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Influence of the IDEAL Problem-Solving Model on Students' Problem-Solving Skills

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ABSTRACT

Problem-solving ability is crucial for students to face 21st-century challenges, especially in physics education, where many concepts are abstract. Despite its importance, students' problem-solving skills in elasticity are often low due to teacher-centered approaches and insufficient use of problem-solving models. This study seeks to evaluate the impact of the IDEAL Problem-Solving model on students' problem-solving skills concerning elasticity material. The research method and design were quasi-experiments with a nonequivalent posttest-only control group design. Analysis revealed outstanding implementation of the IDEAL model, with normality and homogeneity tests supporting the sample's suitability. The t-test (α = 0.05) confirmed that the IDEAL model significantly enhanced problem-solving skills in elasticity. The findings suggest that adopting student-centered models like IDEAL can improve learning outcomes and problem-solving abilities and provide a basis for further research on similar models in other educational contexts.

Keyword: IDEAL Problem-Solving, problem-solving skills, elasticity

INTRODUCTION

Research on physics problem-solving skills has been the focus of physics education research in recent years (Susanti et al., 2021). In education, students' skills are refined through problem-solving activities that enhance their competencies (Sumartini, 2016). One of the essential competencies needed for preparing a superior generation capable of competing in the 21st century is problem-solving skills (Kurniawati et al., 2019). In addition to problem-solving, 21st-century education requires mastery of 4C skills, namely critical thinking, communication, creative thinking, and collaboration. These skills enable students to think critically and creatively, collaborate effectively, and solve complex problems, which are crucial in the 21st century (Redhana, 2019). According to Destania & Riwayati (2021) problem-solving is one of the most critical abilities in 21st-century learning and plays a vital role in the educational process. The learning paradigm of the 21st century highlights the importance of students' abilities to identify problems, think critically, and collaborate in finding solutions (Juwita & Ariani, 2020). Problem-solving skills refer to an individual's capacity to seek solutions by gathering and organizing information. Problem-solving skills and competence are essential for academic success and life skills in the modern world. Low problem-solving skills will result

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in low-quality human resources. Therefore, teachers must design learning that can train students' problem-solving skills (Cahyani & Setyawati, 2016).

According to Apriyani et al. (2019) problem-solving ability refers to the mental and intellectual process through which students link their prior knowledge to the current problem to arrive at a solution. Various methods, such as reasoning, interpreting, and evaluating, support the significance of problem-solving skills in everyday life. As a result, problem-solving has become the central focus of physics education Maulani et al. (2020). Physics learning is the process of studying nature and its symptoms, with the role of students being guided through a series of methods to acquire and then process knowledge, attitudes, and skills to achieve specific learning goals Nayazik et al. (2019). According to Setianingrum et al., (2016), students retain knowledge by using formulas and transferring it into new contexts, connecting concepts, and drawing conclusions. Problem-solving in science solves everyday problems and becomes the basis for determining the right actions and steps in the future. In the context of physics learning, problem-solving helps students develop relevant skills to solve real-world problems. In addition, this method plays a vital role in shaping students' thinking and building more profound knowledg (Abtokhi et al., 2021). Therefore, problem-solving has become an essential skill that must be developed and trained systematically to support student's needs and abilities in facing future challenges.

However, currently, students have difficulty solving physics problems given by teachers; students often use mathematical calculations and guess the formula used without doing the analysis first (Siregar et al., 2020). Students' success in solving physics problems is not only in knowing the idea of physics but also in connecting all information with the concept of the problem (Ince, 2018). Based on interviews with physics teachers and grade XI students at one of the high schools in Cicalengka, information was obtained that the teacher had linked physics with its application in everyday life but had yet to use a learning model that emphasized the problem-solving process in his learning. Current learning practices remain teacher-centered. Instruction is typically delivered through lectures presenting material, physics problems, and solutions. Students then practice independently, leading to a focus on mathematical procedures during problem-solving activities. Teachers have not emphasized the physics problem ability test with contextually identifying problems, obtaining a solution plan, implementing the solution, rechecking it, and making conclusions in a structured manner, as outlined in many modern problem-solving models (Polya, 1973; Vygotsky, 1978). This gap between theory and practice suggests a need for learning models to foster students' problem-solving skills in physics more effectively.

Information obtained from class XI students through questionnaires also revealed that the teacher played a dominant role in delivering learning material, which reduced students' enthusiasm for learning physics. Students find physics difficult and are unsure about solving physics problems thoroughly. Most students agree that their problem-solving skills need improvement. A preliminary study on students' problem-solving skills used a test instrument based on Polya (1973) problem-solving stages. The results are shown in Table 1.

The results shown in Table 1 indicate that students experienced difficulties, especially in the solution planning stage, which received the lowest average score. According to previous studies Ambrus & Barczi-Veres (2022) in the planning stage, students are often less able to identify appropriate strategies or develop a coherent plan to solve the problem. In studies involving the Polya model, for example, students frequently faced challenges expressing their ideas clearly and consistently and communicating the methods they used logically (Chacón-

Castro et al., 2023). Based on these findings, implementing a more student-centred learning approach is imperative to address the difficulties in the solution-planning stage. The IDEAL Model is one of the effective approaches to enhance students' problem-solving abilities.

Table 1. Results of a Preliminary Study of Problem-Solving Ability Tests

Indicator	Result	Category
Understanding the problem	64,76	Sufficient
Devising a plan	46,67	Poor
Carrying out the plan	56,19	Sufficient
Looking Back	63,81	Sufficient
Average	**54,76**	**Poor**

The IDEAL Problem-Solving model was introduced by Bransford & Stein (1993) as a model that enhances thinking skills and improves the problem-solving process Susiana (2018) IDEAL is an acronym consisting of the initial letters: Identify challenges and opportunities, set objectives, consider potential strategies, predict outcomes and take action, then reflect and gain insights. The third step in the IDEAL model, exploring possible strategies, allows students to think about various alternative solutions that can be implemented. This helps them in designing a better plan and evaluating the chosen strategy's effectiveness before implementation. With the implementation of the structured IDEAL syntax, students will be more guided to develop a coherent plan for the problem at hand. They will also be trained to predict the results of various strategies to make more appropriate decisions when creating a problem-solving plan. This model is very effective in improving students' critical thinking and problem-solving skills, especially in devising a plane, which proved to be a significant weakness in the results of this study.

Relevant research on the IDEAL model includes a study by Zulhendra et al. (2016) revealed the positive influence of geothermal energy-integrated Student Worksheets on improving students' physics competencies, especially in the material of work, energy, momentum, and impulse. Research by Nurhafifah et al. (2018) showed that using a worksheet Model IDEAL Problem Solving to Students' Physics Competencies in spring elasticity. Research by Nasrun & Jum (2020) demonstrated that the IDEAL can enhance students' creativity when learning about straight motion. Additionally, Nindyana et al. (2021) highlighted the development of learning tools based on the IDEAL Model aimed at improving problem-solving skills in static fluid topics.

While several prior studies, including those by Zulhendra et al. (2016) and Nurhafifah et al. (2018), have investigated the IDEAL problem-solving model within physics education, none have specifically addressed its impact on problem-solving skills related to elasticity. These studies predominantly target the enhancement of students' physics competence or creativity in areas such as work, energy, momentum, and linear motion. Consequently, there remains a limited understanding of how the IDEAL problem-solving model could specifically enhance students' skills in tackling problems involving elasticity—a critical physics concept with extensive practical applications. Thus, this study seeks to bridge this gap by examining the effect of the IDEAL problem-solving model on students' problem-solving abilities in elasticity.

METHOD

Research Design

The quasi-experiment method is used in this study. In this study, there is a control class that cannot fully control the external variables that affect the implementation of the experiment (Zarkasyi et al., 2015). Researchers cannot place research subjects in pure situations and conditions during the study because research subjects are constantly on the move, allowing the influence of other variables outside the studied variables. There are two variables: the independent variable and the dependent variable. The independent variable in this study is the IDEAL Problem-Solving learning model, while the dependent variable is Problem-Solving ability.

This research employs a nonequivalent posttest-only control group design, involving an experimental group and a control group. The experimental group receives instruction through the IDEAL model, while the control group using the Direct Instruction model. Furthermore, both classes were given a posttest to see the results.

The techniques employed for data collection in this study included observation and testing. Observations were conducted to assess the implementation of learning through the IDEAL model. The test used in this study was a descriptive test consisting of 8 questions containing indicators of problem-solving ability (Polya, 1973), which consisted of four stages. The final students' problem-solving skills score is presented as a percentage score. This percentage score will be interpreted into categories, as shown in Table 2.

Table 2. Problem-Solving Skills Assessment Qualification

Percentage	Kualifikasi
81 -100	Very good
71 - 80	Good
61 - 70	Enough
51 - 60	Less
0 - 50	Very less

Participants

The study population consisted of all 11th-grade students from the Mathematics and Natural Sciences (MIPA) program at a state senior high school in Cicalengka during the 2023/2024 academic year, totaling 254 students across seven classes. The sampling technique used was purposive sampling. When selecting the experimental and control classes, the researcher considered factors such as the number of students and the homogeneity of standard deviations. Based on these considerations, MIPA 2 was chosen as the experimental class and MIPA 3 as the control class.

Instruments

The study utilized observation sheets and tests as its instruments. During each session, the observer filled out the observation sheets, covering activities from the beginning to the end. The test evaluated students' problem-solving skills following the treatment, with the assessment conducted through a posttest in both groups. The test instrument consisted of 8 descriptive questions, each addressing the four stages of problem-solving abilities outlined by Polya (1973). The entire test instrument was deemed valid for use based on expert validation.

After the trial, seven valid questions were obtained. Furthermore, the instrument's reliability test yielded a score of 0.84, indicating high reliability.

Data Analyis

The data analysis methods encompass preliminary tests and hypothesis testing. Preliminary tests involve assessing normality and homogeneity. The normality test, conducted using the Chi-square formula, evaluates whether the samples are normally distributed. Furthermore, a homogeneity test is performed on both research samples to determine if the post-test data from the experimental and control groups have uniform variances; this test employs the Fisher test. Hypothesis testing with an independent sample t-test aims to determine differences between the mean scores of the experimental class and control class after applying the IDEAL model.

RESULTS AND DISCUSSION

Results

Implementation Data of IDEAL Model

The data on the implementation of the learning model was collected using an observation sheet filled out by three observers, using a Likert scale with a rating range of 1 to 5. The results of the IDEAL model implementation are presented in Table 3. Table 3 indicates that the IDEAL model was implemented in the experimental class with an overall average of 93.13%. Learning activities were organized into the introduction, core, and closing stages. The introductory activities reached a 90% achievement level. They were categorized as excellent, showing that all aspects of the teacher's activities were consistently carried out, including orientation, apperception, motivation, and the provision of references. Items 2 to 6 in Table 3 represent the core activities, forming the IDEAL Problem-Solving model's syntax. In each phase, all aspects of teacher activities were rