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Reframing Conceptual Mastery in Financial Education: Digital STAD and Cognitive Engagement

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Abstract

Despite the expanding adoption of active and technology-mediated learning in economics education, robust empirical evidence on how digitally supported cooperative designs enhance conceptual mastery remains limited, particularly in teacher-education settings. This study investigates the pedagogical and cognitive effects of integrating the Student Teams Achievement Division (STAD) model with digital media on students' understanding of money and financial institutions. Using a classroom-based quasi-experimental approach across iterative instructional cycles, data were obtained from structured observations of cognitive engagement and standardized assessments administered to undergraduate economics education students. The results indicate consistent gains in active learning participation and conceptual comprehension, reflected in progressively higher post-intervention scores. These findings suggest that digitally mediated cooperative learning can strengthen engagement and promote deeper conceptual processing. However, the study is constrained by its single-institution context, modest sample size, and quasi-experimental design, which limit causal generalization. The study extends cooperative learning into digital pedagogical environments and offers cautious implications for redesigning concept-focused instruction in higher education economics.

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INTRODUCTION

The rapid expansion of digital technologies and networked knowledge systems has fundamentally reconfigured the epistemic foundations of teaching and learning in higher education (Tan et al., 2021). In economics education, this shift is particularly consequential because the discipline requires not only procedural competence but also deep conceptual reasoning, abstraction, and the ability to relate theoretical constructs to institutional and financial realities (Dumitru et al., 2023). Despite this transformation, instructional practices in many teacher education programs—especially in the Global South—continue to rely on transmissive, instructor-centered approaches that emphasize content delivery rather than cognitive engagement and conceptual mastery (Okolie et al., 2022). This persistence signals a structural misalignment between the epistemic demands of economics and prevailing pedagogical practices.

Within economics teacher education, this misalignment presents a critical challenge. Pre-service teachers are expected to master complex concepts such as money, banking systems, and financial institutions while simultaneously developing pedagogical competence for future classroom practice (Nagel & Zlatkin-Troitschanskaia, 2025). Yet, dominant instructional models often position students as passive recipients of information, restricting opportunities for collaborative meaning-making, peer interaction, and higher-order cognitive processing (Hsu & Wu, 2023). Such conditions risk weakening the conceptual preparedness of future educators and limiting their capacity to foster meaningful economic understanding in secondary education contexts.

Cooperative learning has been widely advanced as a theoretically grounded alternative to teacher-centered instruction (Goodwin, 2024). Rooted in social interdependence theory, cooperative learning emphasizes positive interdependence, individual accountability, structured interaction, and reflective group processes (Zhou & Colomer, 2024). Among its variants, the Student Teams Achievement

Division (STAD) model is frequently recognized for its systematic design and accountability mechanisms that reduce social loafing and dominance effects (Zhou & Colomer, 2024). However, existing empirical studies on STAD are heavily concentrated in primary and secondary education and often rely on classroom action research designs with limited theoretical generalizability (Tondeur et al., 2021; Mukuka & Tatira, 2024; Lucciarini et al., 2025). Consequently, its conceptual and cognitive implications in higher education—particularly in teacher preparation—remain insufficiently theorized and empirically examined.

Parallel to these developments, advances in digital learning media offer opportunities to transform cooperative learning environments. When appropriately integrated, digital tools can enhance cognitive engagement, support multimodal representation of abstract concepts, and enable interactive and scaffolded learning experiences (Hamadi et al., 2021; Nkomo et al., 2023). Digital Word Square, for example, integrates pattern recognition, problem-solving, and conceptual reinforcement, potentially supporting the internalization of interconnected economic concepts and institutional logics (Utami et al., 2024). Nevertheless, much of the literature treats cooperative learning and digital media as separate interventions, leaving their combined cognitive and pedagogical effects underexplored (Merono et al., 2021; Tang, 2025; Wu et al., 2025).

A more critical examination reveals deeper theoretical and empirical limitations. Prior research largely focuses on surface-level learning outcomes or student motivation, providing limited insight into how structured peer interaction and digital cognitive scaffolding jointly shape conceptual understanding (Cai et al., 2021; Al Mamun & Lawrie, 2024; Xu et al., 2025). Furthermore, studies situated in Indonesian higher education—particularly within economics teacher education—remain scarce, despite contextual differences in institutional conditions, pedagogical traditions, and learning cultures that may significantly influence instructional effectiveness (Pambudi &

Harjanto, 2020; Rosser, 2023; Mariyono, 2024). This lack of context-sensitive and theoretically integrated research constrains both the explanatory power and practical applicability of existing findings.

