

The differential effects of critical thinking and digital literacy on civic engagement in project-based civic learning: Evidence from Indonesian higher education

Galih Puji Mulyoto * 

* UIN Maulana Malik Ibrahim Malang, Indonesia
galihpujimumulyoto@uin-malang.ac.id

Agus Mukti Wibowo 

UIN Maulana Malik Ibrahim Malang, Indonesia
mukti@pgmi.uin-malang.ac.id

Mohammad Miftahusyai'an 

UIN Maulana Malik Ibrahim Malang, Indonesia
moh.miftahusyai'an@pips.uin-malang.ac.id

Basori 

Purdue University, United States
fbasori@purdue.edu

Varidlo Fuad 

UIN Siber Syekh Nurjati Cirebon, Indonesia
varidlo@uinssc.ac.id

*Corresponding Author

Article Info

Article History

Submitted:

13 April 2026

Revised:

18 June 2026

Accepted:

11 August 2026

Keywords

civic education; civic engagement; critical thinking; digital literacy; Indonesian higher education; project-based civic learning

Abstract

This study examined how critical thinking and digital literacy contribute to civic engagement among pre-service primary school teachers in a Civic Education course using Project-Based Civic Learning (PjBCL) at an Indonesian university. Using a quantitative correlational design, data from 126 students were analysed with partial least squares structural equation modelling. Pre-post gains were large for critical thinking ($d = 1.116$), digital literacy ($d = 1.418$) and civic engagement ($d = 1.726$). The two competencies operated through different mechanisms. Critical thinking partially mediated the effect of PjBCL on civic engagement (indirect effect = 0.038; 95% CI [0.012, 0.072]), whereas digital literacy did not. Although digital literacy was the strongest direct predictor of civic engagement ($\beta = 0.350$; $f^2 = 0.124$), its link with PjBCL was negligible ($\beta = 0.004$; $Q^2 = 0.001$), suggesting students develop it mainly through informal online engagement rather than the curriculum. Building on dual-process theory, the study proposes Digitally Scaffolded Civic Learning (DSCL), which embeds digital literacy in each stage of project-based civic instruction, offering implications for curriculum planners in Indonesian civic education.

Article Link: <https://journal.uny.ac.id/index.php/civics/article/view/96905>

Introduction

Democratic societies rest on civic engagement, the everyday business of citizens taking part in political, social, and community life (Schulz et al., 2023). University students should be near the centre of that activity. Survey after survey says otherwise. Across many countries, Indonesia included, their civic engagement runs thin despite the demographic clout they hold (De Coninck et al., 2024; Maulana & Milanti, 2023). Online, the gap becomes even more noticeable, as much involvement now happens through platforms, social media, and other



digital spaces (Li & Li, 2022; Mulyono et al., 2022). For pre-service teachers, the stakes are even higher. The civic behaviours that individuals develop will later influence the classrooms they manage, thereby shaping the next generation of citizens (Sener, 2012; White, 2024). Training them therefore involves two key aspects: shaping them as democratic participants and preparing them to instruct others in civic learning.

Reading through the literature, the same pair of concepts consistently appears as the starting point for engaging in online civic life: critical thinking and digital literacy. The first helps students break down complicated social issues, compare different opposing views, and reach a reasonable stance on civic matters (Dekker, 2020; Wibowo et al., 2024). The second hand gives citizens the capability to locate, assess, and exchange information within a digital setting without causing harm (Gu et al., 2023; Tarsidi et al., 2023). One study does so at scale. Moon and Kim (2020) asked more than 2,500 Korean students about their digital literacy and found that all parts of digital literacy, except basic technical skills, were linked to higher levels of civic engagement. The students picked up these skills through regular media use, rather than through lessons in a school curriculum. Digital literacy in a democratic era encompasses more than just understanding the tools. It brings together the essential abilities of critical thinking, ethics, and creativity that are needed for responsible participation in digital public spaces, as noted by Spires et al. (2019). It also performs a protective role: when situations develop quickly, it protects citizens from false information and supports positive community activities (Milenkova & Lendzhova, 2021). Bessong (2024) took the same idea into adult and vocational education, showing that organised digital literacy programmes have helped increase civic engagement behaviours. So, this theory backs both constructs. What stays murky is the how. We know little about the way they differ in operation, or which mechanisms route them to civic engagement, once you place them inside a structured teaching intervention.

There is a hole in this body of work. Put critical thinking and digital literacy in the same model, as joint mediators between project-based civic learning and civic engagement, and you find nobody has done it. The pieces exist separately. Critical thinking has been studied as its own route to civic participation (Gonzalez-Mohino et al., 2023; Rafzan et al., 2024), and so has digital literacy (Tarsidi et al., 2023; Yue et al., 2019), but the two lines never met for a direct comparison. A few studies edge towards the question. Witorsa et al. (2023) found that citizenship project learning boosted critical thinking among Indonesian university students. Kahne et al. (2019) found media literacy education could lift youth digital political engagement, on one condition: that teachers scaffold it on purpose; that condition shapes how we build PjBCL below. Clements (2020) approached it from a design perspective. Grounding a digital civics framework in the philosophy of information, he argued that real digital civic education must wrestle with the epistemic side of digital information, and that technical skill alone will not carry it.

PjBCL takes a different path in civic education. Its theoretical footing sits in constructivist and experiential learning (Manzuoli et al., 2019; Saputra & Al Siddiq, 2020). The difference from ordinary project-based learning is where the project lives. Ordinary PBL will take any subject; PjBCL fixes the work on a real civic problem and tells students to dig in, analyse it, and put forward solutions to a live societal issue (Duke et al., 2021; Prasetyo et al., 2023). The online face of civic life appears in digital participatory platforms, which open public problems to networked deliberation and collective action (De Filippi et al., 2022). Recent Indonesian data fit our expectations. Yuanti et al. (2025), running SEM-PLS on 200 higher-education students, reported that PBL lifted every dimension of 21st-century skills, and critical thinking gained more than the rest.

Few places fit this question better than Indonesian higher education. The country ranks third among the world's democracies, and it has to cultivate engaged citizens at the same moment its society is going digital in a hurry. The scale is striking. By 2024, there were 221,563,479 internet users, which represented 66.5% of the population (Haryanto, 2024;

Kemp, 2024), with Generation Z making up the biggest group among them (Riyanto, 2024). Despite all that connectivity, it has not led to meaningful involvement in civic activities (Retnasari et al., 2025). Within universities, there is a helpful hint. Widiatmaka and Kurniawan (2023) observed that civic literacy and democratic involvement improved when digital literacy was included in the civic education curriculum. Understanding exactly how PjBCL develops civic competence is not just an academic exercise; this knowledge directly influences the creation of policies and educational programmes (Fajri et al., 2022; Murdiono & Wuryandani, 2021).

Three questions guide the study. The first question focuses on size: to what extent do critical thinking, digital literacy, and civic engagement improve among Indonesian pre-service teachers through the implementation of PjBCL? The second point concerns differences: within PjBCL, do the two competencies contribute to civic engagement in different ways? The third question concerns the route: does either of these factors act as a mediator in the pathway from PjBCL to civic engagement, and if they do, what is the underlying mechanism?

The value added comes from positioning one cognitive ability in contrast to a technical-ethical mediator. The literature on civic education has generally viewed critical thinking and digital literacy as two similar paths towards active participation. They are not. In our data, they operate on different equipment. Critical thinking behaves as a cognitive mediator, the support under reflective civic reasoning. Digital literacy behaves as a standalone predictor, something students mostly grow on their own, beyond the reach of the civic curriculum. To explain why critical thinking only mediates part way, we borrow from dual-process theory (Evans, 2008; Stanovich & West, 2000), and we carry the findings forward into a design proposal we call Digitally Scaffolded Civic Learning (DSCL).

Research Hypotheses

Referring to the theoretical framework and existing research findings, the hypotheses below are presented for testing:

H1: PjBCL significantly improves critical thinking skills among pre-service primary school teacher students.

H2: PjBCL significantly improves digital literacy among pre-service primary school teacher students.

H3: PjBCL raises civic engagement among pre-service primary school teacher students by a significant margin.

H4: Critical thinking has a strong positive influence on civic engagement.

H5: Digital literacy has a strong positive impact on civic engagement.

H6: Critical thinking is a key factor in linking PjBCL with CE, acting as a key factor that links them (PjBCL→CT→CE).

H7: Digital literacy is an important factor in how PjBCL relates to CE, acting as a major mediator in the pathway from PjBCL to CE through digital literacy.

Method

The study used a quantitative, correlational design, measuring participants before and after an intervention, and examined the data using Structural Equation Modelling (SEM). We chose a correlational frame on purpose. The aim was to explore the relationships and extent of connections between critical thinking, digital literacy, and civic engagement, and to examine potential mediating factors, rather than to assert a causal relationship through experimentation. For that reason, the interpretation remains relational throughout and avoids causal language.

Participants and sampling

During the 2024/2025 academic year, 182 students registered for the Civic Education course in the Elementary Madrasah Teacher Education (PGMI) programme at Maulana Malik Ibrahim State Islamic University (UIN Maliki), Malang. We selected 126 individuals through simple random sampling, applying Slovin’s formula to achieve a 5% margin of error (Uakarn et al., 2021), for a sampling ratio of 69.2%. Ages ranged from 18 to 22 ($M = 19.8$, $SD = 0.94$). Female participants dominated 78.6% of the sample, and males accounted for 21.4%. All participants were Indonesian citizens, used social media regularly, and were familiar with it.

Intervention: Project-Based Civic Learning (PjBCL)

The PjBCL intervention followed the six-stage model developed by Krajcik and Czerniak (2018), adapted for civic education contexts: (1) Driving Question; (2) Student Investigation; (3) Artefact Creation; (4) Collaboration; (5) Scaffolding; and (6) Presentation and Reflection. The intervention combined in-person classroom sessions with online sessions through the university e-learning platform and ran over one semester (approximately 16 weeks).

Instruments

Three instruments covered the three constructs. Critical thinking ran on the assessment rubric of Zubaidah et al. (2015); we read its six indicators against students’ written reports and project essays (Nguyen, 2021). Digital literacy needed a composite. We started from a rubric by Jones et al. (as cited in Alrahkman et al., 2024, and Tarsidi et al., 2023), then folded in items from the Theory of Digital Civic Engagement (Tarsidi et al., 2023) and from critical literacy instruments (Nurjanah et al., 2024); for civic purposes, digital literacy has to stretch past finding and judging information into the socio-civic terrain of online participation and digital accountability (Peart et al., 2020; Spires et al., 2019). We used a 4-point Likert questionnaire for civic engagement, keyed to the ICCS framework (Schulz et al., 2023), and benchmarked its properties against the Civic Engagement Scale by Doolittle and Faul (2013), which showed strong construct validity ($\alpha = .85$) in university samples. Every instrument cleared the usual bars, as Table 1 shows: convergent validity is achieved when the average variance extracted is greater than 0.5, internal consistency is ensured with a Cronbach’s alpha value of at least 0.90, and composite reliability is met with a value greater than 0.90.

Table 1.
Validity and reliability test results

No	Item	Cronbach’s Alpha	Composite Reliability (pc)	Average Variance Extracted (AVE)
1	Project-Based Civic Learning	0.945	0.957	0.748
2	Critical Thinking	0.935	0.950	0.756
3	Digital Literacy	0.920	0.937	0.743
4	Civic Engagement	0.954	0.963	0.756

Source: *SmartPLS estimation results, 2026.*

Data analysis

We ran the SEM in SmartPLS 3.2.9, which is well suited for exploratory, predictive work with non-normal data and a modest sample (Hair et al., 2019). Fit looked sound, with SRMR = 0.058 (criterion < 0.08) and NFI = 0.931 (criterion > 0.90). Discriminant validity was assessed using the HTMT ratio, and no value crossed the strict 0.85 line. Path coefficients, t-values, as well as p-values were obtained from 5,000 bootstrap resamples, and indirect effects were based on bias-corrected bootstrap 95% confidence intervals. For mediation, we left the old Baron and Kenny (1986) stepwise rules behind, in favour of the current PLS-SEM practice of reporting bootstrapped indirect effects (Hair et al., 2019). Effect sizes followed Cohen’s f^2 at the usual marks: small ≥ 0.02 , medium ≥ 0.15 , large ≥ 0.35 . Predictive relevance was determined using

the Stone-Geisser Q^2 method through blindfolding, with omission distance $D = 7$ and $Q^2 > 0$ taken as adequate (Hair et al., 2019). The comparison before and after the intervention involved paired-sample t-tests, and Cohen's d was used to measure the effect size

Results and Discussion

Effects of PjBCL on multiple competencies (H1, H2, H3)

Table 2 compares pre-test and post-test results for all three constructs after the PjBCL intervention. All three outcomes showed crucial statistical improvements, indicated by large effect sizes (Cohen's d greater than 1.0) for every variable.

Table 2.

Effects of PjBCL on multiple competencies

No	Hypothesis	Mean Pre	Mean Post	Gain	$\Delta\%$	Cohen's d	t-value	p-value	Decision
1	PjBCL→CT (H1)	15.228	19.563	4.335	28.47%	1.116	18.346	<0.001	H1 Accepted
2	PjBCL→DL (H2)	15.190	20.253	5.063	33.33%	1.418	22.089	<0.001	H2 Accepted
3	PjBCL→CE (H3)	14.772	21.057	6.285	42.54%	1.726	26.047	<0.001	H3 Accepted

Source: Paired-sample t-test results, 2026

The PjBCL intervention produced the largest effect on civic engagement ($d = 1.726$), followed by digital literacy ($d = 1.418$) and critical thinking ($d = 1.116$), confirming H1, H2, and H3. These findings are consistent with constructivist learning theory (Manzuoli et al., 2019) and align with Yuanti et al. (2025), who confirmed using SEM-PLS that PBL positively affects all dimensions of 21st-century skills in Indonesian higher education, with critical thinking as the strongest outcome. The particularly strong effect on civic engagement, the primary intended outcome of PjBCL, confirms that the civic embeddedness of the learning design is consequential: integrating authentic civic problems more directly activates civic dispositions than developing general cognitive or digital skills alone (Duke et al., 2021; Prasetyo et al., 2023). Witarsa et al. (2023) similarly confirmed in a quasi-experimental study using the citizenship project learning model at Indonesian universities that civic project learning significantly improved critical thinking, establishing a direct empirical precedent for the H1 finding in the present study.

The gains in digital literacy ($d = 1.418$) and critical thinking ($d = 1.116$) are large, but we read them with care. We did not run a randomised controlled trial, so part of each pre-post gain may come from students maturing, from practice, or from learning in their other courses, not from PjBCL alone. We take up this limitation at length in the Extended Discussion.

Differential effects of critical thinking and digital literacy on civic engagement (H4, H5)

Table 3 presents bivariate associations between critical thinking (CT), digital literacy (DL), and civic engagement (CE). Both variables demonstrated statistically significant positive associations, but their effect magnitudes differed meaningfully.

Table 3.

Bivariate associations of critical thinking and digital literacy with civic engagement

No	Hypothesis	r-value	p-value	Significance	Decision
1	CT→CE (H4)	0.289	<0.001	Significant	H4 Accepted
2	DL→CE (H5)	0.356	<0.001	Significant	H5 Accepted

Source: SmartPLS bivariate correlation estimates, 2026.

Digital literacy showed a stronger association with civic engagement ($r = 0.356$) than critical thinking ($r = 0.289$), confirming both H4 and H5 while revealing meaningful differences in magnitude. This stronger DL→CE association is consistent with Moon and Kim (2020), who

found across 2,500+ South Korean students that the information usage and content creation dimensions of digital literacy were the most salient predictors of civic engagement, outperforming technical skill dimensions, and that the relationship was especially pronounced among high-media-attention respondents. Park et al. (2023) further confirmed in a national Australian survey (N = 3,510) that confidence in media abilities was the key predictor of civic participation, with more active online interactors consistently demonstrating higher civic engagement levels. The comparatively weaker association between critical thinking and civic engagement reflects Dekker's (2020) argument that critical thinking's effect on civic participation is primarily mediated by other factors, including self-efficacy and civic knowledge, rather than operating as a direct predictor, consistent with the partial mediation finding in the present study.

Critical thinking as a partial mediator of PjBCL on civic engagement (H6)

Table 4 presents the path analysis results testing critical thinking as a mediator in the PjBCL→CE relationship.

Table 4.

Partial mediation testing of critical thinking (PjBCL→CT→CE)

No	Path	Coefficient	Description	Status
1	PjBCL→CT	0.138	Path to mediator (significant, $p < .05$)	H6 Supported
2	CT→CE	0.277	Path from mediator (significant, $p < .001$)	H6 Supported
3	Indirect: PjBCL→CT→CE	0.038	95% CI [0.012, 0.072] significant	Partial Mediation

Source: SmartPLS bootstrapping results (5,000 resamples), 2016.

Critical thinking partially mediated, so H6 holds. The baseline model, with no mediator, put the direct PjBCL→CE coefficient at $\beta = 0.080$. Bring critical thinking in, and that direct path drops to $\beta = 0.040$, about half, the signature of partial mediation (Hair et al., 2019). Meanwhile, the indirect path via critical thinking was significant (0.038, 95% CI [0.012, 0.072]). Two routes, therefore, led PjBCL into civic engagement at the same time. One approach is direct: hands-on civic activities immediately activate a sense of civic responsibility. Another way is indirect: it is developed through the critical thinking skills students build throughout their journey.

Why should critical thinking mediate at all? The reason is reflective civic reasoning. PjBCL repeatedly presents students with the same cycle on real civic issues: identifying the problem, analysing it, reasoning through it, and bringing the elements together (Wibowo et al., 2024). Two studies follow the chain step by step. Witarsa et al. (2023) found that in Indonesian universities, civic project learning helps improve critical thinking. Then, Rafzan et al. (2024) showed that these improved skills lead to better civic engagement behaviours. That two-step process is precisely the CT mediation chain that we identified in this case. The direct PjBCL→CE effect can be explained through experiential learning theory, which suggests that real-world civic engagement directly influences emotions and motivation (Saputra & Al Siddiq, 2020).

Digital literacy as a strong independent predictor rather than a mediator (H7)

Table 5 presents the path analysis findings, which explore how digital literacy affects the relationship between PjBCL and CE.

Table 5.

Path analysis testing of digital literacy (PjBCL→DL→CE)

No	Path	Coefficient	Description	Status
1	PjBCL→DL	0.004	Path to mediator (negligible, non-significant)	H7 Not Supported
2	DL→CE	0.350	Path from mediator (significant, $p < .001$)	H5 Confirmed

3	Indirect: PjBCL→DL→CE	0.001	95% CI [-0.003, 0.009] not significant	No Mediation
---	--------------------------	-------	---	--------------

Source: SmartPLS bootstrapping results (5,000 resamples), 2026.

Digital literacy threw up a puzzle. The most direct way to reach civic engagement had the most significant impact in the entire model ($\beta = 0.350$). However, the connection from PjBCL to DL had almost no impact ($\beta = 0.004$), and this weak link nearly eliminated the indirect path (indirect effect = 0.001; H7 is not supported). The course, as we conducted it, did not effectively contribute to improving digital literacy in a structured manner, despite the notable rise in digital literacy scores observed between the pre-test and post-test ($d = 1.418$). Where did that jump come from? It is most probably due to the way students already live online, using social media, peer-based digital communities, and their own exploratory activities, rather than because of anything specifically added by PjBCL. Moon and Kim (2020) had already outlined the explanation: digital literacy is a strong indicator of civic engagement, but the skills involved develop through regular media consumption rather than through structured teaching. This is why the path from PjBCL to digital literacy shows almost no effect here. Nikou and Mezei (2021) observed a similar pattern in their study on higher education, where digital literacy did not directly influence the intention to use technology as expected, but instead affected technology use through psychological factors. The same lesson applies to us: digital literacy leads to changes in behaviour through indirect pathways that can easily be missed when designing a single-semester course.

Tarsidi et al. (2023) reached the same conclusion but approached it differently, finding that digital literacy was more important than general academic skills in predicting civic engagement in the Indonesian digital-native context. Park et al. (2023) emphasised the point more clearly. The correlation between media literacy and civic engagement lies in active participation online, rather than just spending time in a classroom. A formal PjBCL environment operates in a distinct tone from the informal online spaces where students actually develop digital literacy, even when that setting provides digital tools to use. The design takeaway is hard to miss. If digital literacy is meant to grow inside civic learning, the next iterations cannot leave digital tools as a side activity; they have to scaffold the higher-order digital civic skills on purpose: source-credibility checking, algorithmic awareness, responsible online communication (Gu et al., 2023; Kahne et al., 2019; Prasetyo et al., 2023).

Model fit, effect sizes (f^2) and predictive relevance (Q^2)

Table 6 presents the complete model evaluation statistics integrating model fit indices, Cohen's f^2 effect sizes for each structural path, and Stone-Geisser Q^2 predictive relevance values for each endogenous construct obtained through SmartPLS blindfolding (omission distance $D = 7$).

Table 6.

Model fit indices, effect sizes (f^2) and predictive relevance (Q^2)

Index / Construct	Value	Criterion	Path	f^2	Q^2
A. Model Fit Indices					
SRMR	0.058	< 0.08			
NFI	0.931	> 0.90			
B. Effect Sizes & Predictive Relevance					
Critical Thinking (CT)	$R^2 = 0.019$		PjBCL→CT	0.019	0.013
Digital Literacy (DL)	$R^2 \approx 0.000$		PjBCL→DL	0.000	0.001
Civic Engagement (CE)	$R^2 = 0.208$		CT→CE	0.077	0.113
			DL→CE	0.124	

Note. SRMR = Standardised Root Mean Square Residual; NFI = Normed Fit Index; R^2 = coefficient of determination; f^2 = Cohen's effect size (negligible < 0.02, small 0.02–0.15, medium 0.15–0.35, large ≥ 0.35 ; Cohen, 1988); Q^2 = Stone-Geisser cross-validated redundancy

index ($Q^2 > 0$ = adequate predictive relevance; Hair et al., 2019). Q^2 was obtained through SmartPLS blindfolding ($D = 7$). Near-zero Q^2 values for CT (0.013) and DL (0.001) are bounded by their near-zero R^2 values and constitute theoretically confirmatory findings, not methodological weaknesses.

Overall, the fit indices indicate that the model performs adequately, as both the SRMR and NFI values fall within the recommended ranges, according to Hair et al. (2019) and Lin et al. (2024). The f-squared values change along different paths in a manner consistent with theory. PjBCL→CT falls within the negligible-to-small range ($f^2 = 0.019$), very close to the 0.02 small threshold, and this is consistent with its moderate coefficient ($\beta = 0.138$). PjBCL→DL is essentially flat ($f^2 = 0.000$), which is a direct reflection of its near-zero coefficient ($\beta = 0.004$), and this confirms that, in terms of structure, PjBCL is not a suitable predictor of digital literacy within this model. On the outcome side, the picture becomes clearer. The analysis shows a small effect size ($f^2 = 0.077$) for the relationship between CT and CE, while DL to CE shows a slightly larger effect, approaching the small-to-medium range ($f^2 = 0.124$). This stronger relationship supports the view that digital literacy is a strong, independent predictor of digital civic participation, as advised by Moon and Kim (2020) and Park et al. (2023).

The Stone-Geisser Q^2 values should be interpreted with caution, going beyond the simple rule that a Q^2 value greater than zero is sufficient. Start with the outcome. For CE, Q^2 equals 0.113, which is positive and significant, indicating that the model maintains strong explanatory power for the variable it was most important to predict. In its primary role, the model performs: it explains and predicts civic engagement with reasonable accuracy when applied to new data.

The significant theoretical issue is the two low Q^2 values: CT is 0.013 and DL is 0.001. There is a ceiling at work. In PLS-SEM, a construct's cross-validated Q^2 value cannot exceed its R^2 value. Given that the R^2 for the construct is 0.019 and the R^2 for the discriminant validity is close to zero, there is no further improvement possible in the predictive ability of PjBCL regarding either of these measures (Guenther et al., 2023; Hair et al., 2019). We will not consider these as defects to be stored away. They are, instead, the clearest numbers from the study: within this course, PjBCL had almost no impact on predicting digital literacy and very little on critical thinking, compared to all the other factors that influence these skills outside of the classroom.

Take CT first. Its Q^2 value of 0.013 is accompanied by a substantial pre-post gain ($d = 1.116$), but the structural model attributes only 1.9% of the variance in critical thinking (CT) to PjBCL, which aligns with Witarsa et al. (2023): critical thinking in university students addresses many developmental trends simultaneously, far more than any single course can account for. DL presents a more precise version of the same narrative. The study's Q^2 value of 0.001 indicates the strongest evidence that, for these Indonesian Generation Z students, they develop digital literacy outside the PjBCL curriculum. Instead, they acquire it through self-organised informal digital learning activities, including social media use, peer interactions, and personal exploration (Mehrvarz et al., 2023; Moon & Kim, 2020). Park et al. (2023) support this argument by linking digital skills and self-assurance in civic involvement to regular online activities rather than formal instruction. Then comes the twist. Once students developed digital literacy, regardless of how they acquired it, it became the strongest structural predictor of their civic engagement ($\beta = 0.350$; $f^2 = 0.124$; $Q^2_{CE} = 0.113$). PjBCL is unable to build it, but for a curriculum designer, it remains the most impactful tool for promoting civic engagement, provided a method can be developed to integrate it into formal civic education. The discrepancy between power and reach is the core reason behind the DSCL proposal discussed in the Extended Discussion.

Structural model and unexplained variance

Civic engagement had an R-squared value of 0.208, which indicates that the model accounts for 20.8% of the variability in the data, while the remaining majority is influenced by

factors that the three predictors do not account for. This aligns with the general agreement on civic engagement, which is influenced by various factors (De Coninck et al., 2024). The missing 79.2% likely falls into clusters that were not measured. Dispositional factors, political interest, civic identity, and internal political efficacy. Social aspects related to relationships, community standards among peers, and the influence of family in shaping social behaviour. Structural factors, institutional trust, and access to civic opportunities. Media exposure patterns also intersect with all of these (Maulana & Milanti, 2023; Retnasari et al., 2025; Schulz et al., 2023).

Reach is the obvious limit. The data come from one Islamic state university in a single city in Indonesia and a group predominantly composed of women (78.6%) pursuing careers in primary teaching; this limits how broadly the results can be applied. Quasi-experimental or multi-site designs could expand that scope in future studies (Murdiono & Wuryandani, 2021).

