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The Effect of the Stad Model Integrated with Wayground AI on Improving Learning Motivation and Learning Outcomes among Grade X Students in Economics at SMAN 1 Nanga Pinoh

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Abstract

Integrating cooperative learning with artificial intelligence (AI)-based technology offers opportunities to strengthen interaction, feedback, and student engagement, but empirical evidence from secondary school economics education remains limited. This study examined changes in learning motivation and economics learning outcomes following the implementation of Student Teams Achievement Divisions (STAD) integrated with Wayground AI at SMAN 1 Nanga Pinoh. A quantitative pre-experimental design involved 144 Grade X students. Motivation was assessed using a four-point Likert-scale questionnaire with a Cronbach's alpha coefficient of 0.993, while learning outcomes were measured using a 25-item multiple-choice test covering cognitive levels C2–C5. Data were analyzed using descriptive statistics, paired-samples t-tests, 95% confidence intervals, and paired-samples Cohen's d in IBM SPSS Statistics 31. Mean motivation scores increased from 98.22 (SD = 15.01) to 137.25 (SD = 4.73), representing a mean gain of 39.03 ($|t|(143) = 26.04$, $p < .001$, $d = 2.17$). Mean learning outcome scores increased from 58.53 (SD = 3.68) to 87.32 (SD = 1.29), representing a mean gain of 28.79 ($|t|(143) = 90.86$, $p < .001$, $d = 7.57$). These findings document substantial within-group improvements following the intervention. However, the absence of a control group limits interpretation to pretest–posttest changes and prevents definitive attribution of these gains to the intervention. The findings suggest that STAD integrated with Wayground AI has potential as an active, structured, and

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responsive approach to economics instruction through interactive assessment and digital feedback.

Keywords: STAD; Wayground AI; Learning Motivation; Learning Outcomes; Economics Education

INTRODUCTION

The digital transformation of 21st-century education has shifted the role of technology from merely serving as a presentation medium to becoming an integral component of learning design, assessment, and feedback. This innovation promotes the effectiveness and efficiency of the learning process through the development of adaptive learning models, interactive media, and the integration of learning theories to enhance student engagement and motivation (Triandro, 2025). Within the field of artificial intelligence in education (AIEd), AI technologies can perform functions related to learning, teaching, assessment, and administration; however, their effectiveness largely depends on the pedagogical design underlying their use (Chiu et al., 2023). In the K–12 context, systematic reviews indicate that AI-based learning tends to improve cognitive and affective outcomes when learning activities are student-centered and aligned with the instructional context. A recent meta-analysis by Gençdal and Çoğaltay further confirms the positive effects of AI-assisted interventions on academic achievement and motivation, although the magnitude of these effects varies according to subject area, intervention duration, educational level, and implementation conditions. These findings shift the focus from whether AI is beneficial to how the technology can be appropriately integrated into learning models with clear pedagogical structures (Gençdal, M., & Çoğaltay, 2026).

The urgency of improving Indonesia's education system requires innovative teaching methods, teacher competency development, and interactive, technology-based learning environments (Lestari & Isnawati, 2025). At the senior secondary school level, particularly in Grade X Economics under Phase E of the Merdeka Curriculum, learning is no longer primarily concerned with one-way information transmission or merely memorizing terms. Economics learning requires students to understand relationships among concepts, interpret economic situations, compare alternatives, and process information through problem-solving and small-group activities (Chalina & Sembiring, 2023). However, low student

learning outcomes are often associated with suboptimal instructional models that remain teacher-centered and with insufficient learning motivation (Adnyana, 2020).

Motivation is a crucial prerequisite that encourages students to maintain attention, persist in the face of difficulties, and employ meaningful learning strategies to achieve academic performance (Lestari & Isnawati, 2025). A meta-analysis by (Kriegbaum, 2018) demonstrated that motivation makes a unique contribution to school achievement beyond cognitive ability, while (Fong et al., 2023) found that low perceived competence, autonomous motivation, task value, and self-regulation are closely associated with underachievement. From the perspective of Self-Determination Theory (SDT), learning environments that support the needs for competence, autonomy, and social relatedness can strengthen the quality of students' motivation (Ryan & Deci, 2020). Therefore, Economics learning strategies should simultaneously foster social interaction, learning responsibility, experiences of success, and meaningful feedback.

