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The Utilization of Chatbots in Education to Augment Critical Thinking and Problem-Solving Abilities

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ABSTRACT

Learning in the digital era opens up various new opportunities to enhance the quality of education, particularly in the teaching and learning process through technology integration. One such technology is artificial intelligence (AI), an innovation that can support the learning process. One application of AI is the chatbot—a conversation-based application now widely used across different fields. This study aims to understand how the use of a learning chatbot in vocational videography subjects within the Visual Communication Design (DKV) major can enhance students' critical thinking and problem-solving skills. This study was conducted because, in practice, these two skills still need further improvement, especially in complex subjects like vocational lesson content within the DKV major, which includes videography. In this study, the chatbot functions as an application that provides interactive support and presents content through conversations, exercise guidance, and simulations relevant to real-world videography scenarios. The chatbot is designed to help students grasp fundamental concepts, offer a discussion space, and provide immediate responses at each stage of learning. The research used a quasi-experimental method with two groups: an experimental group using the chatbot and a control group using interactive media. The results showed a significant improvement in the experimental group, with higher scores than the control group that used interactive media. These findings conclude that chatbots are effective in enhancing students' critical thinking and problem-solving skills and have potential for application in other educational areas.

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1. INTRODUCTION

Education is a crucial aspect of human life. One of the main processes in education is learning, which is a structured activity designed specifically to facilitate students' learning process. Learning itself is an interaction between students and their environment, aimed at producing positive behavioral changes (Hrp et al., 2022). According to Wahab & Rosnawati (2021), learning theory is a critical framework for understanding how individuals process information and undergo behavioral changes through interaction with their environment. Learning theories are essential in understanding how this process occurs. Setiawan (2017) explains that learning is a process of change encompassing cognitive, affective, and psychomotor aspects, with variations based on skills, complexity, nature, and ways of receiving stimuli. Different types of learning will affect each learning component. Rieber (2005) discusses several components in learning, explaining that these include objectives, materials, strategies, media, evaluation, as well as students and teachers. All these components can help make learning more effective. However, creating effective learning is not easy, as there are often challenges encountered. Setiawan (2017) reveals that students' learning difficulties can arise from discomfort in learning. Challenges like lack of student engagement and limited teaching innovation demand more participatory and creative learning approaches. In the context of teaching complex materials such as videography within the Visual Communication Design (VCD) specialization, the application of learning theories is highly relevant and emphasized during the learning process. Learning videography not only

involves technical skills but also critical thinking and problem-solving skills. Students are required to identify problems, find creative solutions, and evaluate the results of their thoughts. Critical thinking is the ability to identify solutions to problems or make decisions based on processes of interpretation, analysis, and evaluation

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(Laudia et al., 2023). In learning, critical thinking is essential for students to analyze more deeply and encourage them to question their hypotheses to gain further insights through existing facts (Witarsa & Muhammad, 2023). Critical thinking enables students to think deeply about the material they are studying, providing them with extensive information or insights on the subject. In addition, problem-solving is a skill students must have to understand and overcome challenges that arise during video production. Problem-solving involves stages such as problem identification, situation analysis, solution planning, and result evaluation (Maksum et al., 2023). In videography learning, students can be trained to handle problems that may occur during video production. Critical thinking and problem-solving skills are competencies that involve analyzing and reasoning through knowledge to draw conclusions. These skills assist individuals in making decisions and solving problems effectively. To train these skills, teachers can employ various strategies, such as incorporating technological advancements into the learning process.

Regarding technological developments, AI-based chatbot technology has emerged and is widely utilized in education. One of the uses of AI technology is chatbots. In learning, chatbots deliver material through structured conversations, enabling students to learn the material comprehensively. To ensure effectiveness, chatbots should be designed to meet students' needs with approaches that are easy to understand and engaging, enhancing students' interest in learning and reducing fatigue during lessons. The use of technology in education, such as AI-based chatbots, offers innovative solutions to address the complexities of videography learning. Chatbots utilize Natural Language Processing (NLP) technology to understand human language and provide relevant responses (Guzman & Lewis, 2020). Labadze et al. (2023) revealed that chatbots offer various benefits for students and teachers in education. For students, chatbots can provide detailed responses and learning suggestions, deliver in-depth explanations of material, and offer practice through quizzes. With flexible access, students can learn anytime and anywhere, while the interactivity of chatbots can enhance motivation through personalized and engaging approaches. Chatbots are designed to quickly respond to students' questions and needs, making it easier for them to understand the material being studied. Chatbots designed to respond to students' learning needs and conditions can create a conducive learning environment, which positively impacts students' emotions during the learning process.