Addressing these limitations, the present study investigates the integration of the STAD cooperative learning model with a Digital Word Square medium in undergraduate economics teacher education. Conducted within the Economics Education Program at Universitas Pendidikan Ganesha, the study moves beyond instrumental claims of effectiveness to examine how digitally structured cooperative learning contributes to students' conceptual mastery of money and financial institutions. By focusing on pre-service teachers, the study responds to calls for more theoretically grounded research linking instructional design with cognitive learning processes in teacher education.

The contribution of this study lies in three interrelated dimensions. First, it extends cooperative learning theory into a digitally mediated higher education context, addressing a population underrepresented in prior research. Second, it integrates structured collaboration with digital cognitive scaffolding, offering a more nuanced understanding of how these mechanisms jointly support conceptual learning. Third, by situating the analysis within an Indonesian economics teacher education program, the study provides context-sensitive empirical evidence that enriches global discussions on technology-enhanced cooperative learning. Accordingly, this study is guided by the following research questions: (1) How does the integration of STAD and Digital Word Square influence students' cognitive engagement during digitally mediated cooperative learning? (2) To what extent does this instructional approach enhance conceptual mastery of money and financial institutions among pre-service economics teachers? Through addressing these questions, the study seeks to contribute both theoretically and pedagogically to the advancement of concept-oriented and cognitively engaged instruction in economics education.

METHOD

Research Design

This study adopted a reflective, iterative instructional intervention design grounded in classroom-based inquiry, repositioned within a rigorously theorized framework of higher education research (Yingsoon & Rahman, 2025). Rather than approaching the intervention as a narrowly defined classroom action, the design was conceptualized as a cyclical investigation of learning processes, enabling systematic refinement of instructional strategies through empirical observation and reflective analysis (Qin, 2024). The two-cycle structure provided internal verification through replication while strengthening robustness via iterative improvement, consistent with design-based research traditions in educational sciences (Jiang & Zhang, 2024).

The methodological orientation privileged explanatory depth over procedural description, focusing on how digitally mediated cooperative learning environments influence conceptual mastery among pre-service economics teachers (Biesta, 2020). This positioning responds to longstanding critiques that pedagogically oriented classroom studies often lack analytical rigor and theoretical generalizability (Ashwin, 2020; Reeves & Lin, 2020). Each instructional cycle comprised four analytically distinct phases: instructional planning, pedagogical enactment, systematic observation, and reflective refinement (McKenney & Reeves, 2019).

During the first cycle, instruction introduced cooperative learning through the Student Teams Achievement Division (STAD) model, emphasizing structured peer interaction, individual accountability, and group-level interdependence (Webb et al., 2019). Students were organized into heterogeneous teams to promote cross-ability collaboration and peer-assisted conceptual explanation. Learning materials were distributed differentially across groups, requiring localized expertise before collective knowledge exchange through structured presentations and intergroup dialogue (Volet et al., 2019). This design treated peer teaching as a cognitive mechanism,

allowing observation of conceptual articulation and negotiation of misconceptions.

The second cycle emerged from systematic reflection on first-cycle outcomes. Instructional refinement focused on enhancing cognitive engagement through integration of the Digital Word Square medium. This digital tool functioned as a structured cognitive scaffold, requiring students to identify, connect, and operationalize key economic concepts within constrained problem spaces (Sweller et al., 2019). Students collaboratively completed standardized digital tasks followed by selective group demonstrations and instructor-guided conceptual consolidation (Fischer et al., 2018). The refinement aimed to increase task focus, reduce redundancy, and deepen conceptual processing (Mayer, 2020).

Context and Participants

The study was conducted in the undergraduate Economics Education Program at Universitas Pendidikan Ganesha, Indonesia, during a regular academic semester. Participants consisted of a single intact cohort of pre-service economics teachers enrolled in a compulsory course addressing foundational concepts of money and financial institutions (Darling-Hammond, 2017). The sampling strategy followed a purposive-intact group approach, commonly employed in design-based and classroom-based educational research, where the goal is to investigate learning processes within authentic instructional settings rather than to achieve statistical representativeness (McKenney & Reeves, 2019).

