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EXPLORING THE INFLUENCE OF ONLINE INQUIRY LEARNING WITH E-SCAFFOLDING PROMPTING QUESTION ON PROBLEM-SOLVING SKILLS IN THE WORK ENERGY TOPIC FOR ISLAMIC SENIOR HIGH SCHOOL STUDENTS

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ABSTRACT

This comprehensive investigation delves into the impact of integrating e-scaffolding prompting questions into online inquiry learning on students' problem-solving skills (PSS). With an explanatory design and a mixed-methods approach, the study focuses on XI-MIPA class students at MAN 1 Kediri City during the academic year 2022-2023. Utilizing meticulously crafted learning instruments, five problem-solving skills questions, and precise interview guidelines, the research employs triangulation through pre-tests, post-tests, and in-depth interviews. Quantitative data undergoes rigorous scrutiny via Analysis of Covariance (ANCOVA). The primary objective is to unveil the discernible influence of online inquiry learning complemented by e-scaffolding on the nuanced domain of PSS. Employing quasi-experimental methodologies, the study systematically compares a class engaged in conventional direct learning with one immersed in the intricacies of online inquiry learning. ANCOVA results decisively highlight a statistically significant disparity in PSS, with the online inquiry learning cohort consistently outperforming the control group. The granular analysis extends to specific problem-solving processes, delineating stages like problem identification, physics-rooted strategic planning, application of problem-solving strategies, mathematical procedures, and critical evaluation. The experimental cohort consistently surpasses the control group across these facets, affirming the pronounced efficacy of online inquiry learning enhanced by e-scaffolding. Qualitative insights from meticulously structured interviews corroborate quantitative findings, revealing a methodical and structured problem-solving approach within the experimental group. A discernable emphasis on conceptual reasoning emerges, reflective of a profound understanding nurtured by the synergistic amalgamation of online inquiry learning and e-scaffolding. The study conclusively advocates for the widespread implementation of this pedagogical framework as a transformative tool to enhance PSS across diverse physics topics. The implications extend to providing a robust foundation for future scholarly investigations, fortified by empirical evidence supporting the affirmative impact of online inquiry learning with e-scaffolding on students' problem-solving skills in physics education.

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INTRODUCTION

The evolution of education within the context of the fourth industrial revolution mandates that students cultivate proficient problem-solving skills (PSS). This aptitude holds paramount significance in the context of diverse learning activities and has been integrated into the physics learning curriculum across various educational tiers (Estuhono, 2022; Novitra et al., 2021; Wang, 2018).

The process of problem-solving serves as a facilitator for students engaged in physics learning, aiding comprehension of intricate physics concepts (Jua et al., 2018). Pospiech (2019) asserts that problem-solving stands as a primary instrument in fostering students' comprehension of physics. It encompasses a cognitive process aimed at deriving solutions through methodical approaches (Sutarno et al., 2021). The resolution of problems entails three fundamental dimensions: the procedural steps undertaken, the strategic framework guiding the entire process, and the proficiency in PSS (Milbourne & Wiebe, 2018).

The imperative to cultivate PSS arises from its inherent connection to students' cognitive processes and their ability to discern solutions to various challenges (Estuhono, 2022; Lund, 2019; Novitra et al., 2021). Despite this necessity, a considerable number of students continue to encounter difficulties in problem-solving, reflecting a suboptimal proficiency in PSS (Rahmatina et al., 2018). The analysis of several physics topics, including work energy (Afiat et al., 2020; Rahmatina et al., 2018; Wati et al., 2021), harmonic motion (Fitroh et al., 2020), static fluid (Nadhini et al., 2017), vibration and waves (A. T. Astuti et al., 2020), momentum and impulse (Eveline et al., 2019), and particle dynamics (Saman et al., 2018), reveals a prevalent low proficiency in students' knowledge of physics concepts (KPC). The etiology of this deficiency in students' PSS within the realm of physics is influenced by various factors, including the non-cohesive nature of students' problem-solving approaches (Afiat et al., 2020; Amanah et al., 2017), the intrinsic complexity of the skill, and the pedagogical competence of educators in imparting PSS within the context of their subject matter (Alfathy et al., 2018).

Furthermore, students often exhibit a tendency to directly employ mathematical equations without a preliminary identification and comprehension of the underlying conceptual framework (Ding et al., 2011; Gunawan et al., 2018; Saman et al., 2018). This practice leads to the inappropriate application of physics concepts due to a lack of foundational problem identification. Conversely, educators frequently prioritize the direct dissemination of subject matter, thereby limiting students' opportunities to engage in exploratory problem-solving processes through diverse learning activities (Fitroh et al., 2020; Gunawan et al., 2020).

