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The Impact of Android Puzzle Adventure Games on Vocational Students' Critical Thinking

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This research employed a quasi-experimental research design, involving an experimental group that received instruction through an Android-based puzzle adventure game and a control group that followed conventional learning methods. Data collection was conducted through pre-tests and post-tests to measure students' critical thinking skills across six dimensions: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Statistical analysis confirmed the validity and reliability of the research instrument, with a Cronbach's Alpha value of 0.87, indicating high internal consistency. The results of the independent samples t-test showed a significant difference between the post-test scores of the experimental and control groups, with a p-value of 0.000 ($p < 0.05$). These findings confirm the positive impact of game-based learning on students' critical thinking skills. The research findings highlight the impact of educational games as an instructional tool in vocational education, enhancing student engagement and cognitive development. This study suggests that integrating Android-based games into the vocational curriculum can improve students' learning experiences and better prepare them for professional careers. Further research should explore the long-term impact of game-based learning and its adaptability across various vocational subjects.

Keywords: quantitative, educational game, puzzle adventure, critical thinking, Android.

Penelitian ini menggunakan desain penelitian kuasi-eksperimental, melibatkan kelompok eksperimen yang menerima instruksi melalui game petualangan teka-teki berbasis Android dan kelompok kontrol yang mengikuti metode pembelajaran konvensional. Pengumpulan data dilakukan melalui pre-test dan post-test untuk mengukur keterampilan berpikir kritis siswa di enam dimensi: interpretasi, analisis, evaluasi, inferensi, penjelasan, dan regulasi diri. Analisis statistik mengkonfirmasi validitas dan reliabilitas instrumen penelitian, dengan nilai Cronbach's Alpha sebesar 0.87, menunjukkan konsistensi internal yang tinggi. Hasil uji-t sampel independen menunjukkan perbedaan signifikan antara skor post-test kelompok eksperimen dan kontrol, dengan nilai p sebesar 0.000 ($p < 0.05$). Temuan ini mengkonfirmasi pengaruh positif pembelajaran berbasis game terhadap keterampilan berpikir kritis siswa. Hasil penelitian menyoroti dampak game edukasi sebagai alat instruksional dalam pendidikan vokasi, meningkatkan keterlibatan siswa dan perkembangan kognitif. Studi ini menyarankan bahwa mengintegrasikan game berbasis Android ke dalam kurikulum vokasi dapat meningkatkan pengalaman belajar siswa dan mempersiapkan mereka lebih baik untuk karir profesional. Penelitian selanjutnya harus mengeksplorasi dampak jangka panjang pembelajaran berbasis game dan adaptabilitasnya di berbagai mata pelajaran vokasi.

Kata kunci: kuantitatif, game edukasi, petualangan teka-teki, berpikir kritis, Android.

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1. Introduction

Critical thinking skills are one of the key 21st-century competencies that students must possess to face the dynamic and complex challenges of the world of work. In vocational education environments, this ability is very important because students are required to be able to analyze information, evaluate data, and make logical decisions in practical contexts such as accounting and taxation (Zainuddin, Z., Perera, C. J., & Halili, 2023). Unfortunately, most vocational students still show weaknesses in the dimension of critical thinking due to learning that is solely centered on procedural memorization (Schmitz, B., Felicia, P., & Bignami, 2015).

The reality in the field shows that the learning approach in many Vocational High Schools (SMK) is still dominated by traditional teacher-centered lecture methods. This approach has proven to be less effective in building higher-order thinking skills (Anderson, L. W., & Krathwohl, 2021). Previous studies (Novak, E., Johnson, T. E., & Parker, 2022); (Seifi, A., Fatahi, A., & Moghaddam, 2022) show that vocational students tend to memorize procedures without understanding concepts, thus being weak in problem-solving and decision-making.