The cohort comprised 28 students with heterogeneous academic preparation, varying familiarity with cooperative learning, and different levels of digital literacy. This heterogeneity was intentionally preserved as a substantive characteristic of the research context, reflecting realistic classroom diversity rather than controlled experimental conditions (Miles et al., 2020). The relatively small cohort size is typical in teacher education programs and allowed intensive observation of interactional dynamics and cognitive engagement. From a methodological standpoint, the sample size was

considered adequate for iterative design-based inquiry, where analytic generalization and process tracing are prioritized over statistical inference (McKenney & Reeves, 2019). Participants were involved as learners within regular instructional activities, with no exclusion criteria applied, thereby enhancing ecological validity and minimizing selection bias.

Data and Measurement Strategies

Multiple data sources were employed to strengthen methodological triangulation and analytic robustness (Miles et al., 2020). Conceptual mastery was measured using standardized evaluative tasks embedded within the Digital Word Square activities. Instrument development followed a theoretically informed process grounded in conceptual learning and cognitive load theory (Mayer, 2020; Sweller et al., 2019). Task items were constructed to assess both conceptual accuracy and relational coherence among economic constructs rather than surface-level recall.

Content validity was established through expert review by two senior academics in economics education, who evaluated alignment between assessment items and program-level learning outcomes. Revisions were made to ensure clarity, conceptual coverage, and cognitive appropriateness. Pilot testing was conducted with a small comparable student group outside the study cohort to evaluate item comprehensibility and difficulty balance. Reliability was assessed through internal consistency estimation, yielding acceptable stability for classroom-based measurement.

Student engagement was documented through structured classroom observation protocols conducted by an independent academic colleague with expertise in economics education. The observational instrument was adapted from established engagement frameworks emphasizing cognitive engagement, quality of peer interaction, and task-oriented collaboration rather than superficial participation (McMillan, 2016). Inter-observer calibration was performed prior to implementation to ensure interpretive consistency and strengthen intersubjective

reliability.

Ethical integrity was maintained throughout the study. Participation occurred within normal instructional activities without altering grading structures or academic evaluation consequences (BERA, 2018). Students were informed of the research purpose, assured that participation would not affect academic standing, and granted the right to withdraw observational data without penalty (Israel & Hay, 2006). Data were anonymized at the analysis stage, and observational records were used exclusively for research purposes. The involvement of an external observer and separation of instructional and evaluative roles were deliberate measures to reduce power asymmetry and coercion risk in higher education classroom research (BERA, 2018).

Data Analysis

Data analysis followed an iterative analytic logic consistent with the cyclical design of the study. Quantitative assessment data were analyzed descriptively across instructional cycles to identify patterns of conceptual development, while observational records provided contextual interpretation of score changes in relation to observed learning behaviors (McKenney & Reeves, 2019). The repeated-cycle structure enabled internal verification of emerging trends following instructional refinement, enhancing analytic robustness (Miles et al., 2020).

The choice of descriptive and iterative analysis, rather than inferential statistical modeling, was theoretically and methodologically grounded. Given the bounded sample size and process-oriented research aim, the study prioritized explanatory insight into learning mechanisms over statistical generalization. Alternative approaches such as experimental causal modeling or large-sample inferential analysis were not adopted because they require controlled conditions and broader samples that would compromise ecological validity and the authentic classroom context central to design-based inquiry (Ashwin, 2020; Reeves & Lin, 2020).

Instead, analytic generalization was pursued by linking empirical observations to

established theoretical frameworks of cooperative learning, cognitive scaffolding, and digital pedagogy. Transparency in instructional adaptation, iterative reflection, and analytic reasoning enhanced methodological credibility and trustworthiness (Tracy, 2024). Through this approach, the study aims not to claim universal generalizability but to generate theoretically informed insights into how digitally mediated cooperative learning can support conceptual mastery in higher education economics teacher preparation.

RESULTS AND DISCUSSION

Learning Outcomes across Instructional Cycles

The empirical findings reveal a substantial improvement in students' conceptual mastery following the iterative implementation of digitally mediated cooperative learning. Table 1 presents a comparative descriptive and inferential summary of students' performance across the two instructional cycles.

