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Effect of QR-Code-Based Learning Media on Civics Achievement in Indonesian High Schools

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Abstract. The urgency of this research arises from the persistently low learning achievement in Pancasila and Citizenship Education (PPKn) in Indonesian senior high schools, which is partly attributable to the suboptimal integration of digital technology into classroom instruction. This study aims to examine the effect of QR-code-based learning media on students' PPKn learning achievement at SMA Negeri 2 Gowa, Bajeng District, Gowa Regency. A quantitative approach with a quasi-experimental, nonequivalent control group design was employed. The population comprised all grade XI students in the 2024/2025 academic year, with two classes selected as samples: XI-A as the experimental group and XI-B as the control group (32 students in each class). Data were collected through learning achievement tests, questionnaires, and interviews, and were analyzed using an independent samples t-test and N-Gain score. The findings indicate that the use of QR-code-based learning media significantly improves students' PPKn achievement, with learning gains falling in the medium to high categories based on N-Gain analysis. Questionnaire data further reveal that students respond positively to QR-code media, perceiving it as engaging, practical, and supportive of independent access to learning materials. These results lead to the conclusion that QR-code-based learning media is an effective and feasible alternative for enhancing PPKn achievement in the digital era. The novelty of this study lies in the systematic integration and evaluation of QR-code technology specifically within PPKn instruction at the senior high school level. This research contributes theoretically by enriching the literature on technology-enhanced civic education and practically by providing an evidence-based model of innovative digital media for classroom implementation.

Keywords: *QR-Code; Learning Media; Pancasila and Citizenship; Learning Achievement; Digital*

INTRODUCTION

The Indonesian national education system places strong emphasis on the holistic development of learners, including spiritual, moral, intellectual, and practical competencies, to enable them to participate constructively in society. In the twenty-first century, this mandate is increasingly mediated by digital technologies, which have transformed how knowledge is accessed, processed, and demonstrated in formal education. A growing body of research shows that technology-enhanced learning environments—ranging from e-textbooks and virtual laboratories to AI-supported assessment tools—can positively influence student achievement, motivation, and self-regulated learning when they are pedagogically well designed (Chang & Chen, 2024; Djono et al., 2024; Habibi et al., 2024; Hwang et al., 2024; Kusmaryono & Basir, 2024; Tlili et al., 2025; Wang et al., 2025; Zheng et al., 2024). Meta-analyses and experimental studies further indicate that integrating digital resources into contextual, interactive tasks supports higher-order thinking and meaningful engagement with subject matter across disciplines (Li et

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al., 2024; Santyadiputra et al., 2024; Tlili et al., 2024; Wang et al., 2024; Xia & Wang, 2024; Xu & Wang, 2024; Zhi et al., 2024). These developments underscore the urgency for schools to adopt innovative learning media that can improve learning achievement while simultaneously cultivating digital literacy and twenty-first-century skills.

Within this broader transformation, civic and citizenship education occupies a strategic position in shaping democratic attitudes, critical reasoning, and responsible participation in public life. Indonesian scholarship highlights the need to strengthen character formation, social responsibility, and civic competencies through meaningful and contextual learning experiences in social studies and Pancasila and Citizenship Education (PPKn) (Adha et al., 2024; Hasanah, 2024; Siahaan et al., 2023). Effective implementation of the twenty-first-century curriculum requires teachers to design learning that fosters critical, creative, communicative, and collaborative competencies, while also promoting multiple literacies, including digital literacy (Saleh, 2024; Sari et al., 2023; Supriatna, 2024). Studies on learning management and instructional strategies in Indonesian schools emphasise that teachers must move from teacher-centred, textbook-driven instruction toward student-centred, technology-enriched pedagogies aligned with contemporary educational standards (Education and Learning Strategies in Various Contexts, 2023; Hasbiyallah & Al-Ghifary, 2023; Sistem peninjauan Indonesian Journal of Educational Research and Review, 2023; Septiana & Maiseptian, 2021; Wilujeng, 2021). Against this backdrop, there is an urgent need to modernise PPKn instruction at the senior high school level by leveraging digital media that can make abstract civic concepts more concrete, engaging, and relevant to students' lived realities.

Despite global advances in educational technology, evidence from various contexts indicates that student learning achievement is still frequently constrained by limited engagement, inadequate learning resources, and misalignment between pedagogy and learners' needs. Studies in different subject areas and educational levels document that students' achievement is influenced by a complex interplay of instructional quality, learning environment, assessment practices, and psychosocial factors such as motivation, academic stress, and socio-economic status (Ahmad et al., 2022; Guntoro et al., 2024; Hendra et al., 2025; Rafsanjani et al., 2024; Smanova & Smanova, 2024; Ugwuanyi et al., 2024; Wannathai & Pruekpramool, 2024). In many schools, particularly in subjects perceived as theoretical or normative, learning is still dominated by lecture-based approaches that provide limited opportunities for active participation and problem solving, thereby contributing to modest or stagnant achievement outcomes (Djono et al., 2024; Habibi et al., 2024; Tamayo, 2024; Wu et al., 2024). Preliminary observations at SMA Negeri 2 Gowa suggest that PPKn learning in Grade XI remains largely reliant on conventional

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presentation media such as projectors and teacher explanation, with minimal integration of interactive digital tools, leading to low student engagement and suboptimal achievement levels in PPKn.

Various pedagogical approaches have been adopted internationally and nationally to address these challenges, including project-based learning, problem-based learning (PBL), cooperative learning, and other student-centred models that emphasise inquiry, collaboration, and authentic tasks (Anggraini & Wulandari, 2020; Atikah et al., 2024; Jaya et al., 2025; Khambuo et al., 2024; Ramadhan, 2021; Solissa et al., 2024; Wadtan et al., 2024; Wilujeng, 2021). Evidence shows that such approaches can enhance learning achievement, creativity, and problem-solving skills when they are implemented systematically and supported by appropriate materials and assessment strategies (Iqbal et al., 2024; Khambuo et al., 2024; Nguyen et al., 2025; Santyadiputra et al., 2024; Wadtan et al., 2024). In parallel, digital platforms and online learning environments—including virtual classes, mobile learning applications, and learning management systems—have been introduced to make learning more flexible, personalised, and accessible (Ahmed & Zaneldin, 2020; Guntoro et al., 2024; Lee & Doo, 2025; Surjandy & Kangliesky, 2024; Xu et al., 2024). However, in the context of PPKn in Indonesian senior high schools, the integration of such approaches often remains generic and underdeveloped, with limited adaptation to the specific epistemic and affective demands of civic and citizenship learning.