Numerous endeavors have been undertaken to enhance PSS, rendering it a focal point of research in the 21st century (Bao & Koenig, 2019). Within the purview of physics education, several studies have delved into strategies aimed at ameliorating competence in physics problem-solving (Mazorodze & Reiss, 2019). Saman et al. (2018) stated that the problem presented is still not contextual with the students' initial knowledge and learning activities are limited to minds-on among students in solving problems and there is no hands-on activity so that solution of the problem are less precise. Indriyani et al. (2018) implemented modeling instruction as a means to cultivate students' PSS. Wartono et al. (2019) employed inquiry-discovery learning with web-assisted empirical-theoretical review to bolster students' PSS. Amanah et al. (2017) utilized a generative learning model supported by scaffolding and advanced organizers to enhance students' PSS. These concerted efforts underscore the multifaceted approaches being explored to elevate PSS levels among students.

Inquiry online (IO) serves as a valuable resource for students engaging in inquiry and problem-solving activities aligned with the exigencies of the 21st century, providing ubiquitous access for students regardless of time or location (Korkman & Metin, 2021; Sotiriou et al., 2020; Streich & Mayer, 2020). In this contemporary educational landscape, students are adept at acquiring knowledge and honing problem-solving skills through processes of discovery and investigation. Inquiry learning becomes particularly pertinent when educators aspire to instill in students the practice of systematic problem-solving. This iterative inquiry process empowers students to actively construct new knowledge through thoughtful reflection and practical application (Kariawan et al., 2015; Song, 2018). However, a noteworthy concern emerges regarding the perceived limitations of students, particularly those classified as low achievers lacking requisite prior knowledge, in successfully undertaking inquiry activities (Tavares et al., 2021).

The utility of inquiry-based learning extends beyond mere pedagogical practice, it also serves as a compelling case study to address the learning challenges faced by students who may grapple with confusion during the learning process (Gaffney, 2013; Suhandi et al., 2018). Rönnebeck et al. (2016) elucidate the dual dimensions inherent in the concept of inquiry, encompassing students actively engaging in inquiry activities and the requisite level of guidance provided. This delineation proves essential as students, in their nascent stages of learning to emulate scientific methodologies, may not possess the inherent ability to spontaneously coordinate steps toward achieving anticipated learning objectives (Gregorcic et al., 2017; Streich & Mayer, 2020).

An effective approach to facilitate inquiry learning involves the judicious integration of learning technologies through online platforms, which not only aids students in grasping instructional content but also supports problem-solving endeavors while fostering the development of independent learning skills (Korkman & Metin, 2021; Mamun et al., 2020). Despite the potential of information and communication technology (ICT)-assisted inquiry learning models, their current implementation has not fully optimized the enhancement of students' PSS. E-scaffolding emerges as a strategic solution to address this limitation by mitigating challenges in the learning process and elevating student proficiency.

Saman et al. (2018) posit that procedural e-scaffolding, in particular, exhibits promise in enhancing students' problem-solving skills. Additionally, Koes-H et al. (2019) advocate for a hybrid approach, asserting that the combination of two scaffolding types proves beneficial for students with limited knowledge, contributing to both improved conceptual understanding and heightened PSS. Scaffolding, as delineated in the research by Brauer et al. (2019), Raes et al. (2012), and Suwastini et al. (2021), entails a collaborative learning strategy wherein students, supported by guidance, engage in group exploration, discussion, and critical analysis of each other's thoughts. This collaborative process serves to enhance the overall quality and intensity of learning experiences.

Previous investigations into the application of e-scaffolding to enhance students' PSS have yielded affirmative results. Nurhayati et al. (2016) conducted research demonstrating the successful improvement of students' mathematical PSS through the strategic deployment of scaffolding. Similarly, Saputri and Wilujeng (2017) provided empirical evidence supporting the efficacy of e-scaffolding in enhancing students' overall problem-solving proficiency. Further corroborated these findings by Mudhofir et al. (2022), students PSS can be achieved through the application of the right steps. These steps are effective selections of models, strategies, media, and instruments. Learning models that can be applied include PBL, PIL, Inquiry, IBMR, PO2E2W, Discovery Learning, PjBL, Virtual

Laboratory, CPSL, and CTL learning models. Learning strategies can be peer instruction, scaffolding, Heller, Keith and Enderson strategies, knowledge planning strategies, Rosengrant strategies, and visualization of the imaginary world. Various supporting media can be in theform of computing media, the development of teaching materials, mobile applications, and games.

In the domain of physics education, Mardiani et al. (2018) employed inquiry-based student worksheets incorporating scaffolding prompting questions, resulting in improved physics learning outcomes for students. Mahtari et al. (2020) also adopted a pedagogical approach involving student worksheets coupled with PhET simulations and scaffolding prompting questions, leading to observable enhancements in students' physics learning outcomes. These collective research endeavors underscore the utility and versatility of e-scaffolding as a pedagogical tool in diverse educational contexts, consistently proving instrumental in augmenting students' problem-solving acumen.

The training and assessment of PSS pertaining to the material on work and energy assume critical significance, given the documented challenges that students encounter in comprehending this particular physics concept. work and energy, as elucidated by Barniol and Zavala (2014), constitute a domain emphasizing the mastery of intricate concepts. The concept of work underscores a nuanced understanding of the interplay between force, displacement, and energy, as expounded by Serway and Jewett (2014). Several studies have identified notable difficulties faced by students in grappling with work and energy material. Challenges include interpreting the sign or direction of work, discerning positive, negative, or zero work, and determining the work exerted by specific force components (Barniol & Zavala, 2014; Kim & Pak, 2002).

Furthermore, students often encounter hurdles in grasping the abstract nature of energy as a conceptual entity (Bezen et al., 2016; Dalaklioğlu et al., 2015). Research by Jewett (2008), Lawson & McDermott (1987), and Lindsey et al. (2009) has revealed additional complexities, such as students struggling to correlate work with changes in energy within a system and articulating the intricate relationship between work and kinetic energy. Despite the pivotal importance of the energy concept, it is noteworthy that its introduction is frequently delayed, and the time allocated for learning this material is observed to be less than that for the acquisition and memorization of formulas in kinematics material (Astuti et al., 2020; Indriyani et al., 2018; Zulfa et al., 2019).

The preceding discussion underscores the existing body of research that explores diverse online inquiry learning models supplemented by e-scaffolding across various modalities. However, a notable gap persists in the literature concerning the investigation of e-scaffolding prompting questions within the context of inquiry learning and its correlation with students' PSS in the realm of physics education, especially when juxtaposed against the traditional approach of direct instruction learning. The unique contribution of this research lies in its utilization of e-scaffolding prompting questions, implemented through a Google Form platform, during online inquiry learning—a methodology not extensively examined in prior studies.

As elucidated earlier, while numerous studies have investigated the efficacy of inquiry learning models coupled with diverse scaffolding approaches to enhance PSS, this research represents a departure by specifically focusing on online inquiry learning coupled with e-scaffolding prompting questions. The implementation of these questions in a Google Form format is designed to enhance accessibility, allowing students to easily access guidance when needed during the online inquiry learning process.

Therefore, the objective of this study is to analyze the impact of the online inquiry learning model, complemented by e-scaffolding prompting questions, on the PSS of islamic senior high school students specifically within the context of work energy material—a novel and understudied dimension in the current body of literature. By addressing this research gap, the study aims to contribute valuable insights into the potential efficacy of this instructional approach and its implications for fostering enhanced problem-solving skills in physics education.

METHOD

The research design employed in this study involves one independent variable, the online inquiry learning model with e-scaffolding prompting question, and one dependent variable, namely student problem-solving skills (PSS). The study utilizes a mixed-methods approach with an explanatory design (Creswell & Clark, 2018). The research begins with a pre-test administered prior to the treatment, followed by the implementation of two distinct learning processes: online inquiry learning accompanied by e-scaffolding prompting questions and direct instruction. The treatment culminates with a post-test assessing PSS, complemented by interviews to gather qualitative insights.

Quantitative data are collected through a quasi-experimental design, specifically the nonequivalent control group design, wherein the assignment of participants to experimental and control groups is not randomized (Gall et al., 2003). The nonequivalent control group design is chosen to examine the impact of the treatment. Concurrently, the qualitative research design adopts a case study approach to provide a comprehensive understanding of the treatment's effect.

