

Integrating AI-assisted design thinking in citizenship education: Enhancing university students' problem analysis and critical thinking skills

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Abstract

This study aims to analyse the implementation of an AI-assisted design thinking learning model in enhancing university students' problem analysis and critical thinking skills in Citizenship Education programmes. The study employed a qualitative approach involving undergraduate students from several Citizenship Education programmes at universities on Java Island, Indonesia. The learning implementation integrated artificial intelligence (AI) to assist students in exploring information, generating ideas and reflecting on solutions to civic and social issues. Research data were collected through observations of the learning process, analysis of students' assignment documents, AI-assisted interaction records and group discussions conducted during the implementation of the model. Data were analysed descriptively to identify the dynamics of the learning process at each stage of design thinking. The findings indicate that AI-assisted design thinking encouraged students to engage actively in social problem analysis and problem-solving. During the *empathise* stage, students identified social issues through digital information exploration, AI use and group discussions, enabling them to understand problems from multiple perspectives. In the *define* stage, students formulated problems more systematically by identifying causal relationships and the underlying social contexts. The *ideate* stage encouraged students to generate alternative solutions creatively and collaboratively through group discussions and AI-supported idea development. In the *prototype* and *test* stages, students developed solution designs in the form of programmes or simple policy models and evaluated their effectiveness through reflection, feedback and AI-assisted analysis. The study concludes that AI supports, but does not replace, students' critical reasoning, the quality of which depends on reflective pedagogical design.

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Introduction

The development of global society in the 21st century requires universities to function not only as institutions for transferring knowledge but also as spaces for fostering students' higher-order thinking skills. One of the primary competencies emphasised in higher education today is critical reasoning (Song, 2016; Van Damme et al., 2023). This competence enables students to analyse information in depth, evaluate arguments and make rational, evidence-based decisions. In higher education, critical reasoning is an essential foundation for academic literacy, complex problem-solving and active participation in social and professional life (Alрахman et al., 2024; Chen et al., 2021; Culver et al., 2019; Facione, 2015; Ghanizadeh, 2017). This issue is increasingly important in teacher education programmes, including Citizenship Education, where students are expected not only to understand academic concepts but also to analyse social and civic issues critically and reflectively. There is therefore a need for learning models that can strengthen students' critical reasoning skills systematically and contextually.

Various studies indicate that university students' critical reasoning skills remain relatively low. Most students are categorised at a moderate level of critical thinking, while others remain at a low level (Fong et al., 2017; Wale & Bishaw, 2020). Students also continue to experience difficulties in analysing, evaluating and interpreting information argumentatively. This condition is reinforced by educational reports in Indonesia showing that students' higher-order thinking skills still require significant improvement. In the Programme for International Student Assessment (PISA) 2022, Indonesian students achieved a reading literacy score of 359, far below the OECD average of 476, indicating weak analytical, reasoning and evaluative abilities (Darmawan et al., 2025; Nurjain et al., 2026; Sousa et al., 2026). Furthermore, reports from the Indonesian Ministry of Education, Culture, Research, and Technology indicate that most Indonesian students remain at the basic competency level in understanding and critically analysing information (Anisa et al., 2021; Ariani et al., 2025; Martha et al., 2021; Wahid et al., 2025). These findings demonstrate that strengthening critical reasoning skills remains a major challenge for the education system, including at university level.

One factor contributing to students' weak critical reasoning skills is the dominance of conventional teaching approaches in higher education (Amirian et al., 2023; Aston, 2024; Song, 2016; Tanszil et al., 2023). Learning processes are still largely oriented towards content delivery and knowledge reproduction: lecturers act as the primary source of information, while students assume passive roles as recipients of knowledge. As a result, student engagement is limited because instructional activities rely more heavily on lectures than on discussion, analysis, reflection and independent exploration of ideas. Students therefore have few opportunities to develop higher-order thinking skills such as analysis, critical evaluation, and logical and systematic argument construction. In Citizenship Education, this condition is particularly problematic because students should be encouraged to understand social and democratic issues critically, reflectively and on the basis of evidence (Auh & Kim, 2024; Bosio, 2023).

In this context, design thinking is considered a pedagogical approach with strong potential to develop students' higher-order thinking skills. Design thinking is a human-centred problem-solving approach that emphasises empathy, idea exploration, prototyping and iterative testing of solutions (Karunarathne, 2026; Makokha & Cakmakci, 2026; Micheli et al., 2019). In educational settings, design thinking is viewed not merely as an innovation method but also as a learning strategy that encourages students to engage actively in investigation, reflection and experimentation with possible solutions. Through the stages of *empathise*, *define*, *ideate*, *prototype* and *test*, students are encouraged to identify problems comprehensively, generate creative alternative solutions and evaluate the effectiveness of the proposed solutions. This approach is highly relevant to the demands of 21st-century learning because it promotes creativity, collaboration, communication and complex problem-solving.