Many previous studies have revealed that conventional learning methods such as lectures are less able to encourage the development of higher-order thinking skills. (Chi, M. T. H., & Wylie, 2014) in the ICAP Framework emphasize that passive learning activities that are only oriented towards providing information rarely result in meaningful conceptual change. Therefore, an approach that stimulates active student involvement is needed, such as game-based learning, which has been proven to be able to increase student interactivity and cognitive engagement in an authentic learning environment (Dahalan, F., Alias, N., & Shaharom, 2023).

Vocational education plays a crucial role in equipping students with the theoretical knowledge and practical skills needed for jobs. However, traditional rote learning methods often fail to develop students' problem-solving and analytical abilities (Lee, H., Kim, H., & Park, 2023). As a result, vocational graduates often struggle to apply critical thinking in real-world business environments (Novak, E., Tretter, T., & McNeill, 2022).

In the field of tax accounting education, critical thinking is essential. Tax regulations are dynamic and constantly changing, requiring professionals to analyze policies, interpret financial data, and make informed decisions (Kebritchi, 2010). Studies show that students trained in problem-based and interactive learning environments exhibit higher retention rates and better problem-solving abilities (Seifi, A., Fatahi, A., & Moghaddam, 2022).

The development of critical thinking in vocational education is crucial to bridge the gap between classroom learning and workplace expectations. Employers are increasingly seeking graduates with analytical reasoning, adaptability, and decision-making skills, emphasizing the need for curriculum reform that prioritizes critical thinking (Huang, R., Spector, J. M., & Yang, 2022). Although the demand for critical thinking skills is increasing, many vocational schools still rely on conventional teacher-centered approaches that emphasize passive learning (Agung, 2020). Lecture-based teaching often lacks student engagement and real-world application, leading to low retention rates and limited problem-solving skills among students (Osborne, J., Erduran, S., & Simon, 2004).

Recent studies indicate that traditional vocational education often focuses on procedural knowledge rather than conceptual understanding, which prevents students from developing adaptive problem-solving skills (Kim, S., & Park, 2023). This limitation calls for a pedagogical shift towards active learning strategies that encourage independent thinking.

To address these challenges,Game-based learning has emerged as a promising instructional strategy. Educational games provide interactive, challenge-based learning environments that engage students and enhance cognitive abilities (Rusman, 2012). Research by (Novak, E., Johnson, T. E., & Parker, 2022) found that students who participated in game-based learning activities demonstrated higher levels of engagement, problem-solving skills, and conceptual understanding compared to those who underwent traditional instruction.

A systematic review by (Johnson, R. B., & Christensen, 2022) highlighted that game-based learning improves student motivation and engagement, leading to better knowledge retention and skill application. The interactive nature of educational games fosters curiosity and encourages learners to experiment with different problem-solving strategies (Gros, 2022a).

Among various types of educational games, puzzle adventure games have gained popularity due to their engaging and problem-solving nature. These games present students with complex scenarios that require logical reasoning, critical analysis, and decision-making (Lee, H., 2016). Studies have shown that students who play puzzle adventure games develop higher-order thinking skills, increased motivation, and improved problem-solving abilities (Seifi, A., Fatahi, A., & Moghaddam, 2022).

With the increasing accessibility of mobile technology, Android-based educational games have become a viable learning tool for vocational students. Mobile learning applications offer flexibility, engagement, and personalized learning experiences, making them an effective alternative to traditional classroom settings (Kebritchi, M., Hirumi, A., & Bai, 2010).

A study by (Huang, R., Spector, J. M., & Yang, 2022) indicated that students who engaged with mobile learning applications demonstrated improved problem-solving abilities and greater engagement than those who used conventional materials. Furthermore, mobile-based learning platforms allow students to practice tax accounting concepts in real-world simulations, reinforcing their understanding and practical application of knowledge (Novak, E., Tretter, T., & McNeill, 2022).