The treatment involves the implementation of the online inquiry learning model with e-scaffolding prompting questions, comprising five stages: problem identification, problem formulation, hypothesis formulation, data analysis, and conclusion drawing. The e-scaffolding prompting questions position students as active researchers engaged in independent scientific investigation activities. The process is facilitated through electronic student worksheets accompanied by scaffolding, fostering a supportive environment for students in the discovery process.

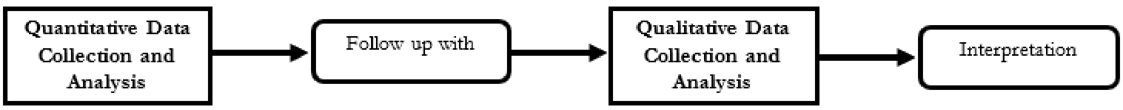

Figure 1. Flowchart of research design (Cresswel & Clark, 2018).

Table 1. Research design of the nonequivalent control group design.

Pre-test	Intervention	Post-test
O_1	X_1	O_3
O_2	X_2	O_4

Table 2. Test results of problem-solving skills questions.

Question Item No.	Validity r_{table} = 0,159	Reliability	Differentiating Power	Level of Difficulty
1	r_{count} = 0,481 (valid)	0.79 (high reliability)	DP = 0,41 (enough)	LD = 0,651 (medium)
2	r_{count} = 0,685 (valid)		DP = 0,58 (good)	LD = 0,572 (medium)
3	r_{count} = 0,638 (valid)		DP = 0,63 (good)	LD = 0,616 (medium)
4	r_{count} = 0,543 (valid)		DP = 0,51 (good)	LD = 0,627 (medium)
5	r_{count} = 0,451 (valid)		DP = 0,41 (enough)	LD = 0,632 (medium)

The research design is visually represented in Figure 1 sourced from Cresswel and Clark (2018), illustrating the overall flow of the study. Meanwhile, Table 1 represents the specific components of the quantitative research design. This study aims to contribute valuable insights into the efficacy of the online inquiry learning model with e-scaffolding prompting questions in enhancing students' problem-solving skills in the context of physics education.

The study involves four observations: O_1 is a pre-test on the experimental class group, O_2 is a pre-test on the control class group, O_3 is a post-test on problem-solving skills for the experimental class group, and O_4 is a post-test on problem-solving skills for the control class group. Additionally, there are two interventions: X_1 is online inquiry learning with e-scaffolding prompting questions for the experimental class, while X_2 is direct instruction learning for the control class.

The participants in this study were drawn from the XI MIPA class during the 2022/2023 academic year at MAN 1 Kota Kediri. A purposive sampling technique was employed to select two classes as research samples. The selection criteria were based on the impact of the intervention, as evidenced by students' PSS test results. The learning intervention spanned nine sessions over the course of eight weeks. Class XI MIPA 1 constituted the experimental group, comprising 32 students, while Class XI MIPA 2 served as the control group with an equal number of participants.

The measurement instrument employed in this study consisted of knowledge of physics concepts (KPC) test questions administered in two trials: a pre-test and a post-test. The assessment focused on students' responses to five problem-solving description questions. The analysis of these responses centered around five problem-solving indicators, namely useful description (UD), physics approach (PA), specific application of physics (SAP), mathematical procedures (MP), and logical progression (LP). These indicators were developed based on the framework proposed by Docktor et al. (2016). The item testing results are presented in Table 2, providing a comprehensive overview of the students' performance on the KPC test questions across the specified problem-solving indicators.

To assess the impact of online inquiry learning accompanied by e-scaffolding prompting questions on PSS regarding the material of work and energy, a quantitative data analysis approach was employed. The data, sourced from pre-test and post-test scores, underwent preliminary analyses, specifically normality and homogeneity tests conducted on problem-solving ability values.

The normality and homogeneity tests were applied to ensure that the data met the assumptions necessary for subsequent statistical analyses. These prerequisite tests focused on assessing the distributional normality and homogeneity of variances, respectively.

Following the prerequisite tests, a hypothesis test using the analysis of covariance (ANCOVA) was conducted. This differential test aimed to examine the differences between two class groups: one exposed to online inquiry learning accompanied by e-scaffolding prompting questions and the other engaged in direct learning. The ANCOVA test allows for the control of potential covariates, enhancing the precision of the analysis. The calculations for these tests were executed using the SPSS 24 software for Windows. The utilization of ANCOVA enables the identification of any significant differences in post-test scores between the two class groups while controlling for pre-test scores as a covariate.