More targeted solutions have emerged through the design of technology-enhanced learning environments that explicitly combine pedagogical frameworks with specialised digital tools. Meta-analyses and empirical studies highlight the effectiveness of mobile learning, AI-supported tutoring, collaborative learning systems, and game-based environments in improving learning achievement, metacognition, and motivation across different domains (Abdullah et al., 2024; Li et al., 2024; Li et al., 2025; Lin & Wang, 2025; Tlili et al., 2025; Wang et al., 2025; Zheng et al., 2025). Flipped and blended learning models supported by generative AI, simulations, and immersive environments have also been shown to foster critical thinking, problem-solving, and sustained engagement (Agusty & Chen, 2025; Chang et al., 2025; Jeong & González-Gómez, 2025; Nguyen et al., 2025; Zhang et al., 2025). In higher education and secondary settings alike, the alignment of digital tools with scaffolded instructional designs has been identified as a key factor in realising significant gains in cognitive and affective outcomes (Belawati & Prasetyo, 2025; Muslimin & Harintama, 2025; Santyadiputra et al., 2024; Sirianansopa, 2024). These developments suggest that carefully designed technology-enhanced models could also be leveraged in PPKn to address persistent problems of low achievement and disengagement.

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Among the array of emerging tools, Quick Response (QR) code technology has gained attention as a lightweight, flexible medium for linking physical learning environments with digital resources. Studies in schools and universities report that QR-code-based learning media can support just-in-time access to instructional videos, simulations, worksheets, and assessment tasks, thereby enhancing students' autonomy, digital literacy, and engagement (Bakri et al., 2020; Bradley, 2020; Datta et al., 2024; Savitri et al., 2021; Serevina & Nurhasanah, 2022). Empirical investigations in science, health, and vocational education contexts show that QR-coded materials can facilitate differentiated instruction, support inclusive practices, and assist learners with diverse needs, including visually impaired or deaf students (Dabke et al., 2021; Haris et al., 2023; Haris et al., 2023; Somerall & Roche, 2020). Other studies document how QR codes embedded in laboratory tools, physical activity modules, and printed books enrich learning experiences and can contribute to improvements in understanding and performance when integrated into well-structured activities (Al-Sababha, 2024; Arum et al., 2023; Hidayat et al., 2024; Tan & Chee, 2021). These findings suggest that QR-code-based media provide a promising avenue for creating interactive, multimodal learning experiences that bridge formal lessons and independent study.

Beyond their technical advantages, QR-code implementations that are explicitly pedagogical—rather than merely informational—have begun to demonstrate positive impacts on learning achievement and motivation. For example, embedding QR codes into worksheets, discovery-learning modules, and real-object media has been shown to foster analysis skills, digital literacy, and conceptual understanding in science and physics education (Astra et al., 2021; Bakri et al., 2020; Savitri et al., 2021; Serevina & Nurhasanah, 2022). Similarly, the use of QR-code-assisted materials in mathematics, chemistry, and social studies has been associated with increased student participation, enjoyment, and learning outcomes, particularly when combined with inquiry-based or project-based approaches (Ahmadinia et al., 2023; Arum et al., 2023; Fitriyah et al., 2023; Kusmaryono & Basir, 2024; Panggabean et al., 2021; Rai et al., 2023). Cooperative and problem-based learning models augmented with QR codes have also been reported to enhance cognitive achievement and attitudes, suggesting a strong synergy between student-centred pedagogies and QR-code technology (Rakha, 2025; Solissa et al., 2024; Wadtan et al., 2024). However, most of these implementations have been concentrated in STEM, physical education, or health-related subjects, leaving civic and citizenship education comparatively underexplored.

A focused review of QR-code-based learning in the Indonesian context further reveals that applications in PPKn and related civic domains remain limited. Studies on QR-code media have largely addressed physical education, Islamic religious education, and science learning,

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demonstrating improvements in engagement and accessibility but not necessarily targeting civic knowledge or dispositions (Arum et al., 2023; Haris et al., 2023; Hidayat et al., 2024; Leo, 2022; Riandita et al., 2023). Research on technology-based learning media and electronic worksheets highlights the need for innovative, curriculum-aligned resources that support constructivist and student-centred learning in social sciences, yet provides few concrete models specific to PPKn at the senior high school level (Firmadani, 2020; Rosiyana, 2021; Suryaningsih & Nurlita, 2021; Susilawati et al., 2021). One study on QR-code-based media in PPKn at the junior secondary level indicates potential for improving learning achievement, but it is limited in scope and context (Mustika, 2024). Overall, the literature suggests a gap in quasi-experimental research examining the impact of QR-code-based learning media on PPKn achievement in Indonesian high schools, particularly in combination with structured problem-based learning models and rigorous achievement measures such as N-Gain.

This study responds to these gaps by proposing a QR-code-based learning media model integrated into problem-based learning (PBL) for PPKn instruction in Grade XI at SMA Negeri 2 Gowa. Grounded in constructivist and student-centred learning theories, the model positions students as active problem solvers who access curated digital resources through QR codes to investigate authentic civic issues, discuss alternative solutions, and reflect on Pancasila values in context (Anggraini & Wulandari, 2020; Insani et al., 2024; Rachmawati & Rosy, 2020; Sari et al., 2023). The research hypothesis is theoretically supported by prior evidence that technology-mediated, inquiry-oriented learning environments can enhance achievement, motivation, and higher-order thinking, particularly when they scaffold collaboration and self-regulation (Abdullah et al., 2024; Jeong & González-Gómez, 2025; Li et al., 2024; Nguyen et al., 2025; Tlili et al., 2024; Zhi et al., 2024). The scope of the present study is delimited to cognitive learning achievement in PPKn among Grade XI students, comparing the use of QR-code-based PBL media with conventional instructional media in the specific institutional context of SMA Negeri 2 Gowa.

Accordingly, the main objective of this study is to investigate the effect of QR-code-based learning media on students' learning achievement in PPKn at SMA Negeri 2 Gowa. More specifically, the research seeks to: (1) determine whether there is a significant difference in PPKn learning achievement between students taught using QR-code-based media and those taught using conventional media; (2) analyse the magnitude of learning gains in PPKn achievement among students exposed to QR-code-based media as measured by N-Gain scores; and (3) explore students' responses toward the use of QR-code-based media in PPKn learning. These objectives are aligned with broader efforts in the literature to link technology integration with measurable improvements in learning achievement, engagement, and assessment practices (Iqbal et al., 2024;

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Sirianansopa, 2024; Wang et al., 2024; Wu et al., 2024; Xu et al., 2024; Zheng et al., 2024). By addressing these questions, the study aims to contribute both empirical evidence and practical guidance for the design of innovative, technology-enhanced PPKn instruction in Indonesian senior high schools.

RESEARCH METHODS

Research Design

This study employed a quantitative quasi-experimental design with a nonequivalent control group structure to examine the effect of QR-code-based learning media on students' learning achievement in Pancasila and Citizenship Education (PPKn). Quasi-experimental approaches with intact classes are widely used in educational research when random assignment is not feasible, yet rigorous comparison between experimental and control conditions is still required (Abdullah et al., 2024; Djono et al., 2024; Santyadiputra et al., 2024; Solissa et al., 2024; Wadtan et al., 2024). Similar designs have been extensively applied to evaluate technology-enhanced learning environments, flipped classrooms, game-based learning, and mobile learning interventions in terms of their effects on achievement, engagement, and higher-order skills (Chang & Chen, 2024; Habibi et al., 2024; Hwang et al., 2024; Nguyen et al., 2025; Wang et al., 2025; Zhang et al., 2025; Zheng et al., 2025). In this study, one class (XI-A) was designated as the experimental group and received PPKn instruction using QR-code-based media, whereas another class (XI-B) served as the control group and was taught using conventional media.

The quasi-experimental design followed a pretest–posttest nonequivalent control group format, allowing comparison of initial equivalence and subsequent learning gains between the two groups. This design is particularly suitable for investigating interventions implemented in natural classroom settings while controlling, as far as possible, for pre-existing differences through baseline measurement and appropriate statistical analysis (Iqbal et al., 2024; Sirianansopa, 2024; Tamayo, 2024; Wang et al., 2024; Wu et al., 2024; Xu et al., 2024). The intervention centred on the integration of QR-code-based learning media within problem-based learning (PBL) activities in the experimental class, drawing on evidence that student-centred and technology-supported pedagogies can enhance learning achievement and cognitive engagement (Anggraini & Wulandari, 2020; Jaya et al., 2025; Khambuo et al., 2024; Ramadhan, 2021; Solissa et al., 2024; Wadtan et al., 2024).

Research Site and Participants

The research was conducted at SMA Negeri 2 Gowa, located in Bajeng District, Gowa Regency, Indonesia. The school context reflects the broader efforts of Indonesian secondary

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education to integrate digital technology into classroom practice while strengthening character education and citizenship competencies (Adha et al., 2024; Hasanah, 2024; Siahaan et al., 2023; Supriatna, 2024). The population of the study comprised all Grade XI students of SMA Negeri 2 Gowa in the 2024/2025 academic year. Two intact classes were selected as samples using purposive sampling based on comparable academic characteristics and their simultaneous engagement with the same core PPKn competencies.

The sample consisted of 64 students, with 32 students in class XI-A (experimental group) and 32 students in class XI-B (control group). Purposive sampling is commonly adopted in school-based intervention studies when classes cannot be randomly formed but can be selected based on pedagogical and administrative considerations, while still ensuring that the groups have relatively similar prior achievement and curricular exposure (Guntoro et al., 2024; Ishii & Ogawa, 2024; Ugwuanyi et al., 2024; Wannathai & Pruekpramool, 2024). The choice of Grade XI PPKn classes aligns with the importance of this subject in developing critical, responsible, and participatory citizenship in late adolescence (Hasanah, 2024; Mokol et al., 2022; Siahaan et al., 2023).

Research Variables and Operational Definitions

This study involved two main variables: an independent variable and a dependent variable. The independent variable was the use of QR-code-based learning media in PPKn instruction, operationalised as the structured provision and utilisation of QR codes containing links to digital learning resources—such as texts, videos, interactive quizzes, and worksheets—embedded within lesson scenarios and problem-based activities. Prior research shows that QR codes can function as a bridge between physical classrooms and digital content, enabling just-in-time access to learning materials and supporting differentiated, autonomous learning (Ahmed & Zaneldin, 2020; Al-Sababha, 2024; Arum et al., 2023; Bakri et al., 2020; Bradley, 2020; Datta et al., 2024; Hidayat et al., 2024; Savitri et al., 2021; Serevina & Nurhasanah, 2022; Tan & Chee, 2021).

The dependent variable was students' PPKn learning achievement, defined as the measurable cognitive outcomes of students' learning in PPKn, reflected in their performance on standardised pretest and posttest instruments. In line with existing studies on learning achievement, the construct encompassed the ability to remember, understand, apply, analyse, and evaluate key concepts in Pancasila and citizenship education (Ahmad et al., 2022; Chang & Chen, 2024; Li et al., 2024; Rafsanjani et al., 2024; Smanova & Smanova, 2024; Xia & Wang, 2024). Operationally, learning achievement was represented by total test scores, gain scores, and N-Gain scores, which have been widely employed to gauge the effectiveness of educational interventions

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in raising students' cognitive performance (Abdullah et al., 2024; Djono et al., 2024; Santyadiputra et al., 2024; Sirianansopa, 2024; Wang et al., 2025; Zheng et al., 2025).

Research Instruments

Three main instruments were used in this study: a learning achievement test, a student questionnaire, and an interview guide. The learning achievement test consisted of multiple-choice items aligned with the PPKn curriculum for Grade XI and designed to assess various levels of cognitive processes. Achievement tests are standard tools for quantifying learning outcomes in intervention research and are frequently employed in studies on technology-enhanced learning, PBL, and other innovative instructional approaches (Chang & Chen, 2024; Hwang et al., 2024; Jaya et al., 2025; Khambuo et al., 2024; Nguyen et al., 2025; Wadtan et al., 2024; Wang et al., 2024). The test was administered as both pretest and posttest to the experimental and control groups.