The Student Teams Achievement Divisions (STAD) cooperative learning model provides a solid structure for achieving these objectives through five main components: class presentation, heterogeneous team work, individual quizzes, individual improvement scores, and team recognition (Slavin, 1995). Unlike unstructured group work, STAD connects group success with individual contributions, thereby promoting cooperation and individual accountability simultaneously (Artzt & Newman, 1990). Empirical evidence supports the positive effects of cooperative learning on academic achievement and learning attitudes (Kyndt et al., 2013; Silalahi & Hutauruk, 2020), as well as its potential to address declining motivation following online learning (Lestari & Isnawati, 2025). Gillies demonstrated that structured cooperative groups exhibit more on-task behavior, elaborative assistance, group cohesion, and social responsibility (Gillies, 2004). Specifically, among secondary school students, STAD has been shown to improve achievement, self-efficacy, intrinsic valuing, learning-goal orientation, and the use of deep-processing strategies (Nichols, 2016).

Nevertheless, cooperative learning does not automatically increase motivation in every context. Research (Shachar & Fischer, 2004) found that STAD could improve achievement among some ability groups but might reduce motivation when the quality of activities and feedback mechanisms were suboptimal. At this point, the use of gamification and artificial intelligence (AI) can complement STAD by providing challenges, interactive activities, real-time progress information, and transparent recognition (Meldy Atina Kuron,

2025). So as (Ratinho & Martins, 2023) caution that gamification elements such as points and rankings need to be carefully designed to prevent novelty effects or excessive dependence on external incentives.

Wayground AI, as an AI-based interactive platform ecosystem integrated into the modern evolution of Quizizz, is positioned not as a replacement for the teacher's role but as a technological layer for interactive assessment, practice, gamification, and feedback within the STAD instructional syntax (Ahmad et al., 2025). Wayground AI can strengthen conceptual understanding, personalize questions, provide immediate performance analysis, and deliver explanatory feedback that may have moderate to strong effects on academic achievement (Cai, Fan, et al., 2023). However, Orhan caution that the use of gamified media does not automatically produce quantitative advantages over conventional approaches. This emphasizes that the educational value of technology depends substantially on how the platform is orchestrated alongside structured pedagogical strategies (Orhan Göksün, D., & Gürsoy, 2019).

Previous literature reveals several limitations and research gaps that provide the foundation for the present study: 1) Separation of Interventions: Previous studies examining the STAD model for improving motivation and learning outcomes, such as (Dahlan et al., 2020; Chalina & Sembiring, 2023; Lestari & Isnawati, 2025), have not integrated artificial intelligence-based media such as Wayground AI. Conversely, studies examining Wayground AI/Quizizz (Ahmad, R., 2025; Nova et al. 2024; Patimah et al. 2025) have generally examined these technologies independently without integrating them into the formal STAD cooperative learning structure. 2) Measurement Instruments and Cognitive Levels: Evaluation instruments used in previous studies have often not fully incorporated Higher-Order Thinking Skills (HOTS) principles to assess students' critical thinking, analytical abilities, and complex problem-solving skills (Kristiyono, 2018). 3) Subject and Regional Context: Much of the empirical evidence concerning educational technology has originated from higher education, STEM fields, or urban areas, whereas concrete evidence concerning Grade X Economics in secondary schools located in non-urban regions, such as Melawi Regency, West Kalimantan, remains very limited. 4) Methodological Reporting: Many previous studies have reported statistical significance (*p*-values) without presenting the magnitude of practical effects (effect sizes).