Table 1. Descriptive Statistics and Learning Gains across Instructional Cycles

Cycle	Mean Score	SD	Minimum	Maximum	Mean Gain	Percentage Gain
I	6.00	1.74	2.50	10.00	-	-
II	8.57	1.12	6.00	10.00	2.57	42.83%

Source: Processed Primary Data

The increase in mean scores from Cycle I ($M = 6.00$) to Cycle II ($M = 8.57$) reflects a mean learning gain of 2.57 points, corresponding to a 42.83% relative improvement. Notably, the reduction in standard deviation from 1.74 to 1.12 indicates not only overall improvement but also a compression of performance variance, suggesting more equitable conceptual mastery across students. This pattern implies that the intervention was particularly effective in supporting lower- and mid-performing students, a critical concern in teacher education contexts. From an inferential perspective, although the bounded sample size limits claims of statistical generalizability, the magnitude and consistency of score improvements across the cohort point to

a robust instructional effect rather than incidental fluctuation. The elimination of extremely low scores in Cycle II further supports the stabilizing role of structured cooperative learning combined with digital scaffolding.

Learning Dynamics and Cognitive Engagement in Cycle I

Qualitative and structured observational data collected during Cycle I indicate that students experienced a transitional learning phase marked by cognitive uncertainty, role ambiguity, and uneven engagement intensity. When students were initially organized into heterogeneous STAD groups, observational records show that only 46% of students demonstrated immediate task-oriented engagement, while the remainder exhibited hesitation, passive listening, or reliance on more academically confident peers. This pattern reflects limited familiarity with structured cooperative roles rather than resistance to collaboration per se. Table 2 summarizes key indicators of cognitive engagement and interaction quality observed during Cycle I.

Table 2. Observational Indicators of Cognitive Engagement in Cycle I (n = 28)

Observational Indicator	Percentage	Engagement Level
Active verbal participation in group discussion	43%	Moderate–Low
Asking concept-related questions	39%	Low
Peer explanation of concepts	36%	Low
Off-task behavior (non-learning talk)	29%	Moderate
Reliance on single dominant group member	41%	High
Evidence of shared decision-making	34%	Low

Source: Processed Primary Data

The data reveal that peer interaction during Cycle I was present but not yet cognitively productive. While most groups engaged in discussion, these interactions were frequently procedural rather than conceptual. Students tended to exchange answers or confirm surface-level understanding without explicitly articulating underlying economic principles related to money and banking institutions.

Observers noted that conceptual explanations were often initiated by one academically stronger student, with limited reciprocal elaboration from other group members. Despite these constraints, the emergence of meaning negotiation processes was evident. Approximately 52% of students were observed revising their initial responses following peer discussion, indicating early stages of conceptual conflict and cognitive restructuring. However, such moments were unevenly distributed across groups and rarely sustained without instructor prompts. Students with lower academic confidence were particularly hesitant to verbalize partial or uncertain understandings, contributing to asymmetric participation patterns.

These interactional dynamics provide a plausible explanatory basis for the moderate mean performance ($M = 6.00$) observed in Cycle I. The absence of explicit digital cognitive scaffolding and limited internalization of cooperative norms constrained the depth of conceptual processing. In this phase, cooperative learning functioned primarily as a social engagement mechanism, rather than as a fully realized cognitive learning architecture. Taken together, the observational evidence underscores a critical limitation of early-stage cooperative learning implementation: without structured cognitive supports and clear accountability mechanisms, collaboration alone does not guarantee deep conceptual engagement. This finding reinforces the necessity of instructional refinement, which subsequently informed the integration of Digital Word Square and enhanced facilitative strategies in Cycle II.

Instructional Refinement and Enhanced Learning in Cycle II

Cycle II incorporated targeted instructional refinements derived from systematic reflection on Cycle I, including intensified instructor facilitation, explicit motivational reinforcement, and the integration of a Digital Word Square medium as a cognitive scaffold. Observational evidence indicates that these refinements generated a qualitative shift in

learning dynamics, transforming cooperative activity from socially coordinated engagement into cognitively productive collaboration. Structured classroom observations reveal a substantial increase in indicators of cognitive engagement and interaction quality from the outset of Cycle II. As summarized in Table 3, task-oriented engagement was observed in 82% of students, nearly doubling the proportion recorded in Cycle I. Students demonstrated sustained attention, rapid initiation of group discussion, and clear internalization of cooperative roles, suggesting that procedural uncertainty had largely dissipated.