Although the literature has indicated that GBL positively impacts student engagement (Gros, 2022b); (Johnson, R. B., & Christensen, 2022), there has not been much research specifically testing the impact of

Android-based puzzle adventure games on the six dimensions of critical thinking in the context of tax accounting in vocational high schools. Most studies still focus on general subjects or university environments. In addition, there is a methodological gap in measuring the effectiveness of critical thinking instruments that are appropriate for vocational needs (Al-Hroub, A., El-Zraigat, I. A., & Shaheen, 2023), so this research aims to:

1. Analyze the effect of using Android-based puzzle adventure games on the critical thinking skills of vocational high school students in tax accounting subjects.
2. Compare the effectiveness of game-based learning with traditional lecture methods in the context of vocational education, and
3. Assess student engagement, motivation, and problem-solving skills in an interactive learning environment.

This research contributes to the growing literature on educational technology and vocational learning. The findings are expected to provide empirical evidence supporting the integration of educational games into vocational curricula. In addition, this study aims to offer practical recommendations for educators and policymakers in improving vocational training programs and aligning them with the demands of the 21st-century workforce.

By implementing game-based learning strategies, vocational schools can enhance student engagement, improve retention rates,and equip students with essential cognitive skills needed for success in the professional world (Seifi, A., Fatahi, A., & Moghaddam, 2022).

Literature review

1. Critical Thinking in Vocational Education
   Critical thinking is essential in vocational education, particularly for success in the 21st-century workforce. (Facione, 2011) defines it as the ability to analyze, evaluate, and synthesize information to make informed decisions, which is crucial for vocational students facing real-world challenges (Kuswana, 2011). (Huang, R., Spector, J. M., & Yang, 2022) emphasize the need for students to assess workplace situations and apply theoretical knowledge. Research indicates that graduates with strong critical thinking skills perform better on workplace assessments and tasks (Novak, E., Johnson, T. E., & Parker, 2022). However, (Johnson, M., Parker, L., & Lee, 2023) argue that traditional vocational education often focuses more on procedural knowledge than conceptual understanding, hindering critical thinking. (Seifi, A., Fatahi, A., & Moghaddam, 2022) found that lecture-based learning resulted in lower critical thinking scores, while active learning methods, such as project-based learning and gamification, were more effective. (Johnson, M., Parker, L., & Lee, 2023) recommend integrating problem-based learning (PBL) and simulations to enhance analytical reasoning. Studies show that critical thinking is linked to improved job performance, especially in fields like accounting and finance, where professionals with stronger critical thinking skills excel in financial decision-making and risk assessment. Employers prioritize critical thinking, particularly in auditing and taxation, suggesting that integrating game-based learning and simulations can enhance students' critical thinking and job readiness.
2. Traditional Teaching Methods in Vocational Education
   Vocational education often relies on passive, teacher-centered instruction, prioritizing memorization over critical thinking and problem-solving ((Agung, 2011); (Osborne, J., Erduran, S., & Simon, 2004). This approach fails to prepare students for real-world scenarios, especially in fields like tax accounting where complex regulations must be applied (Kim, S., & Park, 2023). Studies show that students in traditional settings struggle with decision-making and problem-solving, scoring lower on assessments compared to those using active learning methods like project-based learning and simulations. To address this, researchers advocate for active learning approaches, such as simulations and gamified learning, which enhance student engagement and critical thinking. These methods better prepare vocational students to analyze financial information and make informed decisions.
3. Game-Based Learning and Educational Games
   Game-based learning (GBL) aligns with constructivist theories by promoting problem-solving, collaboration, and knowledge application (Vygotsky, 1978). It enhances retention, critical thinking, and decision-making skills, particularly in vocational education (Anderson, L. W., & Krathwohl, 2021). Studies show GBL improves cognitive flexibility, with students performing better on problem-solving tasks and gaining a deeper understanding compared to traditional methods.
4. Puzzle Adventure Games in Education
   Puzzle adventure games, which combine problem-solving, exploration, and decision-making, are effective for developing cognitive and analytical skills in education.These games promote critical thinking and decision-making by requiring students to apply logic and solve challenges. Studies show that students using puzzle-based learning perform better in logical reasoning and problem-solving, especially in areas like tax accounting (Lee, H., Kim, H., & Park, 2023). Puzzle games enhance knowledge retention and engagement, encourage independent thinking, and help students connect theory to real-world applications.
5. Mobile Learning and Android-Based Educational Games
   Mobile learning (m-learning) has revolutionized education by providing flexible and interactive learning opportunities, allowing students to access content anytime. Studies indicate that mobile learning improves retention and motivation, with vocational students enhancing problem-solving skills by 35%. Android-based