RESULTS

The statistical data description provided serves to scrutinize the alterations observed in students' problem-solving skills (PSS) concerning the material on work and energy subsequent to the implementation of the online inquiry learning treatment accompanied by e-scaffolding prompting questions. The PSS pre-test consists of five questions that encompass the content of work and energy. The administration of the pre-test instrument took place prior to the commencement of the research, encompassing both the class group engaged in online inquiry learning accompanied by e-scaffolding prompting questions and the group of students undergoing direct instruction learning. The aim of the pre-test was to establish a baseline assessment of students' problem-solving skills before the intervention, facilitating the subsequent analysis of any changes or improvements resulting from the learning treatment.

Table 3. Statistical description of pre-test and post-test scores of experiment and control class group students.

Variables	Pre-test		Post-test	
	Experiment	Control	Experiment	Control
Number of students	32	32	32	32
Minimum	21	18	51	32
Maximum	62	81	94	68
Average	36.41	43.88	67.50	45.81
Standard deviation	10.19	14.40	10.62	9.12

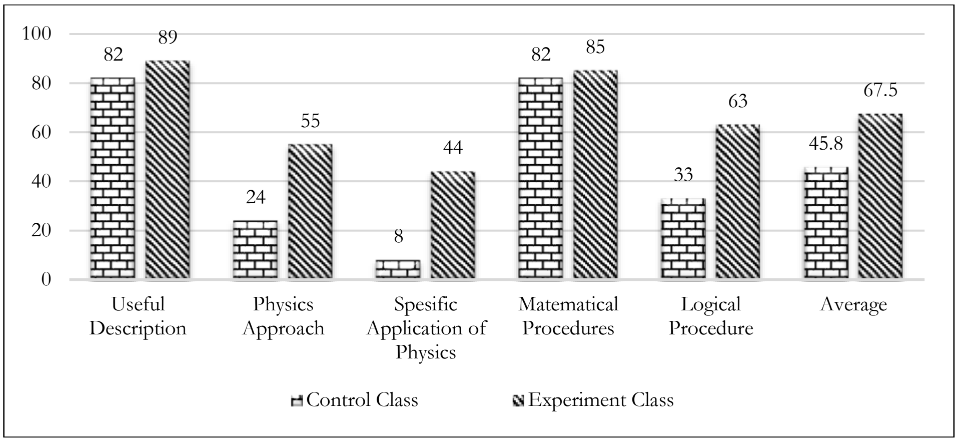

Figure 2. Process chart of problem-solving skills.

Before delving into the analysis of the pre-test scores, individual student scores were calculated by summing the scores of each student. In the experimental class, comprising 32 students, the average pre-test score was 36.41 with a standard deviation of 10.19. Conversely, in the control class, consisting of 32 students, the average pre-test score was 43.88 with a standard deviation of 14.40. Notably, there exists a discernible difference in the average initial ability pre-test scores between the control and experimental groups, with the control group exhibiting higher scores. Consequently, this discrepancy indicates that the experimental group requires intervention or treatment to address the observed disparity in initial ability levels.

The assessment of students' PSS in physics involved the utilization of an instrument comprising five items, each representing a description of the work and energy material. This test was administered subsequent to the completion of the learning process. The evaluation of students' PSS was conducted based on the stages outlined by Docktor et al. (2016), encompassing five processes: useful description, physics approach, specific application of physics, mathematical procedures, and logical progression. The results of each process of PSS were quantified and are depicted graphically, illustrating the average overall scores of students in the experimental and control classes. This graphical representation aims to provide a visual depiction of the differences in PSS processes between the two class groups, one subjected to online inquiry learning accompanied by e-scaffolding prompting questions and the other undergoing direct instruction learning.

For a more comprehensive overview, Table 3 summarizes the data description of students' PSS pre-test and post-test scores, with an ideal maximum score of 100. Table 3 offers a condensed presentation of the key findings related to students' problem-solving skills in the context of work and energy material across both experimental and control classes.