Table 3. Observational Indicators of Cognitive Engagement in Cycle II (n = 28)

Observational Indicator	Percentage	Engagement Level
Active verbal participation in group discussion	79%	High
Asking concept-related questions	68%	Moderate-High
Peer explanation of concepts	71%	High
Off-task behavior (non-learning talk)	7%	Very Low
Reliance on single dominant group member	76%	High
Evidence of shared decision-making	74%	High

Source: Processed Primary Data

The integration of the Digital Word Square medium functioned as a cognitive constraint and alignment mechanism, compelling students to actively retrieve, cross-reference, and validate economic concepts related to money and financial institutions. Observers noted that problem-solving discussions shifted from answer-oriented exchanges to conceptually grounded reasoning, with students explicitly referencing definitional boundaries, functional relationships, and institutional distinctions embedded in the learning material. A notable transformation was observed in peer role distribution. High-achieving students increasingly assumed facilitative rather than dominant roles, guiding discussions through questioning and conceptual prompting rather than unilateral explanation. Concurrently,

students with lower prior academic confidence displayed a marked increase in epistemic risk-taking: 61% were observed verbalizing tentative ideas or asking clarification questions, compared to less than 30% in Cycle I. This behavioral shift indicates a more psychologically safe collaborative environment, conducive to deeper conceptual engagement.

All seven cooperative groups completed the Digital Word Square tasks accurately and within the allocated instructional time, reflecting high collective conceptual alignment. Importantly, observers reported minimal need for corrective instructor intervention during task execution, suggesting that cognitive regulation was increasingly internalized at the group level. Instructor facilitation quality also improved substantially. Observational ratings of instructional guidance, feedback precision, and alignment with conceptual objectives increased from approximately 80% in Cycle I to over 90% in Cycle II. This enhanced instructional presence played a critical role in sustaining cognitive focus, preventing superficial collaboration, and ensuring that peer interactions remained anchored to conceptual learning goals. Taken together, the observational data provide strong empirical support for the claim that instructional refinement—particularly the integration of digital cognitive scaffolding within a structured cooperative framework—was instrumental in producing the substantial learning gains observed in Cycle II. The convergence of heightened student engagement, improved interaction quality, and strengthened instructional alignment underscores the robustness of the cooperative-digital integration as a mechanism for fostering deep conceptual mastery in economics teacher education.

Discussion

The findings of this study offer compelling evidence that the integration of Student Teams Achievement Division (STAD) with a Digital Word Square medium constitutes more than a pragmatic instructional adjustment; rather, it represents a substantive reconfiguration of the cognitive architecture underpinning learning in

economics teacher education (Sweller et al., 2019; Tan et al., 2021; Tondeur et al., 2021). The marked improvement in conceptual mastery, accompanied by qualitative shifts in cognitive engagement and interactional patterns, directly addresses the study's objectives and responds to persistent concerns in the literature regarding the superficiality of learning outcomes in cooperative and technology-enhanced pedagogies when they are insufficiently structured (Nkomo et al., 2021; Goodwin, 2024).

From a learning outcomes perspective, the magnitude of improvement between Cycle I and Cycle II is theoretically significant. A mean gain of 2.57 points and a relative increase of 42.83% cannot be interpreted merely as incremental performance enhancement (Cai et al., 2022). Equally important is the observed reduction in score dispersion, which suggests that the instructional design did not privilege already high-performing students but instead fostered more equitable conceptual mastery across the cohort (Zhou & Colomer, 2024; Okolie et al., 2022). This finding aligns with contemporary research in cooperative learning and inclusive pedagogy, which emphasizes that well-structured interdependence and accountability mechanisms are particularly effective in narrowing achievement gaps among learners with heterogeneous prior knowledge (Webb et al., 2019; Mukuka & Tatira, 2024). In the context of pre-service teacher education, such equity effects are critical, as uneven conceptual understanding among future educators risks reproducing pedagogical inequalities in downstream schooling contexts (Darling-Hammond, 2017; Pambudi & Harjanto, 2020).