applications, popular for their accessibility and ease of use, support competency-based learning and real-world problem-solving. Mobile game-based learning (MGBL) further boosts cognitive engagement and practical skills, improving academic performance and job readiness (Gros, 2022b); (Johnson, M., Parker, L., & Lee, 2023).

6. Studies on Game-Based Learning in Accounting Education
   Game-based learning has positively impacted accounting and finance education by improving student engagement, retention, and decision-making skills (Lee, H., Kim, H., & Park, 2023). Simulations in tax accounting and financial decision-making help students practice in a risk-free environment, with studies showing a 35% improvement in tax compliance assessments. Digital games have increased retention by 40% and enhanced students' ability to apply concepts to real-world scenarios (Johnson, M., Parker, L., & Lee, 2023). Interactive simulations and mobile applications further enhance critical thinking and financial decision-making, highlighting the effectiveness of gamified learning in vocational education.
7. Theoretical Framework for Game-Based Learning and Critical Thinking
   Constructivist learning theory, developed by Vygotsky (1978), emphasizes active engagement and social interaction, which aligns with game-based learning (GBL) by encouraging students to apply knowledge in simulated environments. Research by Novak et al. (2022) indicates that GBL enhances problem-solving skills and cognitive flexibility in vocational education. Highlight that multiplayer educational games improve collaboration and peer problem-solving. GBL also fosters higher-order thinking skills (HOTS) as demonstrated by (Lee, H., Kim, H., & Park, 2023), who found a 45% increase in critical thinking assessments. Additionally, (Seifi, A., Fatahi, A., & Moghaddam, 2022) found that strategy games help students apply complex concepts like accounting principles to real-world scenarios. The use of multimedia design in GBL reduces cognitive load, improving retention, as shown by (Johnson, M., Parker, L., & Lee, 2023), who observed a 30% reduction in cognitive overload with game-based simulations.

2. Method

This research employs a quantitative research approach with a quasi-experimental design of the non-equivalent control group type, which is widely used in educational research to measure the effectiveness of different instructional methods (Creswell, J. W., & Creswell, 2021). This approach was chosen because it allows researchers to evaluate the impact of game-based learning interventions on students' critical thinking skills without random assignment to groups. The quasi-experimental method enables researchers to compare learning outcomes between groups while maintaining the authenticity of the classroom environment (Johnson, R. B., & Christensen, 2022). This design is particularly useful in vocational education, where the application of skills in the real world is a priority (Huang, R., Spector, J. M., & Yang, 2022).

A pre-test and post-test design was implemented to evaluate the impact of game-based learning on students' critical thinking abilities. The pre-test measured students' initial critical thinking levels, while the post-test assessed improvement after the intervention. According to (Gay, L. R., Mills, G. E., & Airasian, 2021), this method ensures a valid comparison between groups and helps determine whether the treatment significantly affected learning outcomes. The selection of the quasi-experimental design is supported by (Cook, T. D., & Campbell, 2022), who state that this design provides a robust framework for educational research, allowing for controlled comparisons without disrupting the natural classroom setting. Furthermore, (Sweller, 2022)highlights that this approach is effective in studying cognitive load and knowledge retention, which are crucial for evaluating the effectiveness of game-based learning.

