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The Effect of the Problem Based Learning Model Assisted by the Educandy Application on Student Learning Outcomes

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Abstract

Despite the growing adoption of digital learning technologies, limited evidence exists regarding the integration of Problem-Based Learning supported by gamified educational applications in economics education. Grounded in active learning theory, this study examines the effect of a Problem-Based Learning approach assisted by the Educandy application on students' learning outcomes. A quantitative study employing a quasi-experimental design with a nonequivalent control group was conducted. The experimental group received Problem-Based Learning supported by Educandy, whereas the comparison group participated in conventional instruction. Learning outcomes were measured using an achievement test, and the data were analyzed through descriptive and inferential statistical procedures. The findings indicate that students exposed to Problem-Based Learning assisted by Educandy achieved higher learning outcomes than those experiencing conventional learning. The results suggest that combining problem-centered learning with interactive digital media enhances student engagement and supports deeper understanding of economics concepts. This study contributes to the active learning literature by demonstrating the pedagogical value of integrating gamified learning applications with Problem-Based Learning and offers practical implications for educators seeking to improve learning effectiveness in economics classrooms.

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INTRODUCTION

Education plays a strategic role in developing human resources capable of responding to increasingly complex social, economic, and technological challenges. In the context of the twenty-first century, education is expected not only to facilitate knowledge acquisition but also to foster higher-order thinking skills, problem-solving abilities, creativity, collaboration, and the capacity to apply knowledge in authentic contexts (Caena & Redecker, 2019; OECD, 2023; Vajen et al., 2023). Consequently, the effectiveness of educational processes is no longer determined solely by curriculum content but also by the pedagogical approaches used to engage students in meaningful learning experiences. Contemporary educational perspectives emphasize that meaningful learning occurs when learners actively construct knowledge through interaction, inquiry, and reflection rather than passively receiving information from teachers (Quigley et al., 2017; Sukackė et al., 2022). Within this context, student engagement has emerged as a critical determinant of learning success because active participation facilitates deeper understanding and knowledge retention.

Despite continuous efforts to improve instructional quality, classroom learning in many educational settings remains predominantly teacher-centered. Such instructional practices often emphasize information transmission rather than knowledge construction, positioning teachers as the primary source of knowledge while students assume relatively passive roles in the learning process. Although teacher-centered approaches may facilitate content coverage, they frequently limit opportunities for active participation, collaborative inquiry, critical discussion, and reflective thinking (Merritt et al., 2017; Seibert, 2021). As a result, students may become disengaged from classroom activities and experience difficulties in developing higher-order cognitive skills. Previous studies have indicated that teacher-dominated instructional practices often contribute to passive learning behaviors and restrict students' active involvement in knowledge construction processes (Widiastuti, 2021). Such conditions are increasingly problematic in an educational landscape that requires learners to become adaptive problem solvers capable of responding to complex real-world challenges (OECD, 2023).

Low levels of student engagement represent a significant educational concern because they are closely associated with learning outcomes. Learning outcomes are widely recognized as indicators of students' mastery of subject matter and the effectiveness of instructional processes. From a constructivist perspective, successful learning outcomes reflect students' ability to integrate, interpret, and apply knowledge rather than merely recall information (Lonergan et al., 2022; Liu & Pasztor, 2022). Therefore, when students demonstrate unsatisfactory academic performance, such outcomes may indicate that instructional strategies have not effectively facilitated meaningful learning experiences. Prior research suggests that limited student participation in learning activities often leads to inadequate conceptual understanding, which subsequently affects academic achievement (Rasyid et al., 2020). Furthermore, studies have shown that active learning environments contribute significantly to improved understanding, critical thinking, and academic performance compared with passive instructional approaches (Malmia et al., 2019; Anggraeni et al., 2023). These findings highlight the

importance of adopting instructional models that actively engage learners in the process of knowledge construction.