Based on these research gaps, the novelty of the present study lies in the following aspects: 1) Integration of Pedagogical Syntax and AI**:** The study synergizes the sociocultural strengths of the STAD cooperative learning model with the interactive features of Wayground AI as an integrated formative assessment and gamification system. 2) HOTS-Based Evaluation**:** The study employs HOTS-oriented test instruments to assess students' understanding of abstract Economics concepts in a concrete manner among Grade X students in Phase E, who are part of the digitally oriented generation of learners. 2) Administrative Efficiency and Motivation**:** The integration seeks to address teachers' administrative limitations in recapitulating STAD scores through the real-time analytical capabilities of Wayground AI, thereby supporting improvements in intrinsic motivation and learning outcomes simultaneously. 3) Comprehensive Statistical Analysis**:** The study presents quantitative analysis that examines not only mean differences and confidence intervals but also calculates the effect size using Cohen's *d*. Based on these research gaps, this study aims to rigorously examine and analyze the effectiveness of implementing the STAD learning model integrated with Wayground AI in relation to changes in learning motivation and Economics learning outcomes among Grade X students at SMAN 1 Nanga Pinoh, as well as to estimate the magnitude of the practical effect associated with these changes through a rigorous quantitative approach.

METHODS

Research Type and Design

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design. This design uses the same group as the basis for measurement before and after the intervention, allowing changes in scores to be directly calculated for each student (Creswell & Poth, 2018). The design notation was Y1–X–Y2, where Y1 represented the initial measurement of learning motivation and learning outcomes, X represented the STAD learning intervention integrated with Wayground AI, and Y2 represented the final measurement. Because the study did not include a control group, this design primarily provides evidence of within-group change and is not intended to causally separate the effect of the intervention from all external factors that may have occurred during the study period.

Participants and Sampling Technique

The study population consisted of Grade X students enrolled in Economics during the first semester of the 2026/2027 academic year at SMAN 1 Nanga Pinoh. Based on the research documents, the sample consisted of 144 students from four classes: X E, X F, X G, and X H. The classes were selected using the sampling procedure established in the source study to determine the classes in which the intervention was implemented. All participants in the sample completed the pre-intervention measurement, participated in the STAD learning sequence integrated with Wayground AI, and completed the post-intervention measurement.

Intervention: STAD Integrated with Wayground AI

The intervention was designed by retaining the core structure of STAD while positioning Wayground AI as a supporting medium for interaction, practice, assessment, and feedback. This integration was intended to ensure that the technology did not function as a separate additional activity but rather as an integral component of the cooperative learning cycle. Table 1 summarizes how the five STAD components were operationalized in Economics learning.

Table 1. Integration of STAD Syntax and Wayground AI in Economics Learning

STAD Component	Main Classroom Activity	Role of Wayground AI	Expected Learning Mechanism
Class Presentation	The teacher organizes the Economics concepts and problems that constitute the focus of the lesson.	Stimuli, diagnostic questions, or an initial quiz are used to activate students' prior knowledge.	Attention, activation of prior knowledge, and development of a common conceptual framework.
Team Work	Students work in heterogeneous groups to discuss concepts, complete exercises, and develop solutions to problems.	Digital items or activities can be used as discussion materials and to check group understanding.	Peer explanation, relatedness, elaboration, and collaborative problem-solving.
Individual Quiz	Each student completes an individual assessment after the team activity.	Wayground presents an interactive quiz and records individual responses.	Individual accountability, retrieval practice, and focused effort.
Individual Improvement Score	Changes in individual performance serve as the basis for determining individual progress.	Digital results provide information about progress and immediate feedback on responses.	Competence information, goal setting, and formative feedback.
Team Recognition	Teams receive recognition based on the contributions	Performance information supports transparent and	Social recognition, collective responsibility,

STAD Component	Main Classroom Activity	Role of Wayground AI	Expected Learning Mechanism
	and progress of their members.	engaging team recognition.	and sustained participation.

Source: Developed from the STAD components documented in the study data and Slavin (1995).

Instruments and Data Collection

Learning motivation was measured using a four-point Likert-scale questionnaire. The instrument used in the research data adopted indicators from the Technology Acceptance Model (TAM), with the measurement dimensions used in this study consisting of the following:

1. Perceived Usefulness

Davis and Adams define perceived usefulness as the degree to which a user believes that using a particular system will provide benefits and improve their performance (Davis, 1989; Adams et al., 1992). Perceived usefulness refers to an individual's perception of the extent to which technology can assist them in performing tasks or achieving their goals (Wicaksono, 2022). This construct influences perceived usefulness, attitudes, intentions, and actual system use. However, its most significant impact is associated with the usability construct, whereas its effects on other constructs are not significant (Jogiyanto, 2008).

According to Soetam Rizky Wicaksono, perceived usefulness can be divided into the following dimensions: a) Making learning or work easier (makes job easier). b) Providing usefulness in learning (usefulness). c) Increasing or adding to learning productivity (increase productivity). d) Increasing or enhancing effectiveness (enhance effectiveness). e) Improving or developing work performance (improve job performance) (Wicaksono, 2022).

2. Perceived Ease of Use

Perceived ease of use refers to an individual's perception of the extent to which a technology is easy to use. Therefore, in technology development, it is important to ensure that technology is designed by considering perceived ease of use so that it can be easily operated by users and assist them in performing their tasks (Wicaksono, 2022). The indicators of perceived ease of use include: a) Information technology is easy to learn (easy to learn). b) Users can easily become skilled in using information technology (easy to become skilful). c) Information technology is very easy to operate (easy to operate).

3. Behavioral Intention to Use

Behavioral intention to use refers to an individual's tendency or intention to use an information system (Davis, 1989). This component refers to an individual's intention to use an adopted technology. Behavioral intention to use influences actual technology use and is influenced by attitudes and perceived usefulness. Two indicators are used to measure this construct: using the system to carry out a task (carrying out the task) and using the system to complete tasks or achieve intended goals (Wicaksono, 2022).

4. Actual System Use

Actual system use refers to the actual use of a system or the real conditions under which an individual uses the system (Davis, 1989). This construct is directly influenced by behavioral intention and perceived usefulness. Three indicators are used to measure technology use: actual use, actual frequency of use, and user satisfaction (Tumandung et al., 2017), as well as planned utilization in the future (Gardner & Amoroso, 2024). If an individual perceives a system as easy to use and believes that it will improve productivity, they are more likely to be satisfied with using the system, which is reflected in actual usage conditions (Tangke, 2004).

The reliability test of the learning motivation instrument yielded a Cronbach's alpha coefficient of 0.993, indicating very high internal consistency. Economics learning outcomes were measured using an objective test consisting of 25 multiple-choice items covering cognitive levels C2–C5. Thus, the assessment did not merely measure factual recall but also students' understanding, application, and analysis. The instrument underwent validity and reliability testing as documented in the source research data.

Data collection was conducted in three stages. In the initial stage, students completed the learning outcomes test and motivation questionnaire to establish baseline measurements. During the intervention stage, learning was conducted using the STAD cycle integrated with Wayground AI on the Economics material being studied. After the learning sequence was completed, students completed the learning outcomes posttest and the motivation questionnaire using the same measurement constructs. This pretest–posttest procedure generated paired scores that could be analyzed at the individual level.