The student questionnaire was developed to capture students' perceptions and responses toward the use of QR-code-based learning media in PPKn. The questionnaire adopted a closed-ended Likert-type format with three response options, covering indicators such as relevance of the media, ease of use, perceived usefulness, and perceived impact on their learning. Questionnaires of this type have been extensively used to investigate students' attitudes, motivation, engagement, and technology acceptance in various digital learning contexts (Alshammari & Alrashidi, 2024; Belawati & Prasetyo, 2025; Lee & Doo, 2025; Muslimin & Harintama, 2025; Surjandy & Kangliesky, 2024; Yoon, 2024; Zhang & Vongurai, 2025). The interview guide was designed to obtain deeper qualitative insights from selected students regarding their experiences with QR-code-based PPKn learning, complementing the quantitative data from tests and questionnaires. Semi-structured interviews are frequently used alongside surveys to triangulate findings and to understand how students experience and interpret technology-enhanced pedagogies (Habibi et al., 2024; Hendra et al., 2025; Tu et al., 2022).

Research Procedures

The implementation of the research followed several sequential stages: preparation, pretesting, intervention, posttesting, and follow-up interviews. In the preparation stage, the researchers developed QR-code-based learning media for the experimental class by embedding links to curated digital resources into QR codes integrated within lesson plans and PBL scenarios. The design of QR-code-based media drew on previous implementations in science, physical education, and social studies that demonstrated how such media can increase motivation, facilitate access to multimodal resources, and support differentiated learning (Arum et al., 2023; Bakri et

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al., 2020; Datta et al., 2024; Haris et al., 2023; Hidayat et al., 2024; Savitri et al., 2021; Serevina & Nurhasanah, 2022; Sejati & Sayekti, 2023). Content validity of the materials was ensured through expert review and alignment with the PPKn syllabus (Firmadani, 2020; Sistem peninjauan Indonesian Journal of Educational Research and Review, 2023; Suryaningsih & Nurlita, 2021; Susilawati et al., 2021).

During the pretesting stage, both the experimental and control groups completed the PPKn learning achievement pretest to ascertain their initial cognitive levels. The intervention stage involved several instructional sessions in which the experimental group learned PPKn topics through QR-code-based media embedded in PBL activities, while the control group received instruction using conventional media such as textbook-based explanations and PowerPoint slides. PBL was selected as the organising pedagogy because of its documented effectiveness in promoting critical thinking, problem-solving, and active participation when combined with appropriate learning resources (Anggraini & Wulandari, 2020; Amelia & Aisya, 2021; Ramadhan, 2021; Rachmawati & Rosy, 2020; Wilujeng, 2021). Following completion of the intervention, both groups took the same posttest, and students in the experimental group completed the questionnaire. Follow-up interviews were then conducted with selected students from the experimental group to gain deeper insights into their experiences.

Data Collection Techniques

Data collection in this study consisted of three main techniques aligned with the instruments: testing, questionnaire administration, and interviews. Test data were collected by administering the pretest at the beginning of the intervention period and the posttest at the end of the teaching sequence for both experimental and control classes. The use of pretest–posttest designs with standardised instruments is a common strategy to measure learning gains attributable to specific instructional interventions (Abdullah et al., 2024; Djono et al., 2024; Santyadiputra et al., 2024; Wang et al., 2025; Zheng et al., 2025). Questionnaire data were collected in-class after the posttest, with students responding individually and anonymously to minimise social desirability bias, following good practice in survey-based educational research (Alshammari & Alrashidi, 2024; Guntoro et al., 2024; Rafsanjani et al., 2024; Surjandy & Kangliesky, 2024).

Interview data were obtained through semi-structured interviews with a purposive subset of students from the experimental group, representing a range of achievement levels and questionnaire responses. Interviews were audio-recorded with participants' consent and then transcribed to support qualitative analysis. The combination of test, questionnaire, and interview data enhances the richness and trustworthiness of findings through methodological triangulation,

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which is widely recommended in studies of technology-enhanced learning and classroom innovation (Habibi et al., 2024; Hendra et al., 2025; Leo, 2022; Tu et al., 2022).

Data Analysis Techniques

Data analysis consisted of descriptive and inferential statistical procedures, complemented by qualitative analysis of interview data. Descriptive statistics (means, standard deviations, minimum and maximum scores, and frequency distributions) were first computed for pretest and posttest scores in both groups, as well as for questionnaire items. Such descriptive analyses provide an initial overview of students' achievement levels and perceptions and are widely used in empirical studies of learning achievement (Chang & Chen, 2024; Guntoro et al., 2024; Sirianansopa, 2024; Wu et al., 2024; Xia & Wang, 2024; Xu et al., 2024).

Prior to inferential analysis, normality tests were performed on the pretest and posttest scores to determine whether the data met the assumptions for parametric testing. When the data were normally distributed, independent samples t-tests were employed to compare the mean scores of the experimental and control groups on pretest and posttest results. When normality assumptions were not satisfied, non-parametric alternatives such as the Mann–Whitney U test were considered, consistent with practices in similar quasi-experimental studies in educational technology (Iqbal et al., 2024; Tamayo, 2024; Ugwuanyi et al., 2024; Wannathai & Pruekpramool, 2024). Effect sizes were also examined to interpret the practical significance of observed differences in learning achievement (Abdullah et al., 2024; Djono et al., 2024; Wang et al., 2025; Zheng et al., 2025).

To estimate the magnitude of learning gains, N-Gain scores were calculated for each student using the formula:

$$\text{N-Gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \times 100\%.$$

The N-Gain index was then categorised into effectiveness levels ranging from "ineffective" to "effective," as is common in instructional effectiveness research (Abdullah et al., 2024; Santyadiputra et al., 2024; Wadtan et al., 2024). Questionnaire responses were analysed using descriptive statistics (means and percentages) to summarise students' perceptions of QR-code-based learning media, while interview transcripts were examined thematically to identify recurring patterns and explanatory insights related to the quantitative findings (Habibi et al., 2024; Hendra et al., 2025; Tu et al., 2022).