The rapid development of artificial intelligence (AI) has also created new opportunities for advancing design thinking-based learning. Integrating AI into learning processes enables students to receive support in exploring information, generating ideas, reflecting on issues and analysing alternative solutions more comprehensively. AI can help students access diverse perspectives and information sources more efficiently, thereby enriching and deepening problem analysis (Huang & Rust, 2018; Tang et al., 2023; Zawacki-Richter et al., 2019). Moreover, the use of AI in learning can encourage students to become more active in exploring ideas, evaluating arguments and developing solutions to social issues. Consequently, AI-assisted design thinking has the potential to become a pedagogical approach that strengthens students' critical reasoning skills in Citizenship Education.

Several studies have shown that the integration of design thinking in education can enhance students' creativity, problem-solving abilities, and collaborative skills (Guaman-Quintanilla et al., 2023; Leem, 2024). Students are encouraged first to understand problems thoroughly, generate multiple solution alternatives, and subsequently test and evaluate these solutions reflectively through collaborative processes. However, most previous studies have primarily focused on design thinking as a practical instructional method and a general innovation strategy. Research specifically aimed at developing pedagogical models based on AI-assisted design thinking to strengthen students' critical reasoning skills in the context of Citizenship Education remains limited. In other words, only a few studies have explicitly integrated design thinking stages, AI support, and critical reasoning development within Citizenship Education learning in higher education. This research gap forms the fundamental basis for the pedagogical model developed in this study.

The AI-assisted design thinking approach can also be linked to the principles of andragogy, a theory of adult learning that emphasises learner autonomy, experiential relevance and problem-oriented learning (Knowles et al., 2015). From this perspective, university students are adult learners who need to be actively involved in contextual, reflective and experience-based learning processes. Such processes align closely with the characteristics of design thinking, which positions experience, exploration and reflection as essential components of learning (Bosch et al., 2025; Schoormann et al., 2023). Research further demonstrates that this approach can increase student engagement and improve complex problem-solving abilities (Benjamin, 2024; Wagino et al., 2024). Therefore, integrating AI-assisted design thinking into learning can serve as a relevant pedagogical strategy for developing students' critical reasoning skills systematically and contextually.

Based on this background, this study aims to develop a pedagogical model based on AI-assisted design thinking to enhance university students' critical reasoning skills in higher education. The proposed model emphasises the integration of design thinking stages, AI utilisation, social problem exploration, idea generation, and critical reflection throughout the learning process. Through this approach, students are expected not only to understand academic concepts theoretically but also to apply critical reasoning in analysing various social and civic issues and in formulating innovative and responsible solutions.

This study is expected to contribute both theoretically and practically to the development of innovative learning practices in higher education. Theoretically, this research enriches the discourse on the integration of AI-assisted design thinking in higher education pedagogy, particularly in relation to the development of students' critical reasoning skills within the context of Citizenship Education. Practically, the resulting pedagogical model may serve as an alternative instructional strategy for lecturers to create more active, reflective, collaborative, and higher-order thinking-oriented learning environments for students.

Method

This study employed a qualitative approach using the Design-Based Research (DBR) method. This approach was selected because the study aimed to develop a pedagogical model

based on AI-assisted design thinking to enhance university students' critical reasoning skills in higher education. Design-Based Research is a research approach that emphasises the integration of theory development and educational practice through systematic processes of designing, implementing, evaluating, and refining learning innovations in authentic educational settings. Unlike traditional development research that mainly focuses on producing instructional products, DBR emphasises an iterative refinement process through repeated cycles that allow the pedagogical model to be continuously improved based on empirical findings during implementation. Therefore, this study not only produces a learning model but also develops a conceptual understanding of how and why the model works in improving students' critical reasoning skills (McKenney & Reeves, 2025).

The study was conducted with undergraduate students in Citizenship Education programmes at public universities in Indonesia. The participants were students from Citizenship Education departments at three public universities on Java Island, namely Universitas Negeri Semarang, Universitas Sebelas Maret, and Universitas Negeri Yogyakarta. Participants were selected using purposive sampling by considering students' involvement in courses related to social problem analysis, civic learning, and project-based activities. The study involved approximately 90 students from three learning classes across the three participating universities. Each university was represented by one class purposively selected based on its suitability for implementing the AI-assisted design thinking learning model. The selection of three universities and one class from each institution aimed to provide a more comprehensive understanding of the implementation of the pedagogical model in the context of Citizenship Education in higher education, while also enhancing the transferability of the research findings.