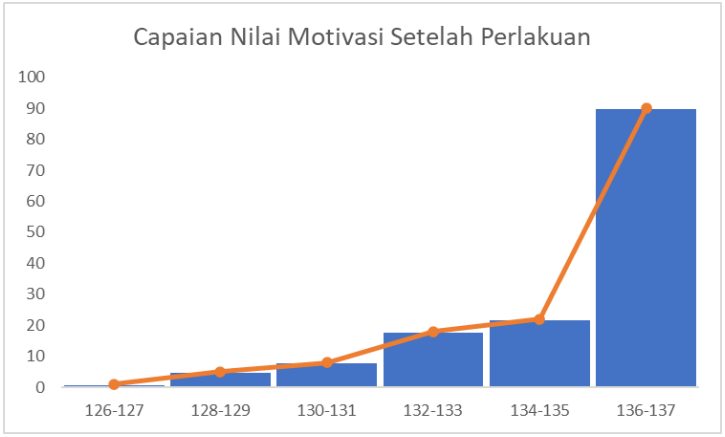
Data Analysis

Data analysis was conducted using IBM SPSS Statistics 31. Descriptive statistics, including the mean, standard deviation, and standard error, were used to describe changes in scores. Pretest–posttest differences were examined using a paired-samples *t*-test at a significance level of 0.05 with a 95% confidence interval. Effect size was calculated using paired-samples Cohen's *d* based on the standard deviation of the difference scores, consistent with the SPSS output. The *d* value was reported as an absolute magnitude to facilitate interpretation of the positive direction of change from pretest to posttest; the negative sign in the original SPSS output resulted from calculating the paired difference in the order of pretest minus posttest. Effect size interpretation considered (Cohen, 1998) guidelines; however, the magnitude of the effect was interpreted in conjunction with the study design and characteristics of the data rather than as standalone evidence of causality. Statistical testing followed the principles of parametric data analysis described by (Fong et al., 2023).

RESULTS

Changes in Learning Motivation

Learning motivation showed a consistent change following the implementation of the STAD model integrated with Wayground AI.



The mean score increased from 98.22 at pretest to 137.25 at posttest. At the same time, the standard deviation decreased from 15.01 to 4.73, indicating that the post-intervention scores were not only higher but also more concentrated around the mean. Table 2 presents the main descriptive and inferential results.

Table 2. Pretest-Posttest Analysis of Learning Motivation

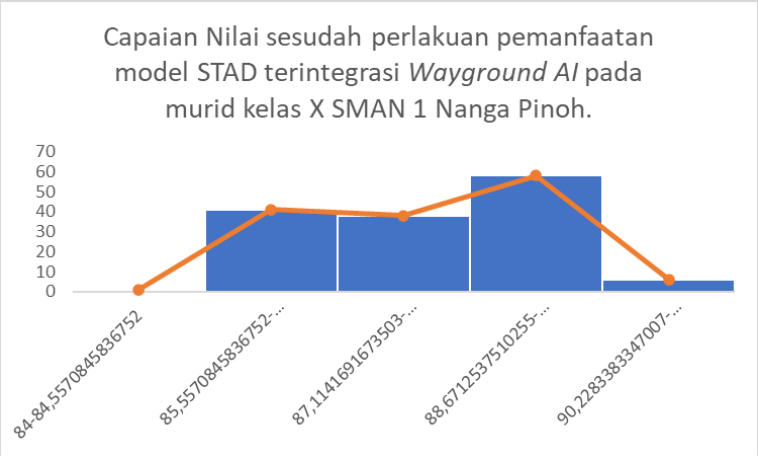
Measure	Pretest M (SD)	Posttest M (SD)	Mean Gain	95% CI of Gain	|t|	p	Cohen's d (95% CI)
Learning motivation	98.22 (15.01)	137.25 (4.73)	39.03	[36.06, 41.99]	26.036	< .001	2.170 [1.869, 2.468]

Source: Research data processed with IBM SPSS Statistics 31, 2026.

The paired-samples *t*-test indicated that the increase in learning motivation was statistically significant, $|t|(143) = 26.036$, $p < .001$. The mean gain was 39.03 points, with a 95% confidence interval ranging from 36.06 to 41.99. The paired-samples Cohen's *d* of 2.170 indicates a very large standardized change within the same group. This value reflects the magnitude of the pretest–posttest shift in the study sample; however, it does not, by itself, identify the proportion of the change that can be exclusively attributed to STAD, Wayground AI, or other factors because the study did not include a control group.

Changes in Economics Learning Outcomes

A similar pattern of improvement was observed in Economics learning outcomes.