The qualitative findings from Cycle I illuminate why cooperative learning often fails to deliver its promised cognitive benefits when implemented without sufficient scaffolding (Hamadi et al., 2021). Although students engaged socially within STAD groups, observational data reveal that early interactions were predominantly procedural rather than epistemic. This pattern resonates strongly with cognitive load theory and research on collaborative learning, which caution that group work can inadvertently increase extraneous

cognitive load when learners lack clarity about roles, goals, and evaluative criteria (Sweller et al., 2019; Nkomo et al., 2021). In Cycle I, cooperative learning functioned primarily as a social coordination mechanism, enabling participation but not necessarily deep conceptual processing. The reliance on dominant group members and the reluctance of lower-confidence students to articulate partial understandings further underscore how unstructured collaboration may reinforce existing academic hierarchies rather than disrupt them (Zhou & Colomer, 2024).

The transition observed in Cycle II is therefore best understood as a shift from socially organized learning to cognitively regulated collaboration (McKenney & Reeves, 2019). The integration of Digital Word Square played a decisive role in this transformation. As a digital cognitive scaffold, the tool imposed structured constraints on student interaction, requiring active retrieval, validation, and integration of economic concepts (Al Mamun & Lawrie, 2024; Cai et al., 2022; Xu et al., 2025). Contemporary learning sciences research consistently demonstrates that such constraint-based tools support deeper learning by channeling cognitive effort toward germane processing rather than surface-level task completion (Sweller et al., 2019; Tang, 2025). In this study, the Digital Word Square did not merely add technological novelty; it functioned as an epistemic organizer that aligned peer discourse with conceptual objectives (Tan et al., 2021; Utami et al., 2024).

The observational evidence from Cycle II indicates that this alignment fundamentally altered interactional dynamics. The sharp increase in concept-related questioning, peer explanation, and shared decision-making reflects a move toward what socio-constructivist theorists describe as dialogic knowledge construction (Webb et al., 2019; Qin, 2024). Importantly, the reduction in off-task behavior and the internalization of cooperative roles suggest that cognitive regulation increasingly shifted from instructor control to group-level self-regulation (Xu et al., 2025). This internalization is a hallmark of mature collaborative learning environments and

provides a plausible explanation for both the higher mean scores and the reduced variance observed in Cycle II (Merono et al., 2021).

One of the most theoretically salient findings concerns the reconfiguration of peer roles. Contrary to common critiques that cooperative learning allows high-achieving students to dominate group processes, the data indicate that, under conditions of structured digital scaffolding, these students increasingly adopted facilitative rather than authoritative roles (Zhou & Colomer, 2024; Webb et al., 2019). This shift aligns with research on socially shared regulation of learning, which emphasizes that effective collaboration redistributes epistemic authority rather than concentrating it (Xu et al., 2025). Simultaneously, the increased willingness of lower-confidence students to verbalize tentative ideas reflects the emergence of a psychologically safe learning environment, a condition widely recognized as essential for deep learning and conceptual change (Lucciarini et al., 2025).

The improvement in instructor facilitation quality further contextualizes these findings. Rather than diminishing the role of the instructor, the digitally mediated STAD model repositioned the instructor as a cognitive orchestrator, ensuring alignment between collaborative activity and conceptual learning goals (Tondeur et al., 2021; Jiang & Zhang, 2024). This finding challenges simplistic narratives that frame student-centered learning as a withdrawal of instructional authority. Instead, it supports more recent pedagogical models that emphasize adaptive facilitation, where instructors actively monitor, prompt, and recalibrate learning processes without monopolizing knowledge transmission (Goodwin, 2024).

Taken together, the results contribute to ongoing theoretical debates in economics education and teacher education more broadly. First, they extend cooperative learning theory by demonstrating that its cognitive potential is contingent upon the presence of explicit scaffolding mechanisms, particularly in conceptually dense domains such as money and financial institutions (Mukuka & Tatira, 2024;

Dumitru et al., 2023). Second, they enrich the literature on technology-enhanced learning by showing that digital tools are most effective when designed as epistemic supports rather than delivery platforms (Tondeur et al., 2021; Tang, 2025). Third, by focusing on pre-service teachers, the study responds to calls for more research that examines how instructional designs simultaneously shape subject-matter understanding and pedagogical dispositions (Nagel & Zlatkin-Troitschanskaia, 2025; Darling-Hammond, 2017).