The research process was conducted through several cyclical and reflective stages in accordance with the characteristics of DBR. Each stage involved repeated processes of evaluation and refinement (a refinement loop) until a more optimal pedagogical model was achieved. The first stage was the analysis phase, which aimed to identify learning problems, particularly those related to students' low critical reasoning skills. At this stage, literature reviews, classroom observations, and interviews with lecturers and students were conducted to gain an understanding of the learning conditions, pedagogical challenges, and students' needs in developing critical thinking skills.

The second stage was the design phase, which focused on designing a pedagogical model based on AI-assisted design thinking. The model integrated the stages of *empathise*, *define*, *ideate*, *prototype*, and *test* into the learning process. In addition, the model incorporated the use of artificial intelligence as a tool for information exploration, idea development, reflection, and solution evaluation. During this phase, the researchers developed learning scenarios, student activities, instructional materials, and indicators of critical reasoning skills to be fostered through the implementation of the model.

The third stage was the implementation phase, during which the pedagogical model was applied in classroom learning activities. At this stage, students engaged in social problem exploration, group discussions, solution development, and critical reflection through the design thinking process. The implementation aimed to observe how students interacted with the learning model, utilised AI in problem analysis, and developed critical reasoning skills through collaborative and reflective learning processes. Throughout the implementation, the researchers observed classroom dynamics, student interaction patterns, and decision-making processes emerging during learning activities.

The final stage was the evaluation and reflection phase, which aimed to evaluate the effectiveness of the implemented pedagogical model and identify aspects requiring further improvement. The reflection process was based on students' learning experiences, group discussion dynamics, the quality of solutions produced, and feedback from both students and lecturers. The results of the evaluation and reflection were then used as the basis for refining

the model in subsequent cycles, ensuring that the model development process remained continuous and reflective in line with DBR principles.

Research data were collected through classroom observations, in-depth interviews, group discussions, and document analysis, including students' assignments, projects, and reflective writings. Model validation was conducted through expert judgement by educational experts and through source and method triangulation to ensure the credibility of the research findings. Students' critical reasoning skills were analysed based on several indicators, including the ability to identify problems, analyse information, evaluate arguments, and formulate logical and evidence-based solutions. Data analysis was conducted through processes of coding, categorisation, and pattern identification to examine the development of students' critical reasoning skills during the implementation of the AI-assisted design thinking pedagogical model. The analysis process was carried out interactively through data reduction, data display, and reflective conclusion drawing.

To ensure the trustworthiness of the study, four criteria were applied: credibility, transferability, dependability, and confirmability. Credibility was established through data triangulation, member checking, and intensive researcher engagement throughout the learning process. Transferability was strengthened through detailed contextual descriptions of participant characteristics and the implementation process of the pedagogical model. Dependability was ensured by systematically documenting the entire research process to enable research auditing. Meanwhile, confirmability was maintained through researcher reflection, field notes, and empirical data tracking to ensure that the findings were grounded in the data collected throughout the research process.

Results and Discussion

Overview of research findings

The findings indicate that implementing a pedagogical model based on AI-assisted design thinking in Citizenship Education in higher education created a more reflective, participatory, and critically problem-oriented learning process. These findings reveal a fundamental shift in students' learning patterns, moving from passive, knowledge-reproduction-oriented learning to a more active, collaborative, and problem-exploration-based process. In the context of Citizenship Education, this transformation is highly significant because students are not only expected to understand normative civic concepts but also to develop critical reasoning skills in analysing various social, political, and democratic issues emerging within society.

Overall, the model shows that integrating design thinking with artificial intelligence functions not merely as a technological innovation in learning, but as a pedagogical approach that strengthens students' reflective thinking processes. Students became more active in identifying social problems, exploring multiple perspectives, developing alternative solutions, and evaluating the effectiveness of the ideas they generated. Consequently, the learning process shifted from lecturers' content delivery to collaborative exploration, reflection, and solution development.

The pedagogical model based on AI-assisted design thinking was also able to establish a stronger connection between academic concepts and the social realities encountered by students. Students not only studied civic theories in the abstract but also became directly involved in analysing real issues such as intolerance, digital polarisation, misinformation, youth political participation, social inequality, and various other democratic challenges. This shows that learning became more contextual and meaningful because students gained experiences directly connected to their social lives.