Extended Discussion: Addressing Theoretical and Methodological Considerations

The core findings are on the table. This study presents seven theoretical and methodological approaches worth examining more closely.

The multifactorial architecture of civic engagement variance

The fact that R^2 equals 0.208 is worth noting, as it highlights how civic engagement is formed rather than indicating a flaw in the model. Hair et al. (2019) note that in the behavioural and social sciences, an R^2 value ranging from 0.10 to 0.25 for complex constructs is typical and not something to be concerned about. Subhaktiyasa et al. (2024) also express the same caution: R squared only shows what the selected predictors account for, and nothing beyond that. The remaining categories form four clusters that our model did not include: the dispositional-motivational, the social-relational, the structural-institutional, and the patterns of media exposure (Retnasari et al., 2025; Schmitt et al., 2024; Schulz et al., 2023).

Dual-process theory and the partial mediation of critical thinking

Partial contribution: Critical thinking accounted for approximately 47.5% of the total effect that PjBCL had on CE along the CT pathway. The indirect effect was 0.038, and the 95% confidence interval for this effect ranged from 0.012 to 0.072. That figure is seeking an explanation, and the dual-process theory offers one. Human thinking operates through two separate processes happening at the same time. The first process is fast, automatic, and based on feelings and gut reactions. The second process is slower, more thoughtful, and involves careful analysis. Evans (2008), Stanovich and West (2000), and Kahneman (2011) developed these ideas. The indirect route, PjBCL $\rightarrow$ CT $\rightarrow$ CE, represents the System 2 pathway: improved cognitive abilities enable students to think critically and work through civic issues effectively. The immediate impact, often overlooked, is the System 1 pathway: dedicating sufficient time to genuine civic initiatives helps develop strong civic commitments and habits of participation that act automatically, requiring minimal conscious thought. Zhang and Ma (2023) provide meta-analytic support for both approaches, showing that project-based learning enhances both cognitive skills and positive attitudes towards citizenship.

The informal digital learning ecology: Q^2 as theoretical confirmation

Two numbers are central to the study: the nearly zero PjBCL $\rightarrow$ DL path ($\beta = 0.004$) and the almost zero Q^2 value next to it ($Q^2 = 0.001$). We refuse to read them as an empty null. They support the idea that university students today primarily develop their digital literacy through informal digital learning experiences, rather than through structured formal instruction, as noted in research conducted by Mehrvarz et al. (2023) and Meyers et al. (2013).

These Indonesian Generation Z students, who have grown up with social media, are digital natives. They develop their digital literacy through the activities they engage in, such as browsing content on platforms, participating in online communities, creating their own digital media, and navigating social media environments (Fang et al., 2026; Getenet et al., 2024; Mehrvarz et al., 2023). Competencies developed in this manner usually come before and exceed

what a semester-long course can provide. The near-zero Q^2 value for DL, which is $Q^2 = 0.001$, is simply the result of that exact calculation. PjBCL provides the model with very little opportunity to develop digital literacy skills, as the competency is built up in other areas of these students' digital experiences. Moon and Kim (2020) identified that the factors influencing media use in daily life are related to competence and habit, rather than the content that is formally taught. Park et al. (2023) expanded on this by suggesting that it is the active engagement with online platforms, rather than formal training, that fosters media confidence, which in turn enables individuals to participate more effectively in civic activities.

This does not contradict the strong DL→CE path ($\beta = 0.350$; $f^2 = 0.124$; positive Q^2_{CE} contribution); rather, it provides the context for it. The structure of the path and the positive Q^2_{CE} value together indicate that digital literacy becomes one powerful predictor of civic engagement. The catch is provenance. PjBCL did not create the digital-literacy difference because that prediction was not based on the students' own informal digital experiences. The study's main theoretical focus is on distinguishing between how well a competency can predict an outcome and how much a specific intervention can change that competency. The data clearly shows that when Q^2_{DL} is close to zero, it means that PjBCL is unable to improve digital literacy. However, when $f^2_{DL \rightarrow CE}$ equals 0.124, it indicates that digital literacy, once established, has real and significant impact. Kahne et al. (2019) close the loop. Media literacy has the potential to increase political involvement among young people, but this effect is only observed when teachers actively support and guide the learning process. In relation to our design, the issue arises from the inability to find names for the cause: our PjBCL did not provide such a structure, so the PjBCL→DL→CE sequence in H7 was never established.

The proposed DSCL framework: A design response to near-zero Q^2_{DL}

The very low Q^2_{DL} value is what causes the DSCL concept to become apparent. Digitally Scaffolded Civic Learning views digital literacy as essential work, integrating it into every part of a civic project by teaching it, supporting students through it, and evaluating it at each stage, rather than allowing it to develop randomly or unintentionally. Three characteristics distinguish DSCL from regular PjBCL. The first approach is explicit digital scaffolding, where each phase of the project includes a structured activity focused on a specific digital skill. During the investigation phase, students evaluate the credibility of sources. When creating artefacts, they focus on data visualisation. For the presentation phase, they practise responsible online civic communication. The second aspect is civic-digital integration, where digital skills are applied directly to solve civic issues, aligning technical ability with civic goals in the same direction. The third component is assessing digital competency: the curriculum includes digital literacy alongside civic engagement, which introduces a level of accountability that traditional PjBCL does not have. A curriculum designed in this way should create the PjBCL→DL→CE sequence that our study did not observe, transforming digital literacy from an existing background characteristic into an active mediator (Gu et al., 2023; Kahne et al., 2019; Polizzi, 2021; Schmitt et al., 2024).

Civic self-efficacy as an unmeasured mediating mechanism

One missing element can have significant impact: civic self-efficacy. Getenet et al. (2024) discovered that digital literacy contributes to self-efficacy, and self-efficacy further influences engagement, positioning it as a connector between digital literacy and also civic engagement. Chang et al. (2023) went even further by identifying community efficacy expectations as the most powerful factor predicting civic engagement across various behaviours, surpassing both academic knowledge and technical skills. The two findings agree on a single recommendation: future research on PjBCL should treat civic self-efficacy as an outcome to measure and examine it as a potential mediator.

Gender composition and Islamic university context as contextual moderators

Two facts about the sample- the 78.6% women and the Islamic state university- colour the context. On gender, Schulz et al. (2023) report a durable split: women tilt towards community-oriented civic engagement, men towards formal political participation, so some of what we saw may move with it. On setting, the UIN context brings a civic culture that binds democratic participation to religious duty (*amar ma'ruf nahi munkar*). That blend may carry PjBCL's effect on civic engagement beyond anything a secular civic programme would reach (Murdiono & Wuryandani, 2021).

Methodological threats to internal validity and towards a research agenda

Internal validity needs careful reading. The single-group pre-post design has no control group, so maturation, testing effects and concurrent coursework may account for part of the gains, and the self-reported civic engagement measure is open to social desirability bias. Several features nonetheless make PjBCL a plausible contributor. The gains followed the order the design predicts: civic engagement rose most ($d = 1.726$), digital literacy followed ($d = 1.418$), and critical thinking trailed ($d = 1.116$), the very order PjBCL's civic emphasis would forecast. The path coefficients and the mediation result also fall where theory says they should (Gonzalez-Mohino et al., 2023; Prasetyo et al., 2023), which raises the odds further.

Five lines of work follow. Test causal generalisability through quasi-experimental, multi-site studies across Indonesian universities. Build and trial the DSCL framework with explicit digital-skill scaffolding. Follow civic engagement out to 3 and 12 months past the intervention. Break the analysis down by gender, to see whether the CT→CE and DL→CE paths part ways. Finally, set PjBCL against other Southeast Asian democracies for comparison (De Coninck et al., 2024; Schmitt et al., 2024).

Conclusion

Our aim was to see how critical thinking and digital literacy each shape civic engagement when 126 Indonesian pre-service primary school teachers go through PjBCL. Three findings meet that aim. The first is about magnitude. PjBCL lifted all three target outcomes by large margins, critical thinking ($d = 1.116$), digital literacy ($d = 1.418$), and civic engagement ($d = 1.726$), confirming H1, H2, and H3, and marking civic-embedded project learning as a workable route to democratic competence in teacher preparation.

The second finding is about the mechanism. Critical thinking and digital literacy operated through different mechanisms, supporting hypotheses H4 and H5 and clarifying the mediation effects in H6 and H7. Critical thinking acted as a major partial mediator, portraying an indirect effect of 0.038 (95% confidence interval [0.012, 0.072]), supporting hypothesis H6. It accounted for about half of PjBCL's influence on civic engagement, primarily through enhanced reflective reasoning. Digital literacy did the opposite. It had the strongest direct link to civic engagement ($\beta = 0.350$; $f^2 = 0.124$) but did not mediate any effect (indirect effect = 0.001; H7 not supported), because PjBCL contributed very little to its development ($\beta = 0.004$; $Q^2 = 0.001$). The near-zero Q^2 value represents the study's most precise theoretical finding, and we interpret it as confirmation rather than a limitation: students primarily develop digital literacy through informal learning, and once established, it becomes the strongest structural factor influencing civic engagement that we identified. The third finding sets the ceiling. The model explains 20.8% of the variation in civic engagement, as displayed by an R^2 value of 0.208, highlighting that civic participation is influenced by multiple factors and cannot be fully addressed by a single teaching approach.

This yields two theoretical contributions. Through dual-process theory (Evans, 2008; Stanovich & West, 2000), PjBCL reaches civic engagement on two tracks at once: an analytical System 2 track through critical thinking, and an affective System 1 track through direct civic experience and identity. The second contribution sits where the near-zero Q^2_{DL} meets the

strong DL→CE path ($f^2 = 0.124$). Together they say students walk into the classroom with digital literacy already formed, potent enough to predict civic engagement well, yet untouched by the PjBCL course as we ran it. From there, two fresh hypotheses ask to be tested. H-new1 holds that a redesigned PjBCL with explicit digital skill scaffolding, run as Digitally Scaffolded Civic Learning (DSCL), will switch on the PjBCL→digital literacy→civic engagement chain that conventional PjBCL leaves dormant. H-new2 holds that civic self-efficacy will significantly mediate both the PjBCL→CE and DL→CE relationships.

Three recommendations close the case for reforming Indonesian civic education. First, install PjBCL as the main pedagogical framework for Civic Education across universities and teacher preparation, given its strong performance across cognitive, technical, and participatory outcomes. Second, rebuild those PjBCL courses under DSCL so they deliberately scaffold higher-order digital competencies: source-credibility checking, algorithmic awareness, responsible online civic communication, and digital literacy growing within civic work rather than off to the side. The third is to design the next studies as quasi-experimental, multi-site work, with control groups and longitudinal follow-up, both to test how far the findings carry and to put DSCL through its paces across Indonesia and the wider Southeast Asian region.

Authors' contributions

GPM: Conceptualisation, methodology, investigation, formal analysis, data curation, and writing the original draft. AMW: Conceptualisation, validation, supervision, and writing review and editing. MM: Investigation, data collection, and validation. B: Methodology, formal analysis, and validation. VF: Literature review, interpretation, and writing review and editing. All authors reviewed and approved the final manuscript.

Competing interests

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

Acknowledgements

This study received support from Maulana Malik Ibrahim State Islamic University in Malang. The authors thank all students who took part in this study and the research team that helped gather and analyse the data.

Funding Statement

This research was funded by the Lembaga Penelitian dan Pengabdian Masyarakat (LP2M), Universitas Islam Negeri Maulana Malik Ibrahim Malang, under Grant/Contract Number B-1441/LP2M/TL.00/05/2026, dated 6 May 2026.

Ethics Approval

There is no ethics approval needed.

References

- Alrakhman, R., Budimansyah, D., Sapriya, S., & Rahmat, R. (2024). The effect of digital citizenship on the quality learning civic education. *Jurnal Civics: Media Kajian Kewarganegaraan*, 21(1), 29–40. <https://doi.org/10.21831/jc.v21i1.67086>
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182. <https://doi.org/10.1037/0022-3514.51.6.1173>
- Bessong, C. D. (2024). Digital literacy and its effect on learners' civic engagement in adult and vocational education. *Masyarakat, Kebudayaan dan Politik*, 37(4), 418–431. <https://doi.org/10.20473/mkp.V37I42024.418-431>

- Chang, D.-F., You, J.-Y., & Chang, A. (2023). College students' civic engagement efficacy and their implementing effects in selected STEM programs. *SAGE Open*, 13(1). <https://doi.org/10.1177/21582440231220128>
- Clements, E. (2020). A conceptual framework for digital civics pedagogy informed by the philosophy of information. *Journal of Documentation*, 76(2), 571–585. <https://doi.org/10.1108/JD-07-2019-0139>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- De Coninck, D., Waechter, N., & d'Haenens, L. (2024). Unraveling the engagement paradox: High civic engagement among vulnerable European youth in the digital age. *Journal of Applied Youth Studies*. Advance online publication. <https://doi.org/10.1007/s43151-024-00129-y>
- De Filippi, F., Coscia, C., Cocina, G. G., Lazzari, G., & Manzo, S. (2022). Digital participatory platforms for civic engagement: A new way of participating in society? Analysis of case studies in four EU countries. In Information Resources Management Association (Ed.), *Research anthology on citizen engagement and activism for social change* (pp. 218–240). IGI Global. <https://doi.org/10.4018/978-1-6684-3706-3.ch012>
- Dekker, T. J. (2020). Teaching critical thinking through engagement with multiplicity. *Thinking Skills and Creativity*, 37, Article 100701. <https://doi.org/10.1016/j.tsc.2020.100701>
- Doolittle, A., & Faul, A. C. (2013). Civic engagement scale: A validation study. *SAGE Open*, 3(3). <https://doi.org/10.1177/2158244013495542>
- Duke, N. K., Halvorsen, A.-L., Strachan, S. L., Kim, J., & Konstantopoulos, S. (2021). Putting PjBL to the test: The impact of project-based learning on second graders' social studies and literacy learning and motivation in low-SES school settings. *American Educational Research Journal*, 58(1), 160–200. <https://doi.org/10.3102/0002831220929638>
- Evans, J. S. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, 59, 255–278. <https://doi.org/10.1146/annurev.psych.59.103006.093629>
- Fajri, I., Budimansyah, D., & Komalasari, K. (2022). Digital citizenship in civic education learning: A systematic literature review. *Jurnal Ilmiah Peuradeun*, 10(3), 837–858. <https://doi.org/10.26811/peuradeun.v10i3.755>
- Fang, F., Meng, Y., Tang, L., & Cui, Y. (2026). Digital natives' intentions toward informal digital English learning: The roles of desire, engagement, and online learning self-efficacy. *Journal of Intelligence*, 14(1), Article 13. <https://doi.org/10.3390/jintelligence14010013>
- Getenet, S., Cante, R., Redmond, P., & Albion, P. (2024). Students' digital technology attitude, literacy and self-efficacy and their effect on online learning engagement. *International Journal of Educational Technology in Higher Education*, 21, Article 3. <https://doi.org/10.1186/s41239-023-00437-y>
- Gonzalez-Mohino, M., Rodriguez-Domenech, M. Á., Callejas-Albiñana, A. I., & Castillo-Canalejo, A. (2023). Empowering critical thinking: The role of digital tools in citizen participation. *Journal of New Approaches in Educational Research*, 12(2), 258–275. <https://doi.org/10.7821/naer.2023.7.1385>
- Gu, M. M., Huang, C. F., & Lee, C. K. J. (2023). Investigating university students' digital citizenship development through the lens of digital literacy practice: A translingual and transemiotizing perspective. *Linguistics and Education*, 77, Article 101226. <https://doi.org/10.1016/j.linged.2023.101226>

- Guenther, P., Guenther, M., Ringle, C. M., Zaefarian, G., & Cartwright, S. (2023). Improving PLS-SEM use for business marketing research. *Industrial Marketing Management*, 111, 127–142. <https://doi.org/10.1016/j.indmarman.2023.03.010>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Haryanto, A. T. (2024, January 31). APJII: Jumlah pengguna internet Indonesia tembus 221 juta orang [APJII: Indonesia's internet users exceed 221 million]. *Detik.com*. <https://inet.detik.com/cyberlife/d-7169749/apjii-jumlah-pengguna-internet-indonesia-tembus-221-juta-orang>
- Kahne, J., Hodgins, E., & Eidman-Aadahl, E. (2019). Can media literacy education increase digital engagement in politics? *Learning, Media and Technology*, 44(2), 211–224. <https://doi.org/10.1080/17439884.2019.1601136>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Kemp, S. (2024). *Digital 2024: Indonesia*. DataReportal. <https://datareportal.com/reports/digital-2024-indonesia>
- Krajcik, J. S., & Czerniak, C. M. (2018). *Teaching science in elementary and middle school: A project-based learning approach* (5th ed.). Routledge.
- Li, Y., & Li, G. (2022). The impacts of digital literacy on citizen civic engagement: Evidence from China. *Digital Government: Research and Practice*, 3(4). <https://doi.org/10.1145/3532785>
- Lin, M.-L., Huang, C.-F., & Chen, H.-C. (2024). Bridging causal explanation and predictive modeling: The role of PLS-SEM. *International Journal of Research in Business and Social Science*, 13(3), 145–157. <https://doi.org/10.20525/ijrbs.v13i3.3167>
- Manzuoli, C. H., Sánchez, A. V., & Bedoya, E. D. (2019). Digital citizenship: A theoretical review of the concept and trends. *The Turkish Online Journal of Educational Technology*, 18(2), 10–18. <https://eric.ed.gov/?id=EJ1211194>
- Maulana, M. Y., & Milanti, A. A. (2023). A systematic literature review on civic engagement program through citizenship education. *Jurnal Civics: Media Kajian Kewarganegaraan*, 20(2), 341–358. <https://doi.org/10.21831/jc.v20i2.66024>
- Mehrvarz, M., Keshavarzi, F., Heidari, E., & McLaren, B. M. (2023). Improving computational thinking: The role of students' networking skills and digital informal learning. *Interactive Learning Environments*, 32, 6081–6095. <https://doi.org/10.1080/10494820.2023.2249049>
- Meyers, E. M., Erickson, I., & Small, R. V. (2013). Digital literacy and informal learning environments: An introduction. *Learning, Media and Technology*, 38(4), 355–367. <https://doi.org/10.1080/17439884.2013.783597>
- Milenkova, V., & Lendzhova, V. (2021). Digital citizenship and digital literacy in the conditions of social crisis. *Computers*, 10(4), Article 40. <https://doi.org/10.3390/computers10040040>
- Moon, S., & Kim, S. (2020). Components of digital literacy as predictors of youth civic engagement and the role of social media news attention: The case of Korea. *Journal of Children and Media*, 14(4), 503–518. <https://doi.org/10.1080/17482798.2020.1728700>
- Mulyono, B., Affandi, I., Suryadi, K., & Darmawan, C. (2022). Online civic engagement: Fostering citizen engagement through social media. *Jurnal Civics: Media Kajian Kewarganegaraan*, 19(1), 75–85. <https://doi.org/10.21831/jc.v19i1.49723>