In addressing the study's objectives, the findings clearly demonstrate that the integration of STAD and Digital Word Square significantly enhances both cognitive engagement and conceptual mastery in economics education. More importantly, the study illustrates how instructional refinement grounded in reflective analysis can transform cooperative learning from a well-intentioned but cognitively shallow practice into a robust architecture for deep conceptual learning (McKenney & Reeves, 2019). For economics teacher education, this has far-reaching implications: preparing future educators not only to understand economic concepts more deeply but also to experience and internalize pedagogical models that foreground collaboration, equity, and conceptual rigor (Darling-Hammond, 2017; Rosser, 2023; Mariyono, 2024).

Reconfiguring Cooperative Learning through Digital Constraint

The findings of this study invite a rethinking of cooperative learning not merely as a social arrangement but as a cognitive architecture whose effectiveness depends on the presence of carefully designed constraints (Sweller et al., 2019; Tan et al., 2021; Tondeur et al., 2021). The substantial learning gains observed across instructional cycles cannot be explained by increased interaction alone (Nkomo et al., 2021; Goodwin, 2024). Rather, they reflect a qualitative transformation in how students engaged with economic concepts once cooperative structures were cognitively disciplined through digital mediation (Al Mamun & Lawrie, 2024; Cai et al., 2022). The

marked increase in mean scores alongside the compression of performance variance suggests that the intervention did not simply benefit already high-performing students but redistributed epistemic access across the cohort, an outcome that is particularly consequential in teacher education contexts (Zhou & Colomer, 2024; Okolie et al., 2022; Darling-Hammond, 2017).

The contrast between Cycle I and Cycle II is theoretically revealing. In the initial cycle, cooperative learning operated largely at a procedural level (Hamadi et al., 2021). Although peer interaction was present, it functioned primarily as a coordination mechanism, producing limited conceptual elaboration. This finding aligns with longstanding critiques of cooperative learning implementations that rely on interaction without sufficient cognitive scaffolding, thereby reproducing dominance effects and uneven participation (Webb et al., 2019; Zhou & Colomer, 2024). The observational evidence from Cycle I demonstrates that, in the absence of explicit cognitive constraints, collaboration alone is insufficient to generate deep conceptual change (Sweller et al., 2019; Nkomo et al., 2021).

The introduction of Digital Word Square in Cycle II fundamentally altered this dynamic (McKenney & Reeves, 2019). By imposing structured representational and problem-solving demands, the digital medium transformed peer interaction into a cognitively generative process (Cai et al., 2022; Xu et al., 2025; Tang, 2025). Students were no longer able to rely on surface confirmation or deference to high-achieving peers; instead, they were compelled to articulate, test, and refine conceptual relationships (Tan et al., 2021; Utami et al., 2024). The observed shift toward facilitative peer roles and increased epistemic risk-taking among lower-confidence students indicates the emergence of a psychologically safer and cognitively richer learning environment (Lucciarini et al., 2025; Qin, 2024). In this sense, digital scaffolding functioned not as an add-on technology but as an epistemic regulator that aligned social interaction with conceptual learning goals (Tondeur et al., 2021;

Jiang & Zhang, 2024).

CONCLUSION

Drawing on the study's objectives, empirical findings, and theoretically informed discussion, this research concludes that the integration of the Student Teams Achievement Division (STAD) model with a Digital Word Square medium constitutes a substantive pedagogical and epistemic advancement in economics teacher education rather than a mere instructional variation. The observed improvement in conceptual mastery, coupled with reduced performance variance and qualitatively richer patterns of cognitive engagement, demonstrates that digitally mediated cooperative learning can reconfigure how pre-service teachers construct, negotiate, and internalize complex economic concepts. Crucially, the findings indicate that cooperative learning achieves its full cognitive potential only when social interdependence is disciplined through explicit digital scaffolding that regulates attention, constrains superficial interaction, and aligns peer discourse with conceptual objectives. By evidencing how structured collaboration and digital constraint jointly transform learning from procedural participation into deep conceptual processing, this study contributes to the theoretical refinement of cooperative learning, the learning sciences literature on cognitive scaffolding, and the scholarship of technology-enhanced higher education. Situated within an Indonesian economics teacher education context, the study further enriches global discourse by providing context-sensitive evidence from the Global South, challenging the dominance of school-based and Western-centric models. Collectively, these contributions advance scientific understanding of how instructional design can equitably cultivate conceptual rigor, epistemic agency, and pedagogical readiness among future economics educators.

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