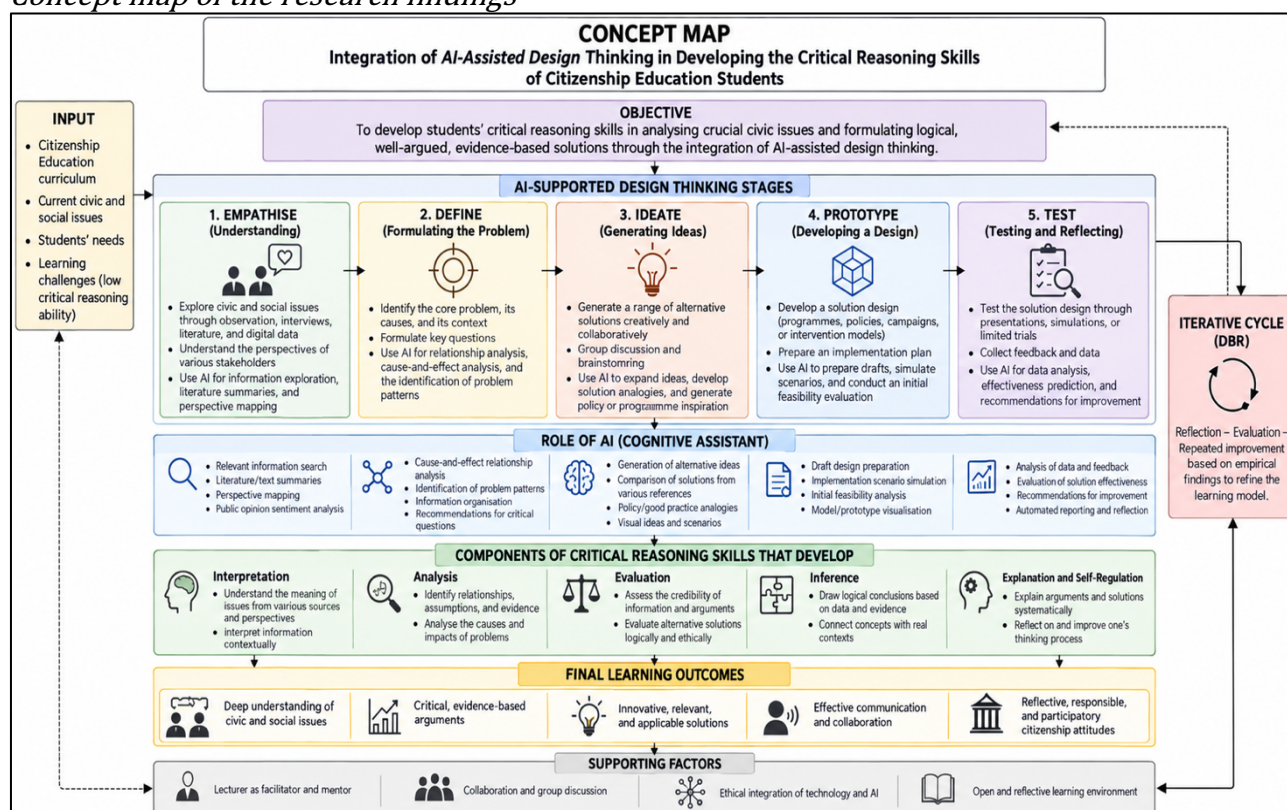
In addition, the findings reveal that the AI-assisted design thinking-based learning process encouraged students to develop higher-order thinking skills more systematically. Students' abilities to identify problems, analyse information, evaluate arguments, and

formulate evidence-based solutions showed greater improvement compared to conventional learning approaches that primarily emphasised concept memorisation. These findings indicate that the pedagogical model developed in this study contributed not only to increasing students' learning engagement but also to transforming their patterns of thinking.

Within the context of Design-Based Research (DBR), the findings also demonstrate that the development of the pedagogical model occurred through reflective and iterative processes. The model was not developed as a final, static product, but through continuous refinement based on empirical findings gathered during implementation. Therefore, this study not only produced a learning model but also generated a conceptual understanding of how integrating AI-assisted design thinking can develop Citizenship Education students' critical reasoning skills.

Figure 1.

Concept map of the research findings



Source: Research data (2026).

AI-assisted design thinking pedagogical model in Citizenship Education

The pedagogical model developed in this study represents an integration between the stages of design thinking and the development of critical reasoning skills within the context of Citizenship Education. The model is a pedagogical framework that not only organises learning activities procedurally but also supports students' reflective thinking through in-depth exploration of social issues.

Conceptually, this model views learning as a cyclical and reflective process of social inquiry. The stages of *empathise*, *define*, *ideate*, *prototype*, and *test* are not merely technical steps for problem-solving, but stages in developing students' thinking processes to understand social realities more critically. Through this model, students are encouraged to construct social understanding through exploratory experiences, collaboration, reflection, and argumentative evaluation.

