing, review and editing, visualization, and project administration. LZ, MIC, RAH, and SLR contributed to methodology, investigation, validation, data interpretation, and writing, review and editing. All authors have read and agreed to the published version of the manuscript.

Funding

This research was funded by the Institute for Research and Community Service (LPPM), Universitas Negeri Jakarta, under Contract Number B/248/UN39.14/PT/III/2026.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Redfame Publishing.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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