In summary, this research design facilitates an objective comparison between game-based learning and traditional instruction, ensuring that any observed differences in student performance are attributable to the learning intervention rather than external factors. These findings are expected to provide empirical evidence on the use of mobile games in vocational accounting education.

The subjects in this study were 11th-grade students in the Accounting and Institutional Finance (AKL) program at SMK Negeri 1 Juwiring, Klaten, Central Java, in the 2024/2025 academic year. There were two groups in this study; Experimental Group: Students who learned tax accounting using an Android-based puzzle adventure game. Control Group: Students who learned the same subject using conventional lecture methods. The location was chosen purposively because the school has integrated technology into its learning and has adequate digital infrastructure.

To assess students' critical thinking skills, data were collected using pre-tests and post-tests designed based on (Facione, 2011) six aspects of critical thinking; Interpretation, Analysis, Evaluation, Inference, Explanation, Self-regulation. The test instruments were validated by experts in the field and underwent validity and reliability testing before use. Cronbach's Alpha reliability analysis was conducted to measure the internal consistency of the test, yielding a value of 0.87, indicating a high level of reliability (Gay, L. R., Mills, G. E., & Airasian, 2021). According to (Creswell, J. W., & Creswell, 2021), the use of validated test instruments ensures accurate measurement of cognitive skills, especially in experimental research. Furthermore, (Sweller, 2022) highlights the importance of construct validity,

stating that well-structured test instruments help reduce cognitive load, enhancing students' ability to effectively demonstrate critical thinking skills.

This study was conducted in several structured phases to ensure a systematic evaluation of students' critical thinking skills before and after the intervention. According to (Creswell, J. W., & Creswell, 2021), a well-structured data collection process enhances the validity and reliability of experimental research findings. Before the treatment phase, all students in both the experimental and control groups took a pre-test designed to measure their baseline critical thinking abilities. The test, based on (Facione, 2011) six aspects of critical thinking, assessed interpretation, analysis, evaluation, inference, explanation, and self-regulation. This step aligns with (Gay, L. R., Mills, G. E., & Airasian, 2021), who emphasize that pre-tests in quasi-experimental research help establish initial competency levels and ensure that observed differences in post-tests are attributable to the intervention, rather than prior knowledge.

The treatment phase lasted for four weeks, ensuring that students had sufficient time to interact with the learning material and develop critical thinking skills through real-world tax scenarios and problem-solving challenges. Following the intervention, both groups completed the same critical thinking test as in the pre-test to measure learning gains. (Seifi, A., Fatahi, A., & Moghaddam, 2022) found that post-test comparisons in experimental studies help determine the effectiveness of different instructional strategies. The post-test data was analyzed to compare the improvement in performance between the experimental and control groups, determining whether game-based learning had a significant impact on students' critical thinking skills. (Lee, H., Kim, H., & Park, 2023) emphasize that post-tests provide empirical evidence of intervention effectiveness and help validate innovative teaching strategies in vocational education.

To determine the effectiveness of using an Android-based puzzle adventure game in enhancing critical thinking skills, the collected data was analyzed through several statistical tests. According to (Creswell, J. W., & Creswell, 2021), the use of a combination of normality, homogeneity tests,and the significance of increasing the validity of research findings and ensuring that the results are scientifically reliable.

The Shapiro-Wilk test was conducted to check whether the pre-test and post-test scores followed a normal distribution. The results confirmed that the data for both groups were normally distributed ($p > 0.05$), ensuring that parametric statistical tests could be applied. According to Field (2022), the Shapiro-Wilk test is one of the most accurate methods for testing normality, especially for small to medium-sized samples. To confirm whether the variances between the experimental and control groups were equal, Levene's test for homogeneity of variances was conducted. The test showed that the variances were homogeneous ($p > 0.05$), allowing for valid comparisons between the two groups.