The integration of artificial intelligence within the model functions as a cognitive and reflective support tool that expands students' exploratory processes. AI assists students in

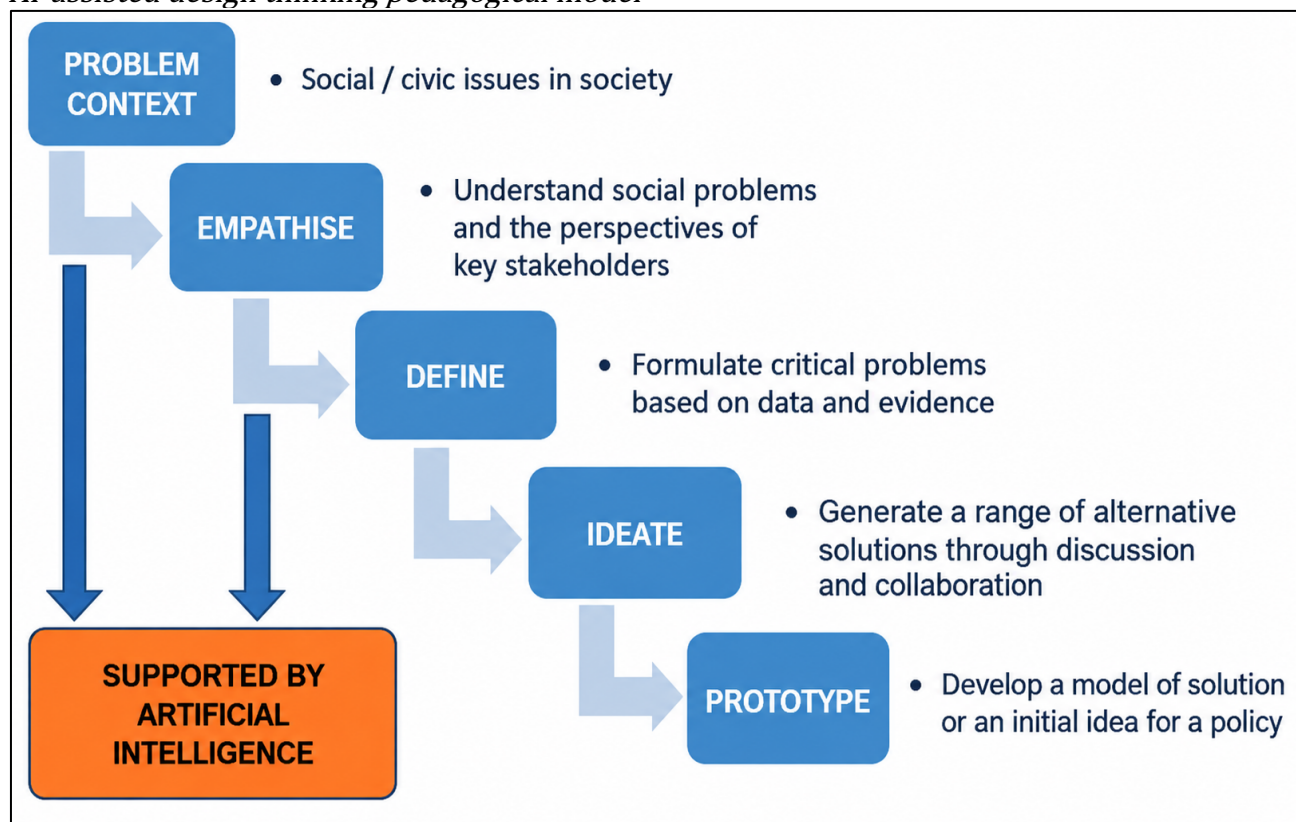
accessing various sources of information, comparing perspectives, evaluating arguments, and developing broader alternative solutions. Nevertheless, the findings indicate that AI does not replace students' thinking processes. Instead, the quality of students' critical thinking remains dependent on their ability to evaluate, verify, and reflect upon the information obtained through AI.

The conceptual significance of this model lies in the integration of social problem-based learning with the development of civic reasoning. In conventional learning environments, students are often directed only to understand civic concepts theoretically. In contrast, the AI-assisted design thinking model positions students as social analysts who are actively involved in understanding, interpreting, and formulating solutions to civic issues. Therefore, learning does not merely produce conceptual understanding, but also develops reflective and participatory thinking skills as responsible citizens.