The mean pretest score of 58.53 increased to 87.32 at posttest. The standard deviation decreased from 3.68 to 1.29, indicating that following the intervention, students' scores were concentrated at a higher and more homogeneous level of achievement. A summary of the statistical results is presented in Table 3.

Table 3. Pretest-Posttest Analysis of Economics Learning Outcomes

Measure	Pretest M (SD)	Posttest M (SD)	Mean Gain	95% CI of Gain	|t|	p	Cohen's d (95% CI)
Economics learning outcomes	58.53 (3.68)	87.32 (1.29)	28.79	[28.17, 29.42]	90.859	< .001	7.572 [6.679, 8.462]

Source: Research data processed with IBM SPSS Statistics 31, 2026.

The difference in Economics learning outcome scores was statistically significant, $|t|(143) = 90.859$, $p < .001$. The mean gain of 28.79 points had a narrow 95% confidence

interval, ranging from 28.17 to 29.42. The Cohen's *d* of 7.572 indicates a very large standardized change. This extremely large magnitude is partly related to the substantial mean gain relative to the relatively small standard deviation of the difference scores; therefore, its interpretation should take into account the one-group design, the duration of the implementation, the characteristics of the measurement instrument, and the distribution of the scores.

Summary of Main Findings

Overall, the two outcomes specified in the research objectives moved in the same direction. Learning motivation and Economics learning outcomes increased significantly following the implementation of the STAD model integrated with Wayground AI. The increase in learning motivation indicates that the post-intervention learning experience was associated with more positive affective engagement, whereas the increase in learning outcomes indicates improved mastery of the learning material as measured by the cognitive test. The descriptive findings, paired-samples *t*-tests, confidence intervals, and effect sizes were all consistent in demonstrating a strong pretest–posttest change.

DISCUSSION

STAD–Wayground Integration and Learning Motivation

The increase in learning motivation from M = 98.22 to M = 137.25 indicates that the integration of cooperative activities and digital assessment was associated with a substantial affective change. Theoretically, STAD provides opportunities for social relatedness through teamwork while simultaneously maintaining individual accountability through quizzes and improvement scores. Such a structure is consistent with Self-Determination Theory, particularly when students receive support for competence through progress information, relatedness through group interaction, and opportunities to participate actively in the learning process (Ryan & Deci, 2020). The classic STAD study by (Nichols, 2016) also demonstrated that cooperative learning can improve self-efficacy, intrinsic valuing, learning-goal orientation, and deep-processing strategies. In the present study, Wayground AI added an interactive rhythm and feedback mechanisms that may have made learning progress more visible to students.

This interpretation is further supported by the gamification literature, example (Bai et al., 2020) demonstrated that gamification, on average, has a positive effect on learning outcomes and that feedback, recognition, enthusiasm, and goal setting are mechanisms frequently valued by learners. So as (Ratinho & Martins, 2023) also found that gamified strategies are widely used to foster motivation among secondary school and university students. However, neither body of literature supports the assumption that game elements invariably produce higher motivation. The effects of gamification may diminish when novelty wears off or when students become excessively oriented toward points and rankings. The findings of (Shachar & Fischer, 2004), which identified decreased motivation in certain cooperative learning contexts, further emphasize that cooperative learning and gamification should be designed as meaningful learning experiences rather than merely as competitive activities.

STAD–Wayground Integration and Economics Learning Outcomes

The increase in learning outcomes from M = 58.53 to M = 87.32 can be understood through a combination of several mechanisms. First, STAD teamwork provides students with opportunities to explain concepts to peers, receive explanations, test their understanding, and correct misconceptions. Research (Gillies, 2004) demonstrated that clearly structured cooperative learning promotes elaborative assistance, on-task behavior, and responsibility for peers' learning. The meta-analysis by (Kyndt et al., 2023) likewise demonstrated a positive effect of cooperative learning on academic achievement. In Economics, this mechanism is particularly relevant because many concepts require an understanding of causal relationships and argumentation rather than simple memorization of definitions.