The challenge of promoting meaningful learning is particularly relevant in economics education. Economics is a discipline that requires students not only to memorize theoretical concepts but also to understand complex relationships among economic phenomena and apply conceptual knowledge to real-world situations. Effective economics learning therefore demands analytical reasoning, critical thinking, and problem-solving skills that enable students to evaluate economic issues from multiple perspectives. However, many students experience difficulties in understanding abstract economic concepts, particularly when instructional activities focus primarily on memorization rather than conceptual exploration. One topic that frequently presents learning challenges is the concept of economic problems, which focuses on the relationship between limited resources and unlimited human wants. Understanding this topic requires students to analyze trade-offs, scarcity, opportunity costs, and decision-making processes within authentic economic contexts. Consequently, superficial learning approaches are often insufficient for helping students develop comprehensive conceptual understanding. Previous evidence indicates that students commonly struggle to master this topic because of its abstract nature and the cognitive demands associated with economic reasoning (Oliveira et al., 2023). This condition suggests the need for instructional approaches capable of facilitating deeper conceptual engagement and meaningful learning experiences.

The persistence of these learning difficulties suggests that conventional instructional approaches may not adequately support the development of conceptual understanding in economics education. Addressing this challenge requires learning environments that actively engage students in inquiry, investigation, analysis, and problem-solving activities (Akcay, 2009; Lonergan et al., 2022). Such environments are consistent with constructivist learning theory, which posits that learners actively construct knowledge through interactions with their environment, peers, and learning tasks rather than passively receiving information from external sources (Prince & Felder, 2006; Sukackė et al., 2022). Constructivist perspectives emphasize that meaningful learning occurs when students are encouraged to connect new information with prior experiences, explore authentic problems, and engage in reflective thinking. Accordingly, instructional models that promote active learning and collaborative problem solving are considered particularly effective for facilitating deeper understanding of economic concepts and improving learning outcomes (Liu & Pasztor, 2022; Anggraeni et al., 2023).

One instructional approach that aligns closely with constructivist principles is Problem-Based Learning (PBL). Problem-Based Learning is a student-centered instructional model that positions real-world problems as the starting point for learning activities, encouraging learners to investigate issues, identify relevant information, and develop solutions collaboratively (Barrows, 1996; Tan, 2003). Rather than emphasizing direct content transmission, PBL focuses on inquiry, exploration, critical thinking, and knowledge construction through engagement with authentic problems. Through these processes, students become active participants in learning while

simultaneously developing analytical reasoning, collaboration, and problem-solving skills. According to Arends (2019), PBL provides opportunities for learners to acquire knowledge through experiences that mirror real-life situations. Such experiences facilitate conceptual understanding and strengthen students' ability to transfer knowledge across different contexts. Recent empirical evidence further demonstrates that PBL contributes positively to critical thinking skills, creativity, collaborative learning, and academic achievement (Amin et al., 2020; Albar & Southcott, 2021; Boye & Agyei, 2023; Anggraeni et al., 2023; Bulut Ates & Aktamis, 2024). Meta-analytic studies also indicate that PBL consistently produces positive effects on students' higher-order thinking skills and learning performance compared with conventional instructional approaches (Liu & Pasztor, 2022).

Although Problem-Based Learning offers substantial pedagogical benefits, its effectiveness may be enhanced through the integration of technology-based learning media. The rapid digitalization of education has transformed expectations regarding instructional design and created opportunities for educators to develop more interactive and engaging learning experiences (Caena & Redecker, 2019; Dhawan, 2020). Technology-enhanced learning environments can facilitate student participation, provide immediate feedback, and support active engagement with learning materials. Moreover, digital learning tools can accommodate diverse learning preferences while increasing motivation through interactive features and multimedia resources. Previous studies have suggested that technology-supported instruction contributes positively to student engagement, conceptual understanding, and learning achievement because it enables learners to interact with content in more dynamic and meaningful ways (Hillmayr et al., 2020; Sukackė et al., 2022). Consequently, integrating appropriate digital technologies into student-centered pedagogies may provide a promising strategy for improving educational outcomes.

Within the context of digital learning innovation, educational game-based applications have attracted increasing attention as tools for enhancing student motivation, engagement, and participation. Gamification refers to the use of game elements such as challenges, rewards, feedback, competition, and progression systems in non-game contexts to increase user engagement and motivation (Deterding et al., 2011; Sailer et al., 2017). Research has consistently demonstrated that gamification can improve learning motivation, engagement, persistence, and academic performance across various educational settings (Alsawaier, 2018; Sailer & Homner, 2020; Zainuddin et al., 2020; Kalogiannakis et al., 2021; Nadi-Ravandi & Batooli, 2022). Furthermore, meta-analytic evidence suggests that gamified learning environments positively influence learning outcomes by fostering greater participation and intrinsic motivation among students (Bai et al., 2020; Huang et al., 2020).

One educational platform that incorporates gamification principles is Educandy. Educandy is a game-based learning application that enables teachers to create interactive learning activities such as quizzes, matching games, word puzzles, and practice exercises. By integrating game mechanics into classroom instruction, Educandy has the potential to transform learning experiences into more engaging and

enjoyable activities while simultaneously reinforcing conceptual understanding. The pedagogical value of gamified learning environments lies in their ability to increase students' motivation, sustain attention, and encourage active participation throughout the learning process (Alt & Raichel, 2020; Aldalur & Perez, 2023; Alt, 2023). Moreover, studies have indicated that gamification can contribute to the development of critical thinking, creativity, and problem-solving abilities, particularly when integrated with active learning approaches (Angelelli et al., 2023; Oliveira et al., 2023).

The pedagogical strengths of Problem-Based Learning and Educandy suggest that combining these approaches may provide a powerful strategy for addressing learning challenges in economics education. Problem-Based Learning offers a structured framework for developing critical thinking and problem-solving skills, whereas Educandy provides interactive and motivational features that can enhance student engagement throughout the learning process. The integration of these approaches is theoretically consistent with constructivist and active learning perspectives because both emphasize learner participation, knowledge construction, and meaningful interaction with learning content (Sukackė et al., 2022; Liu & Pasztor, 2022). Previous studies have reported positive outcomes from combining problem-based pedagogies and gamification elements, demonstrating improvements in student engagement, motivation, creativity, and learning achievement (Duncan et al., 2018; Bayley et al., 2021; Taesotikul et al., 2021; Cubela et al., 2023).

Several previous studies have independently examined the effectiveness of Problem-Based Learning and technology-based learning media. Research conducted by Zainuddin et al. (2020) found that the implementation of Problem-Based Learning improved student learning outcomes by increasing learner participation and engagement during classroom instruction. Similarly, Haptanti et al. (2024) demonstrated that interactive learning media enhanced students' motivation and facilitated better understanding of learning materials. Additional studies have also documented the positive effects of PBL on critical thinking and academic achievement (Anggraeni et al., 2023; Boye & Agyei, 2023), as well as the benefits of gamification for motivation and learning performance (Alt, 2023; Aldalur & Perez, 2023). Nevertheless, the existing literature remains limited in several important respects.

Most previous studies have examined Problem-Based Learning and technology-based learning media as separate instructional interventions. Consequently, limited empirical evidence exists regarding the combined implementation of Problem-Based Learning and Educandy within economics learning contexts, particularly concerning the topic of economic problems. This limitation represents an important research gap because the integration of problem-centered pedagogy and game-based digital media may generate synergistic effects that cannot be fully explained by examining each approach independently. Furthermore, although prior studies have documented improvements in learning outcomes resulting from PBL or gamified learning environments, insufficient attention has been devoted to understanding whether combining these approaches can more effectively address low student engagement and conceptual difficulties in economics education (Bayley et al., 2021; Huang et al., 2023; Oliveira et al., 2023). Consequently,

empirical evidence regarding the effectiveness of Educandy-assisted Problem-Based Learning in economics classrooms remains limited.

Addressing this gap is important both theoretically and practically. Theoretically, investigating the integration of Problem-Based Learning and Educandy contributes to the growing body of literature on constructivist learning, active learning, and technology-enhanced education by examining how pedagogical and technological innovations interact to influence learning outcomes. Practically, the findings may provide educators with evidence-based guidance regarding effective instructional strategies for improving student engagement, conceptual understanding, and academic achievement in economics classrooms.

Based on these considerations, this study aims to examine the effect of Educandy-assisted Problem-Based Learning on students' learning outcomes in economics education, particularly in learning the topic of economic problems. By addressing the identified research gap, this study seeks to provide empirical evidence regarding the effectiveness of integrating problem-based pedagogy and game-based digital learning media in enhancing student learning outcomes.

METHOD

This study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group design. A quasi-experimental design was considered appropriate because the researcher was unable to randomly assign participants to experimental conditions due to existing administrative arrangements within the school. Consequently, intact classes were used as research groups, which is a common practice in educational research where randomization is impractical or ethically constrained. Although the absence of random assignment may increase the possibility of selection bias, the use of a pretest–posttest structure enabled the researcher to examine the initial equivalence of the groups and to control for baseline differences before the intervention was implemented.

The study involved two classes selected from the same grade level. One class was assigned as the experimental group, while the other served as the control group. The assignment was based on existing classroom organization determined by the school rather than by random allocation. Prior to the intervention, both groups completed a pretest to assess their initial knowledge and understanding of the topic of economic problems. The pretest scores were subsequently analyzed to determine whether significant differences existed between the groups before treatment. Establishing baseline comparability was important for strengthening the internal validity of the study and reducing the influence of selection effects.

Following the pretest, the experimental group received instruction through the Problem Based Learning (PBL) model assisted by the Educandy application, whereas the control group received conventional teacher-centered instruction. The intervention was conducted during the learning unit on economic problems and was implemented over several instructional meetings. In the experimental group, learning activities followed the core stages of PBL, including problem orientation, problem analysis, information gathering, collaborative discussion, solution development, and presentation of findings. Real-world economic issues related to scarcity, unlimited human wants, and resource allocation were used as learning stimuli.

During the learning process, the Educandy application was integrated as a gamified learning medium to facilitate concept reinforcement, formative assessment, and interactive practice activities. Through quizzes, matching exercises, and game-based challenges, students were encouraged to actively engage with the learning material and receive immediate feedback. In contrast, the control group learned the same content through lectures, question-and-answer sessions, and textbook-based exercises without the integration of PBL or Educandy.

The research instrument consisted of a multiple-choice achievement test designed to measure students' learning outcomes in economics. Prior to its administration, the instrument underwent validity and reliability testing. Content validity was evaluated through expert judgment involving economics education specialists and experienced teachers to ensure alignment with learning objectives and curriculum standards. Item validity was further examined through item analysis, including item discrimination and difficulty indices. Reliability was assessed using Cronbach's alpha coefficient, and the instrument met the acceptable reliability threshold for educational research, indicating satisfactory internal consistency.

At the conclusion of the intervention, both groups completed a posttest using the same measurement framework as the pretest. The resulting data were analyzed using descriptive and inferential statistical techniques. Descriptive statistics were used to summarize students' performance, including measures of central tendency and dispersion. Prior to hypothesis testing, assumption tests were conducted to evaluate data normality and homogeneity of variance. Following the confirmation of these assumptions, an Independent Samples t-test was employed to determine whether significant differences existed between the posttest scores of the experimental and control groups. In addition to statistical significance testing, effect size analysis using Cohen's d was performed to assess the magnitude of the intervention effect and provide a more comprehensive interpretation of the practical significance of the findings.

Several potential threats to internal validity were considered during the research process. Maturation effects were minimized by conducting the intervention within the same academic period for both groups. History effects were controlled by ensuring that both groups received instruction during the same timeframe and under similar school conditions. Instrumentation threats were reduced through the use of the same validated assessment instrument for both pretest and posttest measurements. Furthermore, the implementation of identical learning objectives, instructional duration, and assessment procedures across groups helped reduce extraneous influences and strengthen the credibility of the causal inferences drawn from the study. Through these procedures, the study sought to enhance methodological rigor and provide more reliable evidence regarding the effectiveness of Educandy-assisted Problem Based Learning in improving students' economics learning outcomes.

RESULTS AND DISCUSSION

Results

This study aims to determine the influence of learning models Problem Based Learning with the help of the

Educandy application on student learning outcomes on the subject matter of economic main problems. The research was conducted in two classes, namely the experimental class and the control class. The experimental class was given treatment using the Problem Based Learning learning model assisted by the Educandy application, while the control class used conventional learning. The data on student learning outcomes was obtained through tests given before and after the learning process, namely **Pretest and Posttest**. The pretest is given to find out the initial ability of students before learning is carried out, while the posttest is given to find out the learning outcomes of students after the learning process.

The results of descriptive statistical analysis showed that there was a difference in learning outcomes between the experimental class and the control class.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Classes	Quantity	Pretest	Posttest
Experiments	33	63	89
Controls	33	52	77s

Based on Table 1, it can be seen that the average pretest scores in the experimental class and the control class did not show a significant difference. This shows that the students' initial abilities in both classes were relatively the same before the treatment was given. However, after the learning process took place, the average posttest score in the experimental class showed a higher increase compared to the control class. The average posttest score of the experimental class reached 89 while the control class was 77.

Before the hypothesis test is carried out, a prerequisite test is first carried out which includes a normality test and a homogeneity test**.** The normality test is carried out to find out whether the research data is distributed normally or not. The normality test in this study uses the Kolmogorov-Smirnov **test.**

Table 2. Normality Test Results

Classes	Sig	Remarks
Experiments	0,200	Normal
Controls	0,200	Normal

Based on the results of the normality test in Table 2, it is known that the significance value in both classes is greater than 0.05, so it can be concluded that the data on student learning outcomes in the experimental class and the control class are distributed normally. Furthermore, a homogeneity test was carried out to find out whether the variance of data from the two research groups had the same or homogeneous variance.

Table 3. Homogeneity Test Results

Test	Sig	Remarks
Lavene Test	0,356	Homogeneous

Based on the results of the homogeneity test in Table 3, it is known that the significance value is greater than 0.05, so it can be concluded that the data variance from the two research groups is homogeneous. After meeting the analysis prerequisite test, a hypothesis test was then carried out using the Independent Sample T-Test to find out if there was a difference in learning outcomes between the experimental class and the control class.

Table 4. Independent Sample T Test Results

Test	Sig	Remarks
Learning Outcomes	0,000	Significant

Based on the results of the Independent Sample T-Test, a significance value of 0.000 < 0.05 was obtained. This shows that there is a significant difference between student learning outcomes in the experimental class and the control class. Thus, it can be concluded that the Problem Based Learning learning model assisted by the Educandy application has an effect on student learning outcomes.

Discussion

The findings of this study demonstrate that the implementation of Problem-Based Learning (PBL) assisted by the Educandy application positively influenced students' learning outcomes in economics, particularly on the topic of fundamental economic problems. The superior posttest performance achieved by students in the experimental group indicates that the integration of a problem-centered pedagogical approach with gamified digital learning media was more effective than conventional teacher-centered instruction. Rather than merely reflecting differences in instructional delivery, these findings suggest that learning environments emphasizing active participation, collaborative inquiry, and interactive engagement can facilitate deeper conceptual understanding and improve academic achievement. This result supports the growing body of evidence indicating that learning outcomes are enhanced when students actively construct knowledge through authentic learning experiences rather than passively receiving information from teachers (Malmia et al., 2019; Lonergan et al., 2022).

From a theoretical perspective, the findings can be explained through constructivist learning theory, which posits that knowledge is actively constructed through interaction, reflection, and engagement with meaningful learning tasks rather than transmitted directly from teachers to learners. Within the constructivist framework, students develop understanding by connecting new information with prior knowledge and by negotiating meaning through social interaction and problem-solving activities. The PBL approach implemented in this study provided opportunities for students to engage directly with authentic economic issues, analyze problems collaboratively, and formulate solutions based on evidence and reasoning. Such learning experiences promote cognitive elaboration, conceptual restructuring, and deeper understanding of subject matter. Consequently, the positive learning outcomes observed in the experimental group are consistent with the assumption that active knowledge construction leads to more meaningful and durable learning than traditional lecture-based instruction (Barrows, 1996; Akcay, 2009; Prince & Felder, 2006).