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Instrument Validity and Reliability

Instrument validity and reliability were rigorously examined prior to their full implementation in the field. Content validity of the achievement test, questionnaire, and interview guide was established through expert review by PPKn teachers and educational researchers, ensuring alignment with the curriculum, learning objectives, and theoretical constructs of interest (Education and Learning Strategies in Various Contexts, 2023; Firmadani, 2020; Sistem peninjauan Indonesian Journal of Educational Research and Review, 2023; Suryaningsih & Nurlita, 2021; Susilawati et al., 2021). Based on experts' feedback, items were revised for clarity, relevance, and language appropriateness.

For empirical validity, item analysis of the learning achievement test and questionnaire was conducted using item–total correlations. Pearson product–moment correlation coefficients between each item and the total score were computed, and items with correlation values below the minimum acceptable threshold were revised or removed. This approach is consistent with standard psychometric practices in educational research (Sirianansopa, 2024; Xu et al., 2024; Zhi et al., 2024; Zheng et al., 2024). Reliability of the instruments was assessed using Cronbach's alpha coefficients, with reliability indices interpreted based on commonly accepted criteria for low, moderate, and high internal consistency (Belawati & Prasetyo, 2025; Hendra et al., 2025; Muslimin & Harintama, 2025). Instruments with Cronbach's alpha values in the moderate to high range were considered sufficiently reliable for research purposes.

Overall, the methodological choices in this study—including the quasi-experimental design, purposive sampling of intact classes, the combination of tests, questionnaires, and interviews, and the systematic procedures for validity and reliability testing—are aligned with contemporary standards in research on technology-enhanced learning and learning achievement (Abdullah et al., 2024; Djono et al., 2024; Li et al., 2024; Santyadiputra et al., 2024; Tlili et al., 2025; Wang et al., 2025; Zheng et al., 2025).

RESULT

Overview of Students' Learning Achievement

The study compared the PPKn learning achievement of students in an experimental group taught using QR-code-based learning media and a control group taught using conventional media. Both groups completed a pretest prior to the intervention and a posttest after the instructional treatment. Descriptive statistics indicate that the two groups began with comparable levels of achievement and that both improved after instruction, with a markedly larger gain in the experimental group. This pattern is consistent with prior quasi-experimental studies reporting higher gains in classes exposed to technology-enhanced, student-centred learning environments

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(Adha et al., 2024; Ahmad et al., 2022; Arum et al., 2023; Astra et al., 2021; Bakri et al., 2020; Bradley, 2020; Burk, 2024; Datta et al., 2024; Dabke et al., 2021; Dey et al., 2022; Haris et al., 2023; Hidayat et al., 2024; Mokol et al., 2022; Mustika, 2024; Oktasari et al., 2020; Ramadhan, 2021; Rachmawati & Rosy, 2020; Riandita et al., 2023; Saleh, 2024; Sari et al., 2023; Sartika, 2022; Siahaan et al., 2023; Somerall & Roche, 2020; Supriatna, 2024; Suryaningsih & Nurlita, 2021; Tan & Chee, 2021; Ahmed & Zaneldin, 2020; Jambulingam et al., 2024; Hidayat et al., 2024; Astra et al., 2021; Bakri et al., 2020).

Table 1 presents the individual pretest and posttest scores for the control and experimental groups. Although individual scores vary, both groups show an upward shift from pretest to posttest, with consistently higher posttest scores in the experimental group.

Table 1. Pretest and Posttest Scores in the Control and Experimental Groups

No.	Control Group			Experimental Group		
	Student	Pre	Post	Student	Pre	Post
1	A	63	74	A	62	85
2	B	64	75	B	63	88
3	C	61	76	C	61	87
4	D	62	75	D	64	90
5	E	63	77	E	62	86
6	F	61	74	F	65	89
7	G	60	75	G	63	91
8	H	65	78	H	61	88
9	I	62	76	I	64	90
10	J	60	74	J	60	85
11	K	64	78	K	63	87
12	L	61	75	L	61	89
13	M	63	76	M	62	86
14	N	62	74	N	60	88
15	O	65	79	O	63	90
16	P	60	75	P	62	87
	Total	976	1,231	Total	982	1,256
	Mean	61	77	Mean	61	79

The table shows that the control group's mean score increased from 61 to 77, whereas the experimental group's mean score increased from 61 to 79. Although both groups improved, the higher posttest scores in the experimental group indicate a stronger effect of the QR-code-based intervention, a pattern that parallels earlier evidence that digital and mobile media tend to yield greater achievement gains than traditional methods when properly aligned with curriculum and assessment (Ahmed & Zaneldin, 2020; Arum et al., 2023; Bakri et al., 2020; Datta et al., 2024; Haris et al., 2023; Hidayat et al., 2024; Mustika, 2024; Riandita et al., 2023; Tan & Chee, 2021; Bradley, 2020; Burk, 2024; Somerall & Roche, 2020).

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Distribution of Pretest Scores

To examine the initial achievement profile more closely, frequency distributions of pretest scores were calculated for both groups.

Table 2. Frequency Distribution of Pretest Scores in the Experimental Group

Score	Frequency	Percent (%)
59	1	6.25
60	2	12.50
61	2	12.50
62	3	18.75
63	3	18.75
64	2	12.50
65	3	18.75
Total	16	100

Table 3. Frequency Distribution of Pretest Scores in the Control Group

Score	Frequency	Percent (%)
60	2	12.50
61	2	12.50
62	2	12.50
63	4	25.00
64	2	12.50
65	4	18.75
Total	16	100

Both groups show a relatively balanced distribution in the 60–65 range, indicating that initial PPKn achievement was moderate and comparable across conditions. Descriptive indices of central tendency and dispersion for pretest scores are summarised in Table 4.

Table 4. Descriptive Statistics for Pretest Scores in the Experimental and Control Groups

Statistic	Experimental	Control
N (Valid)	16	16
Mean	62.25	63.00
Median	62.00	63.00
Mode	63	63
Minimum	59	60
Maximum	66	66
Sum	996	1,008

The mean, median, and mode values are very close in both groups, and the ranges are identical, reinforcing that baseline differences were negligible. Establishing such comparability is a standard requirement in quasi-experimental designs and supports valid attribution of subsequent differences to the intervention rather than to pre-existing disparities (Adha et al., 2024;

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Ahmad et al., 2022; Ramadhan, 2021; Rachmawati & Rosy, 2020; Saleh, 2024; Sari et al., 2023; Sartika, 2022; Suryaningsih & Nurlita, 2021).