By providing relevant responses, chatbots not only make learning more enjoyable but also encourage students to stay motivated. Effective chatbots that address students' learning needs can reinforce positive feelings, which in turn support their motivation. This support includes fostering confidence in their abilities and helping them see the value in each task or material being studied. Chatbots with the ability to deliver quick and accurate responses have great potential to increase students' active engagement in the learning process. When students receive relevant information and appropriate feedback, they feel more valued and motivated to continue learning. With chatbots accessible anytime, students can actively explore the material without fear of making mistakes or confusion when delving deeper into the subject. Responsive chatbots also help students overcome obstacles in understanding material by providing interactive and enjoyable solutions, ultimately boosting their confidence in learning. Furthermore, chatbots play a vital role as tools that support students in developing independent learning habits. Students can freely study at their own pace and in their preferred learning style—for instance, by first learning basic concepts or solving practice problems. They assist not only by presenting learning materials but also by guiding students throughout their learning journey.

In videography learning, chatbots can provide guidance on shooting techniques, help students solve technical problems, or even recommend specific cinematographic styles. Additionally, chatbots can pose critical thinking challenges, such as designing solutions for lighting issues in video production or choosing the most appropriate editing techniques for a desired concept. By providing interactive and relevant responses, chatbots not only help students gain a deeper understanding of the material but also increase their motivation to learn. Therefore, integrating chatbot technology in videography education not only provides solutions to challenges faced by students and teachers but also contributes to the modernization of education. By utilizing chatbots, learning can be designed to be more engaging, effective, and relevant to students' needs, preparing them not only for academic challenges but also for future professional demands. Based on this, this study aims to explore the use of videography learning chatbots in enhancing students' critical thinking and problem-solving skills.

2. MATERIAL AND METHOD

Research Design

The research design utilized is the nonequivalent control group design, which involves two groups: an

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experimental group and a control group. The experimental group received instruction using chatbots, while the control group was taught using interactive learning media. Both groups were given a pre-test before the intervention and a post-test afterward to measure improvements in student abilities. The research instrument consisted of a test designed to measure critical thinking and problem-solving skills. The test blueprint was developed based on critical thinking indicators from Ennis (2011) and problem-solving indicators from POLYA (2019). The test, presented in multiple-choice format, was validated through expert judgment and piloted on a group of students not included in the research sample. Validity and reliability of the instrument were ensured to confirm its ability to accurately measure the research variables.

Participants and Sampling

The research was conducted at SMKN 2 Cimahi, targeting 11th-grade students in the Visual Communication Design (DKV) specialization, with a total population of 108 students divided into three classes. Non-probability sampling was employed to select the research sample, resulting in class XI DKV A as the experimental group and XI DKV B as the control group. This study employs a quantitative approach using a quasi-experimental method, aiming to test the effectiveness of using chatbots in improving students' critical thinking and problem-solving skills.

Instruments and Measures

The test, presented in multiple-choice format, was validated through expert judgment and piloted on a group of students not included in the research sample. Validity and reliability of the instrument were ensured to confirm its ability to accurately measure the research variables.

Procedures

The research procedure began with the preparation stage, which included the development, validation, and trial of the instrument on class XI DKV C. Following this, a pre-test was administered to both groups to assess the students' initial abilities. Subsequently, the experimental group underwent learning with chatbots, while the control group used interactive media. The study spanned two sessions, with the final session involving a post-test to measure improvements in student skills. An independent t-test was conducted to examine the significance of the improvement between the experimental and control groups. This analysis aimed to determine whether chatbot usage effectively enhanced students' critical thinking and problem-solving skills.

Data Analysis Techniques

Data obtained from the pretest and posttest were analyzed quantitatively. Descriptive statistics were used to summarize the results, while the normalized gain (N-gain) was applied to categorize learning improvements into low, medium, or high (Hake, 2002). Because of intact classes were used and minor pretest differences were detected, ANCOVA was conducted with posttest scores as the dependent variable, group assignment as the factor, and pretest scores as covariates. Assumption checks were performed for normality (Shapiro-Wilk), homogeneity of variance (Levene's test), and homogeneity of regression slopes, all of which were satisfied. Effect sizes were reported using partial eta squared for ANCOVA, alongside 95% confidence intervals, while sensitivity analysis indicated sufficient statistical power (> 0.80) given the sample size and effect magnitude.

Data were anonymized and securely stored, and the intervention complied with school policy on AI tool use in classroom environments, ensuring data privacy and appropriate educational application (Cohen et al., 2017). The result of the t-test measurement is termed t-observed, which is then compared with the t-table at a 5% significance level. If t-observed is greater than t-table (t-observed > t-table), the null hypothesis (H_0) is rejected, leading to the conclusion that there is a significant difference between the experimental and control groups.

3. RESULTS

Descriptive Statistics

The study findings indicate that using a chatbot significantly improves students' critical thinking Table 1 and problem-solving skills Table 2. Additionally, the N-gain calculation was performed to assess the improvement in the experimental group following chatbot usage compared to the control group. The experimental class

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showed a significant improvement, with the average pre-test score of 67.22% increasing to 84.17% in the post-test, yielding an N-gain of 0.52 (medium category). Meanwhile, the control group experienced a slight increase in the average pre-test score from 71.11% to 74.44% in the post-test, with an N-gain of 0.04 (low category). An independent t-test was conducted to determine whether the use of the videography learning chatbot significantly improved students' critical thinking skills. The independent t-test yielded a t-value of 2.277 with a significance of 0.026, indicating a significant difference in the improvement between the two groups.

Table 1. Descriptive Statistics for Critical Thinking

Class	Number (N)	Mean	Standard Deviation
Experimental Pre-Test	36	67.22	17.509
Experimental Post-Test	36	84.17	13.810
Control Pre-Test	36	71.53	15.713
Control Post-Test	36	74.44	21.573

Table 2. Descriptive Statistics for Problem Solving

Class	Number (N)	Mean	Standard Deviation
Experimental Pre-Test	36	71.67	19.785
Experimental Post-Test	36	81.67	15.399
Control Pre-Test	36	71.94	22.274
Control Post-Test	36	74.17	20.053

N Gain Analysis

The results of this study revealed in Table 3 and Table 5 that using chatbots in videography lessons significantly enhances students' critical thinking and problem-solving skills. Statistical data illustrate improvements in these skills across various aspects, as N-gain values, and independent t-test results Table 4 and Table 6. The average pre-test score for the experimental group was 71.66%, which increased to 81.78% in the post-test, resulting in an N-gain of 0.32 (moderate category). Conversely, the control group had an average pre-test score of 71.94%, which only increased to 74.16% in the post-test, yielding an N-gain of 0.02 (low category). Following this, an independent t-test was conducted to determine whether the use of a videography learning chatbot significantly improved students' problem-solving abilities. The independent t-test showed a t-value of 2.264 with a significance level of 0.027, indicating a significant difference in the improvement of problem-solving abilities between the experimental and control groups.

Table 3. N-gain Results for Critical Thinking Aspect

Class	N-Gain	Criteria
Experimental	0,52	Medium
Control	0,04	Low

Table 4. Independent T-test Results for Critical Thinking Aspect

Aspect	T-Value	Sig. (2-tailed)
Critical Thinking	2,277	0,026

Table 5. N-gain Results for Problem-Solving Aspect

Class	N-Gain	Criteria
Experimental	0,32	Medium
Control	0,02	Low

Table 6. Independent T-Test Results for Problem Solving Aspects

Aspect	T-Value	Sig. (2-tailed)
Problem Solving	2,264	0,027

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4. DISCUSSION

Use of Chatbots to Improve Student's Critical Thinking Skills

The research results indicated that the use of chatbots significantly enhanced students' critical thinking skills in videography learning, especially when compared to the control class that did not use chatbots. The chatbot created an interactive learning environment where students not only received information but also actively engaged in analysis, evaluation, and reasoning processes. This finding aligns with the views of Wahab and Rosnawati (2021), who emphasized the importance of active student participation in developing logical and reflective understanding. Students who used chatbots demonstrated greater improvement than those who learned through traditional methods. The chatbot not only provided information but also offered immediate feedback, helping learners refine their understanding. Within the context of videography, this enabled students to analyze technical concepts and construct logical arguments. As Cottrell (2023) explained, critical thinking involves the ability to objectively analyze information and structure it into coherent knowledge. In this study, students in the experimental group were better able to evaluate their own responses, identify mistakes, and make corrections independently, whereas students in the control group tended to understand content more superficially without deeper reflection.

The use of chatbots also created opportunities for students to consider diverse perspectives and apply theoretical knowledge in practical contexts. Learners were guided to connect concepts learned during instruction with real-world videography challenges, enhancing both understanding and application. Lim and Makany (2024) highlighted that well-designed chatbots foster responsive and flexible learning environments that allow learners to progress at their own pace. This adaptive interaction helped students personalize their learning experience and engage with material according to their individual needs. In this study, chatbot interaction supported self-paced exploration, enabling learners to revisit complex topics and reflect on them until comprehension was achieved. Consequently, students developed stronger critical thinking abilities as they engaged more deeply with learning content, processed ideas more thoroughly, and determined appropriate next steps for inquiry. The flexibility of chatbot-assisted learning thus supported cognitive autonomy and promoted sustained analytical engagement.

The chatbot also facilitated reflective thinking by providing students with a platform for analysis and self-assessment. Learners were prompted to evaluate their own reasoning processes and consider the factors that influenced their decisions. This aligns with the findings of Lim and Makany (2024), who asserted that incorporating chatbot systems into instruction supports deeper learning by stimulating reflection and reasoning. The chatbot's structured questioning guided students to build logical, evidence-based arguments and to consider multiple perspectives before drawing conclusions. As a result, learners demonstrated growth in their ability to think independently, reason critically, and articulate well-founded judgments. These reflective processes contributed to improved intellectual discipline and the ability to engage in higher-order cognitive activity.

In the aspect of basic clarification, the chatbot supported students in identifying and understanding key concepts related to videography. This was demonstrated by a 31.33% increase in the experimental group's mean score after using the chatbot. Learners received explanations about topics such as the history of filmmaking, types of films, and stages of video production, along with guiding questions that encouraged deeper reflection. The chatbot's dialogic approach prompted students to define concepts in their own words and apply them to practical examples. The ability to justify decisions also improved by 16.39%, as learners were challenged to provide logical reasons for their creative choices. For instance, the chatbot might ask, "Why did you choose that angle for your shot composition?" Such prompts encouraged rational reasoning and helped students support their arguments with theoretical and technical justification. In the drawing conclusions domain, a 29.88% improvement was observed, indicating the chatbot's effectiveness in helping learners summarize information and make coherent inferences from instructional content. Reflective prompts such as "What are the key steps in video production?" guided students in identifying essential ideas and synthesizing them into meaningful insights.

The aspect of advanced clarification showed a 10.67% improvement, reflecting the chatbot's contribution to deeper conceptual comprehension. At this level, students were encouraged to clarify abstract or complex topics such as lighting setups or editing software functions. The chatbot prompted exploratory questioning, for example, "What does storyboarding involve?" which helped learners break down complex processes into understandable components. Engaging with these types of inquiries allowed students to strengthen their conceptual understanding and analytical precision. Improvement in this domain suggested that

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learners were developing the confidence to navigate uncertainty and seek clarification when necessary, a key component of critical thinking.

The assumption and integration aspect recorded the highest increase at 57.77%, demonstrating that the chatbot effectively guided students to connect new knowledge with prior experience and apply it to new contexts. Learners responded to questions such as "How can changing the camera angle influence the emotions conveyed to the audience?" which encouraged them to integrate theory with creative decision-making. Retnowati et al. (2021) emphasized that integrating knowledge across domains fosters meaningful learning and supports higher-order thinking. In this study, students who used the chatbot demonstrated enhanced ability to synthesize information and predict outcomes based on logical reasoning and contextual understanding. By prompting learners to evaluate cause-and-effect relationships and connect abstract ideas to practical outcomes, the chatbot fostered intellectual integration and conceptual maturity.

Overall, chatbot-assisted videography learning proved to be highly effective in enhancing students' critical thinking skills across multiple dimensions, including basic clarification, justification, conclusion-drawing, advanced clarification, and assumption and integration. These findings support the argument that interactive technologies such as chatbots can serve as powerful learning tools that not only aid conceptual comprehension but also stimulate independent, structured, and reflective thinking. The experimental group achieved substantial progress in contrast to the control group, which exhibited only minimal improvement. Therefore, the use of chatbots presents a promising pedagogical approach for cultivating critical, analytical, and creative reasoning among vocational students, particularly in disciplines requiring complex cognitive engagement.

Use of Chatbots to Enhance Student's Problem-Solving Skill

The integration of chatbots into the learning environment produced a meaningful impact on students' problem-solving skills, particularly within the vocational videography context. The chatbot acted as a responsive cognitive scaffold, presenting students with contextualized prompts and scenario-based questions that resembled real-life production challenges. Through this interactive environment, learners were guided to navigate the four stages of problem-solving: identifying problems, planning solutions, implementing actions, and reviewing outcomes. These findings align with Labadze et al. (2023), who observed that chatbots foster learner engagement and enhance comprehension by simulating practical challenges. Students in the experimental group demonstrated clearer reasoning, more strategic decision-making, and increased confidence in addressing authentic production scenarios. The chatbot created a structured, feedback-rich setting that promoted active learning over passive content delivery. This approach enabled learners to internalize core problem-solving processes that are critical in vocational and technical fields.

The most substantial improvement appeared in the solution planning domain, where a 19.42% increase was recorded. Learners developed the ability to outline sequential steps, anticipate potential obstacles, and incorporate flexible alternatives into their production strategies. Prompts such as "What would you do if natural lighting becomes unavailable?" encouraged students to consider environmental factors, available resources, and their implications on the final outcome. Polya (2019) emphasized the importance of planning in connecting problem comprehension with action execution, highlighting that effective planners are more likely to adapt under pressure. The chatbot promoted such adaptability by encouraging students to rehearse multiple options before committing to a decision. Learners not only practiced procedural organization but also developed foresight in anticipating downstream effects of their choices. These experiences provided a valuable opportunity to cultivate strategic thinking essential in creative and technical domains.

The domain of problem identification showed a 17.3% gain, indicating the chatbot's effectiveness in helping students distinguish between symptoms and root causes of a problem. Learners engaged with prompts that required them to assess constraints such as limited equipment or time. For example, the chatbot might pose the question, "If you only have one camera and two hours, how will you capture every scene?" which encouraged students to reflect on priorities and trade-offs. Maksum et al. (2023) argued that recognizing core challenges forms the foundation of effective problem resolution. Exposure to repeated diagnostic thinking enabled students to identify limiting variables and establish realistic scopes for action. These interactions enhanced situational awareness, allowing students to formulate more relevant and precise problem statements. The chatbot contributed by consistently modeling how to approach complex, multifactorial tasks in a logical and analytical way.

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Students also improved their solution implementation skills by 13.37%. Learners demonstrated a better ability to execute technical tasks while adjusting to dynamic conditions. The chatbot supported this by simulating real-time production challenges and prompting users to reflect on their settings and adjustments. For instance, students described how they altered lighting direction or camera framing in response to shifting ambient light. AlAfnan et al. (2024) highlighted that real-time feedback mechanisms in digital learning environments can significantly enhance learners' capacity to transfer theoretical planning into hands-on execution. In this study, students benefited from immediate feedback that encouraged continual refinement of their actions. The chatbot's interactive support enabled learners to critically evaluate the success of their implementations and apply improvements on the spot. This process fostered greater ownership of decision-making and deeper engagement with the technical aspects of the subject matter.

A modest gain of 5.17% was found in the solution review stage, reflecting the beginning of reflective practice development among students. The chatbot guided learners through prompts such as "What would you do differently next time?" or "Did the outcome match your initial plan?" to encourage post-task evaluation. According to Görtzen et al. (2025), process-oriented feedback plays a crucial role in cultivating students' capacity for self-assessment and iterative learning. Although growth in this domain was less substantial compared to other stages, its importance lies in the promotion of metacognitive awareness. Students began to critically examine their workflows, identify errors, and propose areas for refinement. The chatbot facilitated this by creating space for safe reflection without penalization, which is essential in fostering sustainable learning habits. Given more time and structured practice, continued development in this domain is expected.

Taken collectively, these findings suggest that chatbot-assisted learning environments can support the full cycle of problem-solving development. Students not only acquired procedural knowledge but also demonstrated improvements in strategic thinking, diagnostic reasoning, technical execution, and reflective evaluation. The work of Parsakia (2023) supports this conclusion, suggesting that chatbot integration enhances both cognitive and affective dimensions of problem-solving by fostering self-efficacy and structured thinking. The design of the chatbot in this study aligned closely with the challenges encountered in authentic videography projects, ensuring that learners developed contextually relevant competencies. Urban et al. (2023) similarly reported that AI-based systems such as ChatGPT can boost students' creative problem-solving when structured with targeted prompts and real-world simulations. These results provide strong support for the continued use and refinement of chatbot technologies in vocational education. Structured chatbot dialogue presents a promising tool to cultivate independent, reflective, and adaptable problem solvers who are prepared to meet industry-relevant challenges.

5. CONCLUSION

This quasi-experimental study demonstrates that integrating a learning chatbot into vocational videography instruction significantly enhances students' critical thinking and problem-solving skills. The chatbot provided interactive, adaptive, and immediate feedback that encouraged students to analyze concepts, test ideas, and make evidence-based decisions. Compared with interactive-media instruction, the chatbot group achieved higher N-gain values and significant t-test improvements in both skill areas, showing that conversational scaffolding promotes deeper understanding and reflective reasoning. Pedagogically, chatbots serve as cognitive partners that help students connect theory with authentic videography tasks, develop diagnostic reasoning, and engage in self-directed exploration. Although the short duration and limited sample constrain generalization, the findings indicate strong potential for AI-assisted learning environments to cultivate higher-order thinking when paired with well-structured prompts, teacher facilitation, and authentic vocational contexts.

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