- Murdiono, M., & Wuryandani, W. (2021). Civic and nationalism education for young Indonesian generation in the globalization era. *Jurnal Civics: Media Kajian Kewarganegaraan*, 18(1), 158–171. <https://doi.org/10.21831/jc.v18i1.39452>
- Nguyen, H. T. T. (2021). Project-based assessment in teaching intercultural communication competence for foreign language students in higher education: A case study. *European Journal of Educational Research*, 10(2), 933–944. <https://doi.org/10.12973/eu-jer.10.2.933>
- Nikou, S., & Mezei, J. (2021). An assessment of the interplay between literacy and digital technology in higher education. *Education and Information Technologies*, 26, 3893–3915. <https://doi.org/10.1007/s10639-021-10472-5>
- Nurjanah, N., Abdulkarim, A., Komalasari, K., Bestari, P., & Suwandi, M. A. (2024). Critical literacy of young citizens in the digital era. *Jurnal Civics: Media Kajian Kewarganegaraan*, 21(2). <https://doi.org/10.21831/jc.v21i2.70232>
- Park, S., Fisher, C., Fuller, G., & McGuinness, K. (2023). Exploring the relationship between media literacy, online interaction, and civic engagement. *The Information Society*, 39(4), 233–247. <https://doi.org/10.1080/01972243.2023.2169913>
- Peart, M. T., Gutiérrez-Esteban, P., & Cubo-Delgado, S. (2020). Development of the digital and socio-civic skills (DIGISOC) questionnaire. *Educational Technology Research and Development*, 68(6), 3327–3351. <https://doi.org/10.1007/s11423-020-09824-y>
- Polizzi, G. (2021). Internet users' utopian/dystopian imaginaries of society in the digital age: Theorizing critical digital literacy and civic engagement. *New Media & Society*, 23(7), 1736–1753. <https://doi.org/10.1177/1461444820904351>
- Prasetyo, W. H., Sumardjoko, B., Muhibbin, A., Naidu, N. B. M., & Muthali'in, A. (2023). Promoting digital citizenship among student-teachers: The role of project-based learning in improving appropriate online behaviors. *Participatory Educational Research*, 10(1), 389–407. <https://doi.org/10.17275/per.23.21.10.1>
- Rafzan, R., Belladonna, A. P., & Saputra, E. (2024). Improving critical thinking skills in civic education based on project citizen building awareness of environmental issues. *Jurnal Civics: Media Kajian Kewarganegaraan*, 21(2). <https://doi.org/10.21831/jc.v21i2.73198>
- Retnasari, L., Abdulkarim, A., Sundawa, D., Bestari, P., & Kusumawardani, E. (2025). Bridging the participatory gap: Digital literacy and civic engagement among Indonesia's Gen Z from civic educator's perspective. *Proceedings of the International Conference on Education*, 11(1), 250–274. <https://www.proceedings.tiikmpublishing.com/index.php/icedu>
- Riyanto, A. D. (2024, February 21). *Hootsuite (We Are Social): Data digital Indonesia 2024* [Hootsuite (We Are Social): Indonesia's digital data 2024]. Andi.link. <https://andi.link/hootsuite-we-are-social-data-digital-indonesia-2024/>
- Saputra, M., & Al Siddiq, I. H. (2020). Social media and digital citizenship: The urgency of digital literacy in the middle of a disrupted society era. *International Journal of Emerging Technologies in Learning*, 15(7), 156–161. <https://doi.org/10.3991/ijet.v15i07.13239>
- Schmitt, J. B., Baake, J., & Kero, S. (2024). What means civic education in a digitalized world? *Frontiers in Psychology*, 15, Article 1257247. <https://doi.org/10.3389/fpsyg.2024.1257247>
- Schulz, W., Fraillon, J., Losito, B., Agrusti, G., Ainley, J., Damiani, V., & Friedman, T. (2023). Civic attitudes and engagement framework. In *IEA International Civic and Citizenship Education Study 2022 assessment framework* (pp. 39–60). Springer. https://doi.org/10.1007/978-3-031-20113-4_3

- Sener, T. (2012). Civic engagement of future teachers. *Procedia Technology*, 1, 4–9. <https://doi.org/10.1016/j.protcy.2012.02.003>
- Spires, H. A., Medlock Paul, C., & Kerkhoff, S. N. (2019). Digital literacy for the 21st century. In M. Khosrow-Pour (Ed.), *Advanced methodologies and technologies in library science, information management, and scholarly communication* (pp. 12–21). IGI Global. <https://doi.org/10.4018/978-1-5225-7659-4.ch002>
- Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences*, 23(5), 645–665. <https://doi.org/10.1017/S0140525X00003435>
- Subhaktiyasa, P. G., Santika, I. D. M., Purnomo, A., & Dantes, G. R. (2024). PLS-SEM for multivariate analysis: A practical guide to educational research using SmartPLS. *EduLine: Journal of Education and Learning Innovation*, 4(3), 353–365. <https://doi.org/10.35877/454RI.eduline2861>
- Tarsidi, D. Z., Suryadi, K., Budimansyah, D., & Rahmat, R. (2023). Unlocking civic participation: The power of digital literacy for Indonesian digital natives. *European Online Journal of Natural and Social Sciences*, 12(3), 292–307.
- Uakarn, C., Chaokromthong, K., & Sintao, N. (2021). Sample size estimation using Yamane and Cochran and Krejcie and Morgan and Green formulas and Cohen statistical power analysis by GPower and comparisons. *Apheit International Journal*, 10(2), 76–88.
- White, E. S. (2024). Preservice elementary teachers and future civic teaching. *The Journal of Social Studies Research*, 48(4), 261–273. <https://doi.org/10.1177/23522798241252939>
- Wibowo, A. M., Utaya, S., Wahjoedi, W., Zubaidah, S., Amin, S., & Prasad, R. R. (2024). Critical thinking and collaboration skills on environmental awareness in project-based science learning. *Jurnal Pendidikan IPA Indonesia*, 13(1), 103–115. <https://doi.org/10.15294/jpii.v13i1.48561>
- Widiatmaka, P., & Kurniawan, D. (2023). Peningkatan civic literasi dengan memanfaatkan literasi digital melalui pendidikan kewarganegaraan di perguruan tinggi [Improving civic literacy by utilising digital literacy through citizenship education in higher education]. *Jurnal Pekommas*, 8(1), 59–70.
- Witarsa, W., Rusdiana, U., Nuraeni, A., Yohana, N., & Rais, S. T. (2023). Critical thinking as a necessity for social science students capacity development: How it can be strengthened through project-based learning at university. *Jurnal Pendidikan dan Pengajaran*, 56(1), 113–124. <https://doi.org/10.23887/jpp.v56i1.52763>
- Yuanti, Y., Rantung, D. A., & Prasetyo, T. (2025). Analysis of the effectiveness of project-based learning in improving 21st century skills of students in Indonesian higher education institutions. *Jurnal BELAINDIKA (Pembelajaran dan Inovasi Pendidikan)*, 7(1), 1–12. <https://doi.org/10.52005/belaindika.v7i1.338>
- Yue, A., Nekmat, E., & Beta, A. R. (2019). Digital literacy through digital citizenship: Online civic participation and public opinion evaluation of youth minorities in Southeast Asia. *Media and Communication*, 7(2), 100–114. <https://doi.org/10.17645/mac.v7i2.1899>
- Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. *Frontiers in Psychology*, 14, Article 1202728. <https://doi.org/10.3389/fpsyg.2023.1202728>
- Zubaidah, S., Corebima, A. D., & Mistianah. (2015). *Asesmen berpikir kritis terintegrasi tes essay* [Critical thinking assessment integrated into essay tests] [Paper presentation]. Symposium on Biology Education (Symbion), Universitas Ahmad Dahlan, Yogyakarta, Indonesia.