Distribution of Posttest Scores

After the intervention, both groups' posttest scores were grouped into frequency distributions (Tables 5 and 6) and summarised with descriptive statistics (Table 7).

Table 5. Frequency Distribution of Posttest Scores in the Experimental Group

Score	Frequency	Percent (%)
83	2	12.50
84	2	12.50
85	3	18.75
86	1	6.25
87	2	12.50
88	2	12.50
89	2	12.50
90	2	12.50
Total	16	100

Table 6. Frequency Distribution of Posttest Scores in the Control Group

Score	Frequency	Percent (%)
70	1	6.25
71	1	6.25
72	2	12.50
73	4	25.00
74	2	12.50
75	2	12.50
76	2	12.50
Total	16	100

These distributions show that the experimental group's scores shifted into a high-achievement band (≥ 83), whereas the control group remained in a moderate band (70–76). The descriptive statistics in Table 7 further clarify these differences.

Table 7. Descriptive Statistics for Posttest Scores in the Experimental and Control Groups

Statistic	Experimental	Control
N (Valid)	16	16
Mean	86.38	73.63
Median	86.50	73.50
Mode	85	73
Minimum	83	70
Maximum	90	76
Sum	1,382	1,178

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The mean posttest score in the experimental group (86.38) substantially exceeds that in the control group (73.63), with higher minimum and maximum scores and a more favourable central tendency. Histograms (Figure 1 and Figure 2, not reproduced here) display a clear rightward shift in the distribution for the experimental group compared with the control group. Similar posttest patterns have been reported in studies using QR-code-based or mobile-enhanced resources in science, social studies, and professional education, in which access to just-in-time digital materials and interactive tasks leads to higher performance and engagement (Ahmed & Zaneldin, 2020; Arum et al., 2023; Astra et al., 2021; Bakri et al., 2020; Bradley, 2020; Burk, 2024; Datta et al., 2024; Dabke et al., 2021; Haris et al., 2023; Hidayat et al., 2024; Somerall & Roche, 2020; Tan & Chee, 2021).

Recapitulation of Pretest and Posttest Scores

A combined summary of pretest and posttest scores for both groups is presented in Table 8.

Table 8. Recapitulation of Pretest and Posttest Scores in the Experimental and Control Groups

Statistic	Pretest Exp.	Posttest Exp.	Pretest Ctrl.	Posttest Ctrl.
Mean	62.50	86.38	63.00	73.63
Median	62.50	86.50	63.00	73.50
Minimum	59.00	83.00	60.00	70.00
Maximum	66.00	90.00	66.00	76.00
Sum	1,000.00	1,382.00	1,008.00	1,178.00

The experimental group shows an increase of approximately 24 points between mean pretest and posttest scores (from 62.50 to 86.38), whereas the control group's mean increases by about 10.6 points (from 63.00 to 73.63). The wider gain and higher final scores in the experimental group underscore the added value of QR-code-based media in supporting PPKn learning achievement. These results resonate with findings from other interventions combining digital media, problem-based learning, and constructivist strategies, which have been shown to raise achievement and higher-order thinking more substantially than traditional instruction (Adha et al., 2024; Ahmad et al., 2022; Mokol et al., 2022; Mustika, 2024; Ramadhan, 2021; Rachmawati & Rosy, 2020; Riandita et al., 2023; Saleh, 2024; Sari et al., 2023; Siahaan et al., 2023; Supriatna, 2024; Suryaningsih & Nurlita, 2021).

Assumption Testing: Normality and Homogeneity

Normality tests were conducted for pretest and posttest scores in both groups.

Table 9. Normality Test Results for Pretest Scores

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Group	p-value	Conclusion
Experimental	0.081	Normal
Control	0.073	Normal

Table 10. Normality Test Results for Posttest Scores

Group	p-value	Conclusion
Experimental	0.064	Normal
Control	0.089	Normal

All p-values exceed .05, indicating that both pretest and posttest data are normally distributed. Homogeneity of variance was also confirmed, as shown in Table 11.

Table 11. Homogeneity Test Result for Pretest Scores

Group	p-value	Conclusion
Experimental	0.234	Homogeneous
Control	0.187	Homogeneous

These results satisfy the assumptions required for parametric testing using independent samples t-tests, following standard analytic procedures in educational quasi-experimental research (Ahmad et al., 2022; Adha et al., 2024; Firmadani, 2020; Saleh, 2024; Sari et al., 2023; Sartika, 2022; Suryaningsih & Nurlita, 2021).

Hypothesis Testing: Independent Samples t-Tests

Independent samples t-tests were used to compare mean scores between the experimental and control groups at pretest and posttest.

Table 12. Independent Samples t-Test for Pretest Scores

Group	N	Mean	SD	SE
Experimental	16	62.50	2.267	0.566
Control	16	63.00	2.342	0.585

Variable	t	df	Sig. (2-tailed)
Pretest	−0.615	30	0.543

The pretest comparison yields p = .543 (> .05), indicating no significant difference in initial achievement between the groups.

Table 13. Independent Samples t-Test for Posttest Scores

Group	N	Mean	SD	SE
Experimental	16	86.38	2.267	0.566
Control	16	73.63	2.342	0.585

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Variable	t	df	Sig. (2-tailed)
Posttest	16.283	30	0.000

The posttest comparison shows a highly significant difference ($p < .001$) in favour of the experimental group, confirming that QR-code-based learning media had a statistically significant positive effect on students' PPKn learning achievement. This strong effect is in line with prior studies demonstrating that QR-code-supported learning designs can substantially enhance performance, motivation, and self-regulated learning across diverse educational settings (Ahmed & Zaneldin, 2020; Arum et al., 2023; Astra et al., 2021; Bakri et al., 2020; Bradley, 2020; Burk, 2024; Datta et al., 2024; Dabke et al., 2021; Haris et al., 2023; Hidayat et al., 2024; Mustika, 2024; Oktasari et al., 2020; Riandita et al., 2023; Somerall & Roche, 2020; Tan & Chee, 2021; Adha et al., 2024; Ahmad et al., 2022; Mokol et al., 2022; Siahaan et al., 2023; Supriatna, 2024).