The graphical representation in Figure 2 delineates the problem-solving processes involved in students' PSS. The first step in problem-solving is the ability to identify problems (useful description - UD), wherein students collect information about known and uncertain physical quantities in a given problem. In this process, the experimental group class received a score of 89, while the control group class received a score of 88. Following problem identification, the subsequent step is planning a strategy using a physics approach (PA). Strategy planning involves the utilization of related concepts and the selection of mathematical formulas as needed. In this phase, the experimental group class scored 55, whereas the control group class scored 24. The third process in problem-solving is the application of strategies to solve problems (specific application of physics - SAP). After selecting a problem-solving strategy, students apply it to solve the problem or find the final answer. The experimental group class scored 44 in this process, while the control group class scored 8. The fourth problem-solving process involves students using mathematical procedures (MP), entailing the insertion of values into equations and performing calculations (mathematical procedures). The experimental group class scored 85, and the control group class scored 82 in this phase. The final process of problem-solving is evaluating the solution (logical procedure - LP). During this step, the answer derived from applying the strategy is reassessed for completeness and precision in addressing the posed problem. The experimental group class scored 63, whereas the control group class scored 33 in this evaluation phase. Overall, the graphical representation and corresponding scores in Figure 2 provide a comprehensive overview of the differential performance between the experimental and control groups across the distinct stages of problem-solving in the context of work and energy material.

Table 4. Summary of ANCOVA test results post-test problem solving skills.

Tests of Between-Subjects Effects
Dependent Variable: Post-test Problem Solving Skills

Source	Type III Sum of Squares	df	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	7 545.529[a]	2	3 772.765	38.021	0.000	0.555
Intercept	16 450.401	1	16 450.401	165.784	0.000	0.731
Pre-test	19.967	1	19.967	0.201	0.655	0.003
Learning Model	7 105.514	1	7 105.514	71.608	0.000	0.540
Error	6 052.908	61	99.228			
Total	219 034.000	64				
Corrected Total	13 598.437	63				

a. R Squared = .555 (Adjusted R Squared = .540)

The hypothesis testing in this study utilized the analysis of covariance (ANCOVA) test. The results of the hypothesis testing data analysis are succinctly summarized in Table 4. The results of the ANCOVA test presented in Table 4 reveal a significant difference in students' PSS regarding the material on work and energy between those who learned using an online inquiry learning model accompanied by e-scaffolding prompting questions and those who learned using a direct instruction model. The F_{count} value is reported as 71.608, with a significance level of 0.000, which is less than the commonly accepted threshold of 0.05.

The rejection of the null hypothesis (H0) and acceptance of the alternative hypothesis (H1) indicate that there is indeed a statistically significant difference in PSS between the two groups. To determine which group exhibits higher PSS, reference is made to Figure 2, where it is evident that the average PSS of the experimental class group is higher than that of the control class group. This observation aligns with the statistical finding that problem-solving skills in the experimental group, which received online inquiry learning with e-scaffolding prompting questions, are higher.

The η (eta) value in Table 4, specifically the partial eta squared, further quantifies the effect of the learning model on PSS. The coefficient value of 0.540 or 54% suggests a substantial effect, indicating that the learning model implemented in the experimental class significantly contributed to the observed differences in problem-solving skills. In essence, online inquiry learning with e-scaffolding prompting questions has a considerable impact on enhancing students' problem-solving skills in the context of work and energy material.

DISCUSSION

The outcomes of the data analysis using the analysis of covariance (ANCOVA) test reveal notable differences in students' knowledge of physics concepts (KPC) between the experimental and control classes. This finding is consistent with the assertion that computer-based scaffolding can serve as an effective intervention, leading to improved student success in problem-solving (Saman et al., 2018; Saputri & Wilujeng, 2017; Tawfik et al., 2018). Additionally, Mahtari et al. (2020) have suggested that the specific type of e-scaffolding, particularly in the form of prompting questions, can enhance students' learning outcomes and increase their knowledge.

Further distinctions become evident when examining the average scores for each process within problem-solving skills (PSS), including identifying problems (useful description - UD), planning strategies using a physics approach (PA), applying strategies to solve problems (specific application of physics - SAP), using mathematical procedures by entering values in equations and performing calculations (mathematical procedures - MP), and evaluating solutions (logical procedure - LP). In each of these PSS processes, the experimental class group consistently outperformed the control class group. This suggests that the use of online inquiry learning accompanied by e-scaffolding prompting questions not only impacts the overall problem-solving skills but also influences the proficiency in specific problem-solving processes.

The examination of student responses reveals that the experimental class group achieved a higher average score on the PSS test compared to the control class group. Students in the experimental group demonstrated a structured approach that met all PSS assessment indicators. Their problem-solving process involved providing a useful description, selecting an appropriate physics approach, applying a strategy to solve the problem, articulating mathematical procedures by inputting values into equations and performing calculations, and critically evaluating the solution, resulting in a coherent answer.