An independent samples t-test was conducted to compare the post-test scores of the experimental and control groups. The results showed a statistically significant difference, with a p-value of 0.000 ($p < 0.05$), confirming that the use of puzzle adventure games significantly improved students' critical thinking skills.

The research results data are presented in the form of: Descriptive tables and graphs (mean, standard deviation) to illustrate the trend of pre-test and post-test values. Tables of inferential statistical test results, including t-value, p-value, and effect size to assess the strength of the treatment effect. Data presentation also adheres to clear scientific visualization rules, providing table titles, figure captions, and citation sources if available.

3. Results & Discussion

Results

To ensure the accuracy and reliability of the research instrument, a validity test was conducted using Pearson Product-Moment correlation. The results indicated that all test items had r values higher than the critical value, confirming that each item is valid for measuring students' critical thinking skills. This finding aligns with (Gay, L. R., Mills, G. E., & Airasian, 2021), who emphasize that valid instruments accurately measure the targeted construct and reduce measurement error.

Furthermore, a reliability test was performed using Cronbach's Alpha, yielding a value of 0.87, indicating a high level of internal consistency. According to (Sugiyono, 2019), an instrument is considered reliable if its Cronbach's Alpha exceeds 0.70, suggesting dependability in research findings. Similarly, (Kebritchi, 2010)found that game-based learning instruments demonstrate high validity and reliability due to their ability to promote interactive learning experiences and enhance cognitive engagement.

To further validate the instrument, an expert review was conducted, where professionals in the fields of educational research and digital learning assessed the suitability and clarity of the questions.

According to (Creswell, J. W., & Creswell, 2021), incorporating expert validation ensures that the research instrument is well-structured and aligns with theoretical constructs. The study also performed item analysis, measuring the difficulty index and discrimination index to ensure that the test items could accurately differentiate students based on their critical thinking abilities. (Novak, E., Johnson, T. E., & Parker, 2022) suggest that well-calibrated test items enhance assessment sensitivity, allowing researchers to precisely measure learning gains.

Overall, these results confirm that the instrument is both valid and reliable, making it an effective tool for assessing the impact of an Android-based puzzle adventure game on students' critical thinking skills. Future studies could extend this validation process by incorporating larger sample sizes and longitudinal assessment approaches to strengthen the generalizability of the findings. Before conducting the t-test, normality and homogeneity tests were performed to ensure that the data met the assumptions of parametric analysis; The Shapiro-Wilk normality test indicated that both pre-test and post-test scores were normally distributed ($p > 0.05$), which ensures the validity of using parametric statistical tests (Field, 2022). Levene's test for homogeneity confirmed that the variances between the experimental and control groups were homogeneous ($p > 0.05$), supporting the assumption that both groups had similar levels of variability (Creswell & Creswell, 2021).

An independent samples T-test was conducted to compare the post-test scores between the experimental and control groups. The results are presented in Table 4.1*

The results indicate that the mean post-test score of the experimental group (89.68) was significantly higher than that of the control group (78.12). A t-value of 6.729 and a p-value of 0.000 ($p < 0.05$) confirm that this difference is statistically significant, meaning the use of the Android-based puzzle adventure game had a measurable impact on students' critical thinking skills.

These findings align with (Seifi, A., Fatahi, A., & Moghaddam, 2022), who found that educational games significantly enhance students' critical and analytical thinking skills by engaging them in problem-solving activities. Furthermore, (Novak, E., Tretter, T., & McNeill, 2022) reported that students learning through digital games demonstrated better retention of complex concepts compared to those relying on traditional learning methods.

Moreover, the observed improvement in the experimental group supports previous findings by (Huang, R., Spector, J. M., & Yang, 2022), who showed that interactive learning environments foster higher cognitive engagement. Their study indicated that students using educational games developed better problem-solving skills and exhibited increased motivation compared to peers in conventional lecture-based classrooms.

Additionally, (Kim, S., & Park, 2023) argued that game-based learning promotes a deeper understanding of abstract concepts by allowing students to interact with dynamic, scenario-based challenges requiring real-time decision-making. This aligns with the results of this study, where students in the experimental group demonstrated higher scores on the post-test assessment, indicating improvement in critical thinking, logical reasoning, and decision-making abilities.

Discussion

These results indicate that students using Android-based puzzle adventure games are superior in critical thinking skills, particularly in the dimensions of analysis and inference. This finding aligns with Cognitive Load theory (Sweller, 2022) which explains that visual and interactive representations in game-based learning can reduce extrinsic cognitive load and facilitate deep information processing. Furthermore, the success of the experimental group can also be explained through the ICAP Framework (Chi, M. T. H., & Wylie, 2014), where student interaction in solving challenges in the game activates constructive and interactive engagement at the two highest cognitive levels, resulting in deeper conceptual understanding compared to passive lecture methods.

These research findings reinforce the effectiveness of game-based learning as a method to enhance students' critical thinking skills. Educational games provide interactive problem-solving experiences, increase student engagement, and encourage active learning, which are essential elements in developing higher-order cognitive abilities (Johnson, M., Parker, L., & Lee, 2023).

According to (Facione, 2011), critical thinking consists of interpretation, analysis, evaluation, inference, explanation, and self-regulation, all of which significantly improved among students who engaged with educational games. This suggests that Android-based puzzle adventure games actively stimulate the development of critical thinking by involving students in interactive decision-making processes.

These findings are consistent with previous research. (Osborne, J., Erduran, S., & Simon, 2004) found that interactive digital tools enhance students' analytical reasoning and critical thinking skills. (Noviami, R. R., & Christijanti, 2012) reported that puzzle and adventure games significantly increase

student engagement and cognitive development. (Marzano, 2010) concluded that game-based learning contributes to higher achievement compared to conventional lecture-based methods.

The experimental group showed higher post-test scores than the control group, indicating that students using puzzle adventure games were better at analyzing problems, drawing conclusions, and evaluating solutions compared to students in traditional learning environments. This supports (Huang, R., Spector, J. M., & Yang, 2022), who found that students engaged in game-based learning environments retain information more effectively and apply their knowledge more strategically.

Furthermore, the results indicate that active engagement through games improves cognitive load efficiency, aligning with Sweller's Cognitive Load Theory, which states that learning is enhanced when students interact with structured, challenge-based experiences.

4. Conclusion

This research aims to analyze the influence of Android-based puzzle adventure games on the critical thinking skills of vocational high school students in tax accounting subjects, compare the effectiveness of this approach with conventional lecture methods, and evaluate student engagement and motivation in the interactive learning process. Based on the results of the independent samples t-test, it was found that the experimental group using educational games showed a significant increase in critical thinking scores compared to the control group that followed conventional learning. A p-value of 0.000 ($p < 0.05$) proves a real difference between the two groups. This indicates that the game-based approach effectively improves the six dimensions of critical thinking skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2011).

This significant difference also emphasizes that game-based learning can facilitate cognitive engagement and deeper learning experiences through challenge-based interaction, which aligns with the ICAP Framework (Chi, M. T. H., & Wylie, 2014) and Cognitive Load Theory (Sweller, 2022). Puzzle adventure games allow students to learn in a simulated context that encourages reflection, exploration, and independent decision-making. Overall, the results of this study answer all the research questions, namely; Educational games have a positive and significant influence on the critical thinking skills of vocational high school students. The game-based approach is more effective than the lecture method in developing the critical thinking skills of vocational students. Students involved in game-based learning show higher levels of motivation, engagement, and problem-solving, as shown through qualitative evaluation of student perceptions. Thus, game-based learning can be strategically integrated into the vocational curriculum as an innovative alternative to address the weaknesses of the still dominant traditional approach.

Reference (12pt, bold)

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