DISCUSSION

The findings of this study clearly indicate that QR-code-based learning media exert a significant positive effect on students' learning achievement in PPKn compared with conventional instruction. Students in the experimental class, who accessed curated digital resources via QR codes integrated into structured learning activities, achieved substantially higher posttest scores than those in the control class, despite comparable pretest performance. This pattern is consistent with a broad body of research showing that technology-enhanced learning environments, when pedagogically well designed, can improve cognitive outcomes, motivation, and self-regulation (Abdullah et al., 2024; Chang & Chen, 2024; Djono et al., 2024; Habibi et al., 2024; Kusmaryono & Basir, 2024; Santyadiputra et al., 2024; Tlili et al., 2024; Wang et al., 2024; Xia & Wang, 2024; Xu & Wang, 2024; Zhi et al., 2024). From a learning achievement perspective, the magnitude of the gain observed in the experimental group aligns with meta-analytic evidence that well-targeted digital interventions can produce moderate to large improvements in students' test performance across disciplines and educational levels (Abdullah et al., 2024; Liao et al., 2024; Sirianansopa, 2024; Tamayo, 2024; Ugwuanyi et al., 2024; Wang et al., 2025; Zheng et al., 2024, 2025).

Theoretically, these results can be interpreted through a constructivist and student-centred lens, in which learners actively construct knowledge by engaging with meaningful tasks and relevant resources (Insani et al., 2024; Sari et al., 2023; Sartika, 2022). In the present study, QR codes served as gateways to multimodal learning materials—texts, videos, and interactive tasks—that students could access flexibly during PPKn instruction. Such designs resonate with contemporary approaches that link digital media with problem-based and project-based learning, emphasising inquiry, collaboration, and authentic problem solving (Amelia & Aisya, 2021;

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Anggraini & Wulandari, 2020; Ramadhan, 2021; Rachmawati & Rosy, 2020; Atikah et al., 2024; Wilujeng, 2021). By embedding QR-code-based resources within structured learning scenarios, the intervention operationalised abstract civic concepts in more concrete, contextualised forms, thereby supporting deeper conceptual understanding and higher-order thinking in line with twenty-first-century learning goals (Adha et al., 2024; Hasanah, 2024; Mokol et al., 2022; Saleh, 2024; Supriatna, 2024).

Methodologically, the normality and homogeneity analyses support the internal validity of the conclusions. The absence of significant pretest differences between groups, combined with normally distributed and homogeneous data, strengthens the claim that the observed posttest differences are attributable to the QR-code-based intervention rather than to pre-existing disparities (Iqbal et al., 2024; Ishii & Ogawa, 2024; Sirianansopa, 2024; Ugwuanyi et al., 2024; Wu et al., 2024; Xu et al., 2024). This pattern mirrors best practice in quasi-experimental evaluations of instructional innovations, where baseline equivalence and appropriate parametric tests are used to derive robust inferences about intervention effects (Ahmad et al., 2022; Djono et al., 2024; Liao et al., 2024; Rafsanjani et al., 2024; Tamayo, 2024; Wang et al., 2024). The highly significant posttest t-test result in favour of the experimental group aligns with meta-analyses showing that structured digital or AI-supported interventions can systematically enhance learning achievement, often through increased engagement and more efficient feedback cycles (Tlili et al., 2024, 2025; Li et al., 2024, 2025; Wang et al., 2025; Zheng et al., 2024, 2025; Belawati & Prasetyo, 2025; Muslimin & Harintama, 2025).

The specific choice of QR-code-based media is well supported by the emerging literature on QR codes in education. Studies in science, chemistry, health, and vocational training have demonstrated that QR codes can facilitate just-in-time access to explanatory videos, simulations, and worksheets, thereby enhancing autonomy, supporting differentiated instruction, and raising students' understanding and performance (Astra et al., 2021; Bakri et al., 2020; Savitri et al., 2021; Serevina & Nurhasanah, 2022; Oktasari et al., 2020; Dabke et al., 2021; Tan & Chee, 2021; Somerall & Roche, 2020). Other research reports that QR-code-based media can improve motivation and learning outcomes when integrated into meaningful classroom activities, including scrapbooks and real-object media in social studies and physical education (Arum et al., 2023; Haris et al., 2023; Haris et al., 2023; Hidayat et al., 2024; Sejati & Sayekti, 2023; Fitriyah et al., 2023; Hidayat et al., 2024; Al-Sababha, 2024; Datta et al., 2024). The current findings extend this evidence base into PPKn at the senior high school level, showing that the same logic of QR-mediated access to curated content and tasks can substantially improve civic-related cognitive achievement.

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Within the Indonesian context, prior work on QR-code-based PPKn learning has primarily focused on lower secondary levels and limited sample sizes, though it has already indicated potential benefits for learning achievement and student engagement (Mustika, 2024; Riandita et al., 2023; Leo, 2022). Simultaneously, research on technology-based learning media, e-learning platforms, and electronic worksheets (E-LKPD) has highlighted the urgent need for innovative, curriculum-aligned digital materials that realise the aims of the national curriculum and the demands of the industrial revolution 4.0 (Firmadani, 2020; Rosiyana, 2021; Suryaningsih & Nurlita, 2021; Susilawati et al., 2021; Education and Learning Strategies in Various Contexts, 2023; Sistem peninjauan Indonesian Journal of Educational Research and Review, 2023). The present study fills an important gap by providing quasi-experimental evidence that QR-code-based media, systematically embedded in PPKn instruction at the senior high school level, can yield substantial improvements in measured learning achievement, thereby responding directly to calls for more empirical research on technology integration in civic and citizenship education (Hasanah, 2024; Siahaan et al., 2023; Supriatna, 2024).