The inclusion of logical progression in the students' responses served to unveil the conceptual flow they understood while resolving the problem. The phenomena presented in the electronic student worksheet, coupled with e-scaffolding prompting questions, enabled students to establish connections between observed phenomena and physics concepts encountered during experiments. This, in turn, supported their cognitive framework in addressing problem-solving tasks. This aligns with Sambada (2012) assertion that students who actively seek relationships between concepts and natural phenomena can independently apply logical thinking in problem-solving endeavors. The study's results underscore a notable and statistically significant difference in PSS between students engaged in online inquiry learning accompanied by e-scaffolding prompting questions and those involved in direct instruction. This outcome affirms that the intervention implemented by the researcher effectively influenced students' PSS. Qualitative insights obtained through semi-structured interviews further support this conclusion.

According to the interview results, students in the experimental class exhibited superior PSS compared to their counterparts in the control class. This superiority manifested in their approach to problem-solving questions. Notably, students in the experimental group did not immediately resort to applying mathematical formulas to solve problems, instead, they focused on conceptual reasoning. Their mindset emphasized understanding that effective learning in physics, particularly in the context of work and energy, goes beyond mere memorization of formulas. Rather, it involves connecting problems with underlying concepts.

When presented with a problem, experimental group students first comprehensively read all provided information and the problem statement. Subsequently, they initiated the process of formulating solutions, checking their work, and evaluating the outcomes. These stages in the problem-solving process highlighted the students' adeptness at processing information systematically to arrive at accurate solutions.

The study's findings suggest that, beyond achieving high academic scores, students in the experimental group demonstrated their problem-solving prowess during interviews. This observation underscores the notion that students' engagement in observational activities during experiments contributes to the development and enhancement of their PSS.

The challenges faced by students in the experimental class group during the process of grasping concepts highlight the significance of e-scaffolding prompting questions as a facilitative tool that streamlines knowledge construction. E-scaffolding prompting questions are universally provided to all students, irrespective of their knowledge levels. For those who have comprehended each stage of the electronic student worksheet, they have the flexibility to bypass the e-scaffolding prompting questions related to the stages they have mastered, while still accessing them at stages where they find difficulty. Conversely, students who have not yet grasped the stages of the electronic student worksheet can utilize e-scaffolding prompting questions at each stage throughout the learning process.

The positive impact of e-scaffolding prompting questions on students is evident in their focused understanding and pursuit of learning objectives. Students with a robust understanding are better equipped to respond to questions with a more scientific approach (Aristiawan & Istiyono, 2020; Naqiyah et al., 2020). This correlation aligns with the notion that a solid understanding fosters enhanced PSS, empowering students to think critically and adeptly tackle problem-solving tasks (Dewi et al., 2019). The adaptability and tailored support provided by e-scaffolding prompting questions contribute to a more effective learning experience, accommodating students with varying levels of proficiency and ensuring a positive impact on their problem-solving abilities.

The students' problem-solving processes are inherently influenced by their level of understanding of the material concepts they encounter. A robust comprehension of the material is achieved through the active construction and discovery of knowledge. This knowledge-building process inevitably involves students making mistakes as part of the learning journey. In this context, the provision of e-scaffolding prompting questions serves as a valuable aid, directing students more effectively in their knowledge-building endeavors. This aligns with the notion that e-scaffolding prompting questions contribute to effective and interactive learning experiences (Mahtari et al., 2020).

The utilization of e-scaffolding prompting questions in this research is designed to facilitate students in building and discovering knowledge. A well-grounded acquisition of knowledge positively correlates with the enhancement of PSS. As students increase their knowledge base, they are better equipped to navigate the intricacies of problem-solving. The ability to solve problems becomes crucial for students, enabling them to connect, manipulate, and transform their knowledge, ultimately empowering them to make informed decisions in identifying problems, designing strategies, and evaluating solutions. The integration of e-scaffolding prompting questions not only aids in knowledge acquisition but also fosters the development of effective problem-solving capabilities.

The inquiry learning approach adopted in this study positioned students as active participants in the learning process, fostering greater autonomy and interaction among peers. This learner-centric approach encourages students to engage in self-directed learning, facilitating a deeper understanding of the subject matter. The knowledge acquired through individual efforts is more likely to be retained in long-term memory, contributing to a more meaningful learning experience.