Second, the individual quiz administered after teamwork maintains personal accountability. Students cannot fully rely on other group members for success because individual performance remains an important component of the improvement score. Third, digital feedback from Wayground shortens the gap between a student's response and information about the quality of that response. A meta-analysis by (Cai, Gui, et al., 2023) found that feedback in technology-rich learning environments improves academic achievement with a moderate effect, while explanatory feedback demonstrated the strongest effect among the feedback types analyzed. Within the framework of the present study, the

combination of practice, response, and feedback provides opportunities for more rapid correction before misconceptions become established.

Wayground AI as a Pedagogical Layer, Not a Stand-Alone Cause

The findings should be interpreted within a framework that avoids technological determinism. Research (Chiu et al., 2023) demonstrated that AI in education serves multiple functions, but its benefits are closely tied to how the technology is incorporated into learning, teaching, and assessment processes. Similarly, (Rizvi et al., 2024; Lestari & Isnawati, 2025) indicated that positive outcomes in K–12 education are more convincing when AI technology is used in a learner-centered manner and connected to meaningful learning activities. The meta-analysis by (Gençdal, M., & Çoğaltay, 2026) directly demonstrates that the effects of AI-supported interventions on achievement and motivation are moderated by subject area, intervention duration, educational level, and implementation conditions. In other words, Wayground AI in the present study should be understood as a pedagogical layer that strengthens specific functions of STAD particularly assessment, feedback, participation, and gamified recognition rather than as the sole cause of the observed learning outcomes.

This caution is also supported by the study of Orhan Göksün and Gürsoy (2019). Although participants reported positive perceptions of gamified formative assessment, the Quizizz group in their study did not automatically outperform the comparison group on every outcome. Differences in instructional design, infrastructure, participant characteristics, and the way feedback is used may alter the resulting outcomes. Therefore, the contribution of the present study lies not merely in the use of the Wayground platform but in establishing an explicit relationship among STAD phases, Economics learning activities, individual assessment, feedback, and team recognition.

Theoretical, Practical, and Methodological Implications

Theoretically, the findings reinforce the view that motivation and learning outcomes can develop concurrently when instructional design connects social structures with technological support. This relationship is consistent with the findings of (Kriegbaum et al., 2018), which indicate that motivation makes a unique contribution to school achievement, as well as those of (Fong et al., 2023), which show that competence beliefs, autonomous motivation, task values, and self-regulated learning are associated with differences in academic achievement. The present study extends this evidence to the context of Grade X

Economics by demonstrating how cooperative structure, individual accountability, and digital feedback can be incorporated into a single learning sequence.

Practically, Economics teachers can use Wayground AI at functional points in the learning process rather than throughout every learning activity. Concept presentation can be followed by a brief diagnostic prompt; team discussions can be used to develop explanations; individual quizzes can be used to assess personal mastery; feedback can be used to correct errors; and team recognition can be based on progress rather than solely on the highest scores. This approach ensures that technology remains supportive of instructional objectives. So as (Wekerle et al., 2022) emphasize that the relationship between digital technology and learning outcomes depends on the types of learning activities facilitated. Therefore, the teacher's primary decision should concern the design of learning activities rather than the number of digital features employed.

Methodologically, reporting effect sizes alongside *p*-values provides richer information than statistical significance alone. In large samples, *p*-values can become very small even when practical changes are limited. In the present study, $d = 2.17$ for learning motivation and $d = 7.57$ for learning outcomes indicate changes that substantially exceed statistical significance alone. Nevertheless, (Cohen, 1998) emphasizes the importance of interpreting effect sizes within their context. The extremely large effect size for learning outcomes should therefore be considered alongside the low variability of the difference scores, the characteristics of the measurement instrument, and the repeated-measures design employed.

Limitations and Directions for Future Research

This study has several limitations. First, the one-group pretest–posttest design did not include a control group; therefore, testing effects, maturation, history, novelty effects, and other concurrent changes cannot be completely ruled out. Second, the study was conducted at a single school; consequently, generalization to schools with different student characteristics, digital infrastructure, or learning cultures should be approached cautiously. Third, the intervention combined STAD and Wayground AI as a single package, making it impossible to isolate the unique contribution of each component. Fourth, the data available for this article consisted primarily of aggregate statistical outputs; therefore, individual-level moderator analyses and detailed examination of outlier patterns could not be conducted.

Future research should consider using a quasi-experimental nonequivalent control group design or a randomized design when feasible. A factorial design comparing STAD without Wayground, Wayground without STAD, STAD–Wayground, and regular instruction could help disentangle the contribution of cooperative pedagogy from that of the digital platform. Multischool and longitudinal studies are also needed to determine whether increases in motivation persist after the novelty of the technology diminishes. In addition to test scores, future studies could record the quality of team interactions, item-response patterns, completion time, types of feedback used, and engagement indicators to provide a more detailed explanation of the mechanisms underlying the observed changes.

CONCLUSION

This study shows that the implementation of the Student Teams Achievement Divisions (STAD) model integrated with Wayground AI among 144 Grade X students at SMAN 1 Nanga Pinoh was accompanied by a very substantial increase in learning motivation and Economics learning outcomes. Learning motivation increased by 39.03 points, with a paired-samples Cohen's $d = 2.17$, whereas learning outcomes increased by 28.79 points, with a Cohen's $d = 7.57$. Both changes demonstrated very high statistical significance, with $p < 0.001$, accompanied by confidence intervals indicating a positive and consistent direction of change from the pre-implementation to the post-implementation condition. The magnitude of the effect sizes for both outcomes indicates that the observed changes were not only statistically significant but also practically substantial, particularly for learning outcomes. These findings indicate that following the implementation of STAD-based learning integrated with Wayground AI, students experienced positive changes in both the affective domain, as reflected in learning motivation, and the cognitive domain, as reflected in Economics learning achievement. Nevertheless, because the study employed a pretest–posttest design without a control group, the observed increases cannot be interpreted unequivocally as causal effects of the intervention. Therefore, the findings are more appropriately understood as evidence of a very substantial change following the implementation of the learning strategy.

The primary contribution of this study lies in developing an integration between the STAD cooperative learning structure and Wayground AI-based digital assessment technology in Economics education. STAD provides a pedagogical framework through team

formation, collaboration, peer explanation, individual accountability, quizzes, improvement scores, and team recognition, while Wayground AI strengthens these processes through interactive assessment, feedback, progress visualization, and gamification elements that may enhance student engagement during learning. The integration demonstrates that digital technology does not merely function as a medium for delivering questions but acquires instructional value when embedded within a well-planned pedagogical structure. This study also provides initial empirical evidence that the combination of cooperative learning and digital assessment can be implemented concurrently to support changes in learning motivation and Economics learning outcomes. Thus, this study contributes to the literature on digital learning by positioning technology as an integral component of pedagogical design that connects collaborative activities, individual accountability, feedback, progress monitoring, and team recognition within a unified learning sequence.

Future research is recommended to employ stronger research designs, particularly quasi-experimental designs with control groups or factorial designs, so that the effects of STAD integrated with Wayground AI can be compared more convincingly with conventional instruction as well as with the separate use of STAD or Wayground. Subsequent studies should also involve multiple schools, geographical areas, and student characteristics to examine the consistency of the findings and improve the generalizability of the results. In addition, future research could isolate the contribution of each component by comparing a STAD-without-Wayground group, a Wayground-without-STAD group, a STAD-integrated-with-Wayground group, and a conventional-learning group. Measurements could also be expanded by incorporating variables such as learning engagement, collaborative skills, content retention, self-efficacy, and the quality of student–student interactions, as well as conducting follow-up assessments to determine whether improvements in learning motivation and learning outcomes are sustained over a longer period. Such approaches would provide a more comprehensive understanding of the mechanisms, relative effectiveness, and sustainability of implementing STAD integrated with Wayground AI in Economics education.

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