Furthermore, this model demonstrates that critical reasoning skills do not develop instantly, but rather through continuous reflective processes. Each stage of design thinking contributes to the development of specific dimensions of thinking, ranging from understanding social perspectives, analysing causal relationships, evaluating information, to developing evidence-based solutions. Accordingly, the model illustrates that the development of critical thinking skills requires learning environments that allow students to actively and reflectively experience the thinking process.

Figure 2.

AI-assisted design thinking pedagogical model



Source: Research data (2026).

Analysis of the empathise stage

The *empathise* stage became the primary foundation for the development of students' critical reasoning skills. At this stage, students were encouraged to understand various social issues through digital information exploration, social observation, group discussions, and the use of artificial intelligence as a tool for perspective exploration. Rather than being immediately

directed to seek solutions, students were first encouraged to understand the social contexts and experiences of the individuals or groups affected by a particular issue.

The findings indicate that the *empathise* stage helped students develop deeper social awareness. Before the implementation of the model, most students tended to understand social issues in simplistic and normative ways. Many students viewed problems solely from personal perspectives without considering the underlying social, cultural, economic, and political factors. However, after engaging in the *empathise* process, students began to demonstrate the ability to understand issues from multiple perspectives. For example, when discussing the issue of digital intolerance, students no longer viewed the problem merely as interpersonal conflict on social media. Instead, they began to understand how social media algorithms, political culture, information polarisation, and low levels of digital literacy contributed to the emergence of intolerance. Students also began to realise that social issues do not always have a single cause, but are often shaped by interconnected factors.

Analytically, these findings indicate that the *empathise* stage functioned as an initial mechanism for shifting students' thinking patterns from superficial understanding towards more reflective social interpretation. The ability to understand social realities contextually became an essential foundation for the development of critical thinking skills. Within the context of Citizenship Education, this process is highly relevant because civic reasoning is not only related to understanding rules or democratic concepts, but also to understanding citizens' social experiences empathetically and critically. The use of AI at this stage also made an important contribution to expanding students' perspectives. AI helped students discover various sources of information, arguments, and alternative viewpoints that they had not previously considered. Nevertheless, the findings indicate that AI does not automatically improve the quality of students' thinking. Students with reflective thinking tendencies were able to use AI to enrich their analyses, whereas less reflective students tended to accept AI-generated information uncritically and without evaluation.

These findings suggest that the role of AI in learning is more appropriately understood as a reflective support tool rather than an absolute source of truth. Therefore, lecturers play an important role in guiding students to evaluate the validity of information, compare multiple perspectives, and develop evidence-based arguments.

Analysis of the *define* stage

The *define* stage played an important role in strengthening students' analytical abilities. After understanding various social issues during the *empathise* stage, students were guided to formulate the core problems systematically. At this stage, students were required to identify causal relationships, factors influencing the problems, and various conflicts of interest embedded within a social issue.

The findings indicate that the *define* stage helped students move from descriptive understanding towards more structured analysis. Before the implementation of the model, most students tended to describe problems in general terms without being able to identify the root causes in depth. However, after participating in the *define* process, students began to construct more systematic analyses. For example, when discussing the low level of youth political participation, students no longer simply stated that young people were less interested in politics. Instead, they began to identify contributing factors such as low political literacy, distrust towards political institutions, the dominance of identity politics, and the influence of digital media on young people's political perceptions.

Analytically, the *define* stage demonstrates how the design thinking process encouraged students to develop argumentative and logical thinking skills. Students were not only collecting information, but also learning to organise that information into coherent analytical structures. In the context of critical thinking, the ability to identify causal relationships and construct

evidence-based arguments represents an important indicator of the development of critical reasoning.

Figure 3.

Discussion process to build deeper understanding



Source: Research data (2026).

The use of artificial intelligence during the *define* stage also strengthened students' abilities to compare multiple perspectives and evaluate information critically. Students used AI to explore data, search for policy references, and compare arguments from various sources. Nevertheless, the findings revealed that students still needed guidance to avoid relying solely on AI-generated answers and instead develop the ability to critically evaluate the information obtained. These findings indicate that the integration of AI in learning does not automatically produce critical thinking skills. Rather, critical thinking develops when students actively engage in processes of interpretation, evaluation, and reflection on the information they obtain.

Analysis of the *ideate* stage

The *ideate* stage represents the phase in which students begin to develop various alternative solutions to the social issues that have been analysed. At this stage, students worked collaboratively in groups to generate multiple possible solutions through discussions, brainstorming activities, and AI-assisted idea exploration.