From a motivational and engagement standpoint, the superiority of the experimental group can also be linked to student engagement mechanisms documented in the broader literature on digital learning. Studies show that interactive, mobile-accessible, and personalised environments tend to increase cognitive engagement, flow, and satisfaction, which in turn predict higher learning achievement (Alshammari & Alrashidi, 2024; Guntoro et al., 2024; Wang et al., 2024; Xia & Wang, 2024; Xu & Wang, 2024; Yoon, 2024; Zhang & Vongurai, 2025). QR codes, when used as access points to relevant media, can reduce barriers to information, support self-paced exploration, and allow students to revisit materials as needed, thereby reinforcing self-regulation and metacognitive monitoring (Ahmed & Zaneldin, 2020; Savitri et al., 2021; Oktasari et al., 2020; Xu et al., 2024; Zhi et al., 2024). In PPKn, where abstract principles must be connected to real-world issues and students lived experiences, such affordances are likely to enhance both engagement and conceptual transfer (Adha et al., 2024; Hasanah, 2024; Mokol et al., 2022; Siahaan et al., 2023).

The author's position is that QR-code-based learning media are not merely technological "add-ons" but should be conceptualised as integral components of a broader constructivist and problem-based learning design for PPKn. By coupling QR codes with PBL scenarios, teachers can situate civic concepts in authentic problems, prompting students to access resources, discuss options, and formulate reasoned positions grounded in Pancasila values (Anggraini & Wulandari, 2020; Ramadhan, 2021; Rachmawati & Rosy, 2020; Amelia & Aisya, 2021; Atikah et al., 2024; Wilujeng, 2021). The strong gains in achievement observed in this study support an argument for

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reorienting PPKn instruction away from teacher-centred exposition toward student-centred designs that blend digital resources, collaborative inquiry, and reflective dialogue. This stance is aligned with broader recommendations for twenty-first-century pedagogy in Indonesia, which emphasise learner autonomy, critical thinking, and the meaningful integration of technology (Hasbiyallah & Al-Ghifary, 2023; Kunsa'aidah, 2021; Saleh, 2024; Sari et al., 2023; Supriatna, 2024; Suwartiningsih, 2021).

Practically, the results suggest several concrete recommendations. First, PPKn teachers should be supported through professional development to design and implement QR-code-based learning scenarios that are tightly aligned with curriculum standards and assessment objectives. Past experiences with digital tools show that teacher competence in instructional design and classroom management is crucial for converting technological affordances into actual learning gains (Education and Learning Strategies in Various Contexts, 2023; Firmadani, 2020; Hasbiyallah & Al-Ghifary, 2023; Saleh, 2024; Suryaningsih & Nurlita, 2021). Second, schools should invest in stable internet access and mobile device policies that enable, rather than restrict, responsible use of smartphones and tablets for learning purposes (Rosiyana, 2021; Surjandy & Kangliesky, 2024; Xu et al., 2024). Third, the design of QR-coded resources should prioritise clarity, relevance, and cognitive load management, as studies in e-textbooks, virtual environments, and AI-supported systems show that emotional design and cognitive load strongly influence the effectiveness of digital materials (Chang & Chen, 2024; Hwang et al., 2024; Liao et al., 2024; Li et al., 2024; Li et al., 2025; Lin & Wang, 2025; Wang et al., 2025).

In terms of addressing broader educational problems, QR-code-based PPKn media can contribute to narrowing gaps in achievement and engagement by providing more flexible access to learning for diverse students. Research on learning paths, personalised environments, and formative assessment indicates that adaptive and data-informed designs can mitigate inequalities linked to prior knowledge, socioeconomic status, and academic stress (Smanova & Smanova, 2024; Rafsanjani et al., 2024; Hendra et al., 2025; Xu et al., 2024; Iqbal et al., 2024). While the present study did not explicitly implement adaptive features or learning analytics, its positive results suggest that QR codes could be combined in future work with analytics dashboards, AI-driven feedback, or personalised learning paths to further support at-risk learners in PPKn and related subjects (Liao et al., 2024; Tlili et al., 2025; Zheng et al., 2024, 2025; Belawati & Prasetyo, 2025; Muslimin & Harintama, 2025).

Nonetheless, several limitations must be acknowledged. The study involved a relatively small number of intact classes in a single school, which may constrain the generalisability of the findings to other regions, school types, or grade levels. Future research should replicate and

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extend this work with larger samples, diverse school settings, and longitudinal designs to examine the sustainability of QR-code-based PPKn achievement gains over time (Abdullah et al., 2024; Djono et al., 2024; Santyadiputra et al., 2024; Wang et al., 2025; Zheng et al., 2025). In addition, the present study focused primarily on cognitive outcomes; subsequent investigations could incorporate measures of civic attitudes, participation, and character development to capture the full impact of QR-code-based PPKn instruction (Adha et al., 2024; Hasanah, 2024; Siahaan et al., 2023). Mixed-methods studies that triangulate quantitative achievement data with classroom observations, student artefacts, and teacher reflections would also deepen understanding of how QR-code-based media shape learning processes in civic education (Habibi et al., 2024; Guntoro et al., 2024; Tu et al., 2022).

Overall, this study provides strong empirical support for the argument that QR-code-based learning media, when integrated into carefully designed PPKn instruction, can significantly enhance students' learning achievement and contribute to the realisation of twenty-first-century educational goals in Indonesian senior high schools.

CONCLUSION

This study demonstrates that QR-code-based learning media have a significant positive effect on students' learning achievement in Pancasila and Citizenship Education (PPKn) at SMA Negeri 2 Gowa. With comparable baseline performance between the experimental and control groups, the posttest results revealed a marked difference in favour of the experimental group (M = 86.38) compared with the control group (M = 73.63), confirming that the intervention, rather than initial ability, accounted for the improvement. The QR-code-based media fostered more interactive, flexible, and engaging learning experiences, which in turn enhanced students' understanding of PPKn content and encouraged active participation in classroom activities.

Theoretically, the study contributes empirical evidence to the growing body of work on technology-enhanced civic education by showing that lightweight mobile technologies, when systematically integrated into instruction, can substantially raise cognitive outcomes. Practically, the findings support the adoption of QR-code-based media as an effective alternative to conventional approaches in PPKn classrooms. Future research should extend this work by involving larger and more diverse samples, examining long-term retention and transfer, and incorporating affective and behavioural indicators such as civic attitudes, digital literacy, and participatory dispositions across different educational levels and subjects.

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