The investigative aspect of the learning process involved practical experiments, complemented by electronic student worksheets that students were required to complete. These investigative activities not only supported students in comprehending phenomena based on evidence but also guided them in constructing knowledge through conceptual frameworks (Suhandi et al., 2018). The outcomes of this study align with research conducted by Hu et al. (2019) and Reddy (2020), which posit that inquiry learning can enhance students' conceptual understanding, enabling them to substantiate statements based on evidence or concepts when confronted with problem-solving tasks. This underscores the effectiveness of inquiry learning in promoting a deeper and more evidence-based comprehension of the subject matter.

Inquiry learning serves as the foundation for honing scientific explanation skills through investigative activities, allowing students to integrate insights gained from experiments with established theories, principles, and concepts (Putri et al., 2019; Wartono et al., 2019). The investigative process not only facilitates a deeper understanding but also equips students with the tools to identify solutions to problems (Ertikanto et al., 2015). The integration of e-scaffolding prompting questions plays a crucial role in guiding students to gather pertinent information necessary for identifying concepts. Consequently, students become adept at solving problems based on these conceptual frameworks and are capable of providing scientifically sound explanations for the solutions they propose. This approach aligns with research by Hsu et al. (2015), demonstrating that students can engage in independent learning effectively with the aid of scaffolding. Moreover, the findings of Yu et al. (2013) support the notion that students utilizing scaffolding exhibit enhanced learning outcomes.

The observed enhancement in problem-solving skills in this study aligns with findings from previous research on scaffolding-based inquiry learning. Studies by Raes et al. (2012) and Wang et al. (2021) have demonstrated that scaffolding interventions effectively guide students in channeling their knowledge toward improved PSS. In this study, the scaffolding took the form of electronic student worksheets, containing prompts and questions designed to steer students independently through the problem-solving process during each session. The accessibility of these electronic student worksheets without time constraints proved beneficial, enabling students to engage in problem-solving at their own pace and gradually fostering a scientific understanding of concepts. Consequently, the integration of online inquiry learning activities coupled with e-scaffolding prompting questions emerges as a valuable tool in honing students' PSS.

The observed improvement in student problem-solving skills in this study resonates with findings from other research, such as studies conducted by Mahtari et al. (2020), Raes et al. (2012), and Saputri and Wilujeng (2017). These studies have highlighted the effectiveness of inquiry-based approaches in enhancing PSS by encouraging students to critically engage with real-life problems. Widowati et al. (2017) suggest that this skill is honed through hands-on experimental activities and problem-solving experiences. In the current study, students were actively involved in each stage of the inquiry learning process, participating in investigations to uncover scientific concepts. The inclusion of e-scaffolding prompting questions in this research served as an additional resource to guide students when encountering challenges during the investigative process. This iterative and engaging activity contributed to the ongoing improvement of students' problem-solving abilities.

CONCLUSION

The primary objective of this study was to evaluate the effectiveness of online inquiry learning supported by e-scaffolding prompting questions in enhancing students' problem-solving skills (PSS). The empirical findings reveal a substantial distinction in PSS between students undergoing online inquiry learning and those exposed to traditional direct learning methodologies. The deliberate integration of e-scaffolding prompting questions into the pedagogical framework of online inquiry learning exhibits a positive and influential impact on students' problem-solving acumen. This outcome aligns with established scholarship emphasizing the pivotal role of scaffolding mechanisms in guiding students through intricate problem-solving processes. A thorough comparison of the PSS exhibited by students in the experimental cohort (engaged in online inquiry learning with e-scaffolding) and their counterparts in the control cohort (subjected to direct learning paradigms) consistently supports the assertion that the amalgamation of online inquiry learning with e-scaffolding significantly contributes to the improvement of PSS. The study advocates for the prudent application of online inquiry learning strategies, reinforced by e-scaffolding prompting questions, as a means to cultivate enhanced problem-solving proficiencies among students. Furthermore, the findings suggest the potential extension of this instructional approach to strengthen PSS across a diverse array of physics materials. Although the study is confined to the domain of work and energy material, there is a pressing need for additional scholarly inquiry. Future investigations could explore the adaptability of online inquiry learning complemented by nuanced e-scaffolding prompting questions across a more expansive spectrum of physics materials, thereby aiming for a nuanced and comprehensive understanding of its impact on students' PSS.

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AUTHOR CONTRIBUTIONS

All authors contributed to the conception and design of the study, data collection, analyze, interpretation, writing, and revision of the manuscript. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST STATEMENT

Regarding the research, writing, and publication of this paper, the authors state they have no competing interests.

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