The findings indicate that the *ideate* stage encouraged students to develop intellectual creativity and cognitive flexibility. In conventional learning environments, students are often accustomed to seeking a single correct answer that aligns with theoretical perspectives. However, during the *ideate* stage, students were instead encouraged to generate multiple alternative solutions without fear of being considered incorrect. This condition created a more open and participatory learning atmosphere. Students became more active in expressing opinions, defending arguments, and critically evaluating the ideas proposed by their peers. Group discussions functioned not merely as activities for sharing ideas, but also as spaces for argumentative reflection that strengthened students' critical thinking skills.

Analytically, the *ideate* stage demonstrates that critical thinking is not limited to logical evaluation, but also involves the ability to generate new possibilities reflectively. Within the context of Citizenship Education, this ability is highly important because social and democratic issues often do not have a single absolute solution. The use of AI during the *ideate* stage also had a significant impact on the process of solution exploration. AI helped students access various examples of policies, social programmes, and problem-solving approaches from different contexts. Students were able to compare multiple alternative solutions and adapt them according to the social contexts they analysed.

Nevertheless, the findings revealed that the quality of students' ideas remained strongly influenced by their ability to evaluate and reflect upon the information obtained. Reflective students were able to use AI as a tool for intellectual exploration, whereas less reflective students tended to accept AI-generated ideas without critical evaluation. These findings suggest that AI does not replace students' creative thinking processes; rather, it functions as a stimulus that expands the space for idea exploration. Therefore, the integration of AI in learning should be accompanied by the strengthening of reflective abilities so that students remain the primary subjects in the thinking process.

Analysis of the *prototype* and *test* stages

The *prototype* and *test* stages became essential phases in connecting ideas with more concrete social practices. At these stages, students were asked to develop solution designs in the form of social programmes, digital campaigns, simple policy models, or other forms of social intervention. The proposed solutions were then tested through discussions, simulations, and group reflections. The findings demonstrate that the *prototype* and *test* stages helped students understand that social solutions cannot be separated from their implementation contexts. Students began to realise that solutions that appear conceptually ideal may not necessarily be effective when applied within complex social realities.

For example, when students developed anti-hoax digital campaigns, they discovered that the success of such programmes depended not only on the quality of the information delivered but also on digital culture, media literacy levels, and the information consumption patterns of younger generations. Analytically, the *prototype* and *test* stages strengthened students' reflective thinking abilities because they were required to re-evaluate the assumptions, weaknesses, and consequences of their proposed solutions. Through this process, students learned that critical thinking is not merely the ability to criticise problems, but also the ability to evaluate the effectiveness of solutions realistically and based on evidence. Furthermore, the *test* stage highlighted the importance of reflection within the learning process. Students received feedback not only from lecturers, but also from peers and other groups. This process fostered a more dialogic and participatory academic culture.

The use of artificial intelligence at this stage also assisted students in evaluating solutions through idea simulations, implementation reference searches, and analyses of possible social impacts. However, the findings again revealed that the quality of evaluation remained dependent on students' abilities to critically reflect upon the information they obtained. Therefore, the *prototype* and *test* stages demonstrate that the development of critical reasoning skills requires learning experiences that are experimental, reflective, and contextual. Students not only learned to understand theories, but also learned to take social and academic responsibility for the solutions they proposed.

Synthesis of changes in students' thinking patterns

Overall, the implementation of the AI-assisted design thinking model demonstrated significant changes in students' thinking patterns. These changes were reflected not only in increased learning engagement but also in the transformation of how students understood, analysed, and evaluated social issues.

Before the implementation of the model, most students tended to demonstrate linear and normative ways of thinking. Students were more likely to memorise concepts rather than develop critical arguments regarding social realities. In addition, they often viewed social issues simplistically and failed to consider the complexity of relationships among social factors. However, after participating in learning processes based on AI-assisted design thinking, students began to demonstrate more reflective, systematic, and argumentative thinking patterns. They became more accustomed to questioning assumptions, evaluating information, comparing perspectives, and constructing evidence-based solutions. These changes indicate that the development of critical reasoning skills cannot be achieved through learning approaches that merely focus on content delivery. Critical thinking develops when students are given opportunities to directly engage in processes of social investigation, reflection, collaboration, and argumentative evaluation.

In addition, the findings also demonstrate that the integration of artificial intelligence can strengthen students' thinking processes when used reflectively. AI helped students expand their exploration of information and perspectives, yet critical evaluation skills remained essential. Therefore, the success of AI integration in learning strongly depends on the pedagogical design employed. These findings suggest that technology does not automatically improve the quality of learning. Instead, technology becomes meaningful when integrated into learning processes that encourage reflection, dialogue, and critical exploration.