The findings also align with active learning theory, which emphasizes that students learn more effectively when they participate actively in learning processes rather than functioning as passive recipients of information. In conventional classrooms, students often engage primarily in listening and note-taking activities, limiting opportunities to develop higher-order cognitive skills. In contrast, the PBL environment required students to identify economic issues, discuss alternative solutions, evaluate information, and justify their conclusions. These activities encouraged cognitive engagement and promoted critical thinking processes that are essential for understanding abstract economic concepts. Previous research has consistently demonstrated that active learning strategies improve conceptual

understanding, critical thinking, and academic achievement because they require students to engage cognitively, behaviorally, and socially in learning activities (Merritt et al., 2017; Liu & Pasztor, 2022; Anggraeni et al., 2023). Therefore, the superior performance of the experimental group may reflect the effectiveness of active learning mechanisms embedded within the PBL model.

An important contribution of this study is the integration of PBL with the Educandy application. While PBL provides a pedagogical structure for inquiry and problem solving, Educandy contributes motivational and engagement-enhancing elements through gamification. The positive outcomes observed in this study suggest that the combination of these approaches generated complementary effects. PBL encouraged students to engage in meaningful problem-solving activities, whereas Educandy increased participation by making learning activities more interactive and enjoyable. This synergy is consistent with gamification theory, which argues that game elements such as challenges, feedback, progression, and rewards can increase motivation and sustain engagement in educational contexts (Deterding et al., 2011; Werbach & Hunter, 2015). Previous studies have shown that gamified learning environments promote greater participation and persistence because they satisfy learners' psychological needs for competence, autonomy, and relatedness (Sailer et al., 2017; Krath et al., 2021).

The effectiveness of Educandy-assisted PBL may also be explained through motivational mechanisms. Students who participate in gamified learning activities often perceive learning tasks as less monotonous and more enjoyable, increasing their willingness to invest effort in learning. Interactive quizzes, challenges, and game-based exercises provide immediate feedback, enabling students to monitor their progress and identify areas requiring improvement. Such feedback mechanisms are particularly important in economics learning, where students frequently encounter abstract concepts that require repeated practice and reinforcement. The findings therefore support previous evidence suggesting that gamification contributes positively to learning motivation, engagement, and academic performance (Alsawaier, 2018; Zainuddin et al., 2020; Sailer & Homner, 2020; Nadi-Ravandi & Batooli, 2022). Furthermore, recent studies indicate that digital gamified environments can foster critical thinking, creativity, and learner autonomy when integrated with active pedagogical approaches (Alt & Raichel, 2020; Aldalur & Perez, 2023; Alt, 2023).

The findings of this study are generally consistent with previous research demonstrating the effectiveness of PBL in improving learning outcomes. Khoirunnisa (2023) reported that PBL increased student participation and subsequently enhanced academic achievement. Similarly, research conducted by Boye and Agyei (2023), Amin et al. (2020), and Anggraeni et al. (2023) found that PBL positively influences critical thinking skills, problem-solving abilities, and learning performance across different educational contexts. The current study extends this literature by demonstrating that the benefits of PBL can be amplified when combined with a gamified digital learning platform. This finding supports arguments that contemporary educational interventions should not treat pedagogy and technology as separate domains but rather as complementary components of effective

instructional design (Hillmayr et al., 2020; Caena & Redecker, 2019).

The results also support studies examining the educational benefits of gamification. Research by Huang et al. (2020), Bai et al. (2020), and Zainuddin et al. (2020) demonstrated that gamification positively affects learning outcomes across diverse educational settings. Similarly, Haptanti et al. (2024) found that interactive learning media increase students' motivation and understanding of learning materials. However, the present findings contribute additional insight by showing that gamification alone may not be sufficient to optimize learning outcomes. Instead, its effectiveness appears to be enhanced when integrated with pedagogical approaches that emphasize inquiry, collaboration, and higher-order thinking. This interpretation is supported by studies showing that game elements are most effective when embedded within meaningful learning activities rather than functioning merely as entertainment features (Bayley et al., 2021; Taesotikul et al., 2021; Cubela et al., 2023).