Theoretical implications

This study contributes theoretically to the development of Citizenship Education pedagogy and to the discourse on design thinking-based learning in higher education. One of the major contributions of this study lies in positioning design thinking not merely as a creative innovation strategy, but as a pedagogical approach capable of developing civic reasoning and students' critical thinking skills.

Previous studies on design thinking in education have largely emphasised creativity, innovation, and general problem-solving abilities. This study demonstrates that design thinking also possesses strong reflective and argumentative dimensions when integrated into the context of civic education learning. Furthermore, this study also illustrates how the integration of artificial intelligence can strengthen students' critical reasoning development when used within an appropriate pedagogical framework. AI is not positioned as a replacement for human thinking, but rather as a reflective and intellectual exploration tool.

Another important contribution lies in the use of Design-Based Research as an approach for pedagogical model development. This study demonstrates that effective learning model development requires iterative processes that connect theory and practice reflectively. The pedagogical model is therefore understood not as a final product, but as a continuously evolving framework shaped by implementation experiences. Accordingly, the novelty of this study lies in the integration of three main elements: design thinking, artificial intelligence, and civic reasoning within the context of Citizenship Education through a Design-Based Research approach. This integration produced a pedagogical model that is oriented not only towards instructional innovation but also towards the systematic, reflective, and contextual development of students' critical thinking skills.

Practical implications

Practically, this study demonstrates that Citizenship Education learning in higher education needs to shift from a content-oriented approach towards learning that is more inquiry-oriented and reflection-oriented. Students should be provided with opportunities to actively engage in processes of social investigation so that they can develop critical thinking skills through contextual learning experiences. The findings also indicate that lecturers play an important role as facilitators of reflection in AI-assisted design thinking-based learning. Lecturers are no longer positioned merely as sources of information, but as facilitators who

assist students in evaluating arguments, reflecting on learning experiences, and developing socially responsible solutions.

In addition, this study suggests that the use of AI in higher education should be integrated pedagogically rather than merely technologically. The use of AI becomes more meaningful when directed towards strengthening students' reflective processes, perspective exploration, and argumentative evaluation. Therefore, the pedagogical model based on AI-assisted design thinking can serve as an alternative learning strategy for developing students' higher-order thinking skills in the digital era. This model not only helps students understand academic concepts more deeply but also supports them in becoming reflective, critical, and socially responsible citizens within democratic life.

Conclusion

Based on the findings and discussion, it can be concluded that the implementation of a pedagogical model based on AI-assisted design thinking was effective in developing Citizenship Education students' critical reasoning skills in a more reflective, systematic, and contextual manner. The integration of the design thinking stages created a learning environment that was more active, collaborative, and oriented towards solving real social problems. Through this process, students not only understood civic concepts theoretically, but also developed analytical abilities, evaluated arguments critically, and formulated evidence-based solutions to various social issues.

During the *empathise* stage, students improved their understanding of social issues from multiple perspectives through information exploration, social observation, group discussions, and the use of artificial intelligence as a perspective exploration tool. The *define* stage strengthened students' abilities to identify root causes, causal relationships, and social contexts systematically, thereby enhancing their logical and argumentative thinking skills. Furthermore, the *ideate* stage encouraged students to generate creative and collaborative alternative solutions through reflective discussions and AI-assisted idea exploration. Meanwhile, the *prototype* and *test* stages helped students evaluate the effectiveness of solutions realistically and based on evidence through reflection, simulation, and group feedback.

The findings also indicate that AI integration does not automatically improve critical thinking quality. Instead, AI becomes meaningful when used within reflective and inquiry-oriented learning processes. Overall, this study demonstrates that integrating AI-assisted design thinking contributes significantly to creating a more reflective, participatory, and contextual learning environment. The novelty of this study lies in integrating design thinking, AI, and civic reasoning through the Design-Based Research approach to develop students' critical thinking skills in the digital era.

Authors' contributions

Novia Wahyu Wardhani: research coordinator responsible for organising the research team's work distribution. Eni Rahmawati: field coordinator responsible for compiling research data and managing data collection. Ganda Febri Kurniawan: translation and manuscript editing. All authors reviewed and approved the final manuscript.

Competing interests

Conflicts of Interest: The authors declare no conflicts of interest.

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collection, scholarly discussion, and idea development, which were important parts of this study.

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Ethics Approval

This study did not involve medical intervention, clinical human subject experimentation, or animal subjects. The research was conducted within higher education learning activities through classroom observations, analysis of students' assignments, and academic discussions that were part of regular educational activities. All data used in this study were non-sensitive and collected without involving personal information that could directly identify individuals. The authors obtained consent from participating students and lecturers. The authors maintained the confidentiality of the research data and respected the voluntary participation of the parties involved in the study.

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