Despite the consistency of these findings with much of the existing literature, it is important to recognize that not all studies report uniformly positive effects of gamification. Some researchers have argued that the educational benefits of gamification depend heavily on instructional design quality, implementation fidelity, and learner characteristics (Hanus & Fox, 2015; Oliveira et al., 2023). Poorly designed gamification may encourage superficial participation rather than meaningful learning. Consequently, the positive outcomes observed in the present study are likely attributable not only to the use of Educandy itself but also to its integration within a structured PBL framework that directed student engagement toward meaningful problem-solving activities. This observation reinforces the argument that technology should function as a pedagogical enabler rather than a substitute for sound instructional design.

Another important consideration concerns the nature of economics education itself. The topic of economic problems requires students to understand abstract relationships among scarcity, resource allocation, and human decision-making. Such concepts are often difficult to master through memorization-based approaches because they require analytical reasoning and contextual application. The PBL activities implemented in this study encouraged students to connect theoretical concepts with real-world economic situations, thereby reducing abstraction and facilitating conceptual understanding. At the same time, Educandy provided opportunities for repeated practice and immediate feedback, strengthening knowledge retention. This combination may explain why students in the experimental group achieved superior learning outcomes compared with their counterparts in the control group.

Although the findings are encouraging, several limitations should be acknowledged. First, the study employed a quasi-experimental design rather than a randomized controlled experiment. Consequently, the possibility of selection bias cannot be completely eliminated despite efforts to establish baseline equivalence through pretesting. Second, the study was conducted within a limited educational context and involved a relatively small number of participants, which may restrict the generalizability of the findings to other schools, grade levels, or subject areas. Third, the intervention was implemented over a relatively short instructional period, limiting the ability to evaluate the

long-term effects of Educandy-assisted PBL on learning outcomes, motivation, and knowledge retention. Future research should therefore employ larger and more diverse samples, extend the duration of interventions, and examine additional outcome variables such as critical thinking, creativity, engagement, and self-regulated learning.

Overall, the findings suggest that Educandy-assisted Problem-Based Learning represents a promising instructional approach for improving students' learning outcomes in economics education. The combination of inquiry-based problem solving and gamified digital engagement appears to create learning experiences that are cognitively stimulating, motivationally supportive, and pedagogically meaningful. By integrating the strengths of constructivist learning, active learning, and gamification, this approach provides an effective pathway for addressing persistent challenges related to student engagement and conceptual understanding in economics classrooms.

CONCLUSION

This study demonstrates that the integration of Problem-Based Learning (PBL) and the Educandy application positively influences students' learning outcomes in economics, particularly on the topic of fundamental economic problems. The findings indicate that students who participated in Educandy-assisted PBL achieved significantly higher learning outcomes than those who experienced conventional instruction, suggesting that the intervention was effective in enhancing students' conceptual understanding and academic performance. Beyond statistical significance, the findings indicate that combining problem-centered learning with gamified digital media can provide meaningful educational benefits by fostering active participation, sustained engagement, and deeper cognitive processing during learning activities.

From a theoretical perspective, the study provides empirical support for constructivist and active learning frameworks, which emphasize that knowledge is most effectively acquired when students actively engage in problem solving, collaboration, and knowledge construction. The findings further suggest that gamified learning environments can complement problem-based pedagogies by enhancing motivation and learner engagement, thereby strengthening the effectiveness of student-centered instruction. From a practical perspective, the results highlight the potential of integrating PBL with interactive digital applications such as Educandy to create more engaging and meaningful economics learning experiences. Teachers may therefore consider combining authentic problem-solving activities with gamified learning tools to improve student participation and learning achievement.

Despite these contributions, several limitations should be acknowledged. The use of a quasi-experimental design, the relatively limited sample, and the short intervention period may restrict the generalizability of the findings. Future research should involve larger and more diverse samples, longer implementation periods, and additional outcome variables such as critical thinking, creativity, motivation, and learning engagement to provide a more comprehensive understanding of the long-term impact of gamified problem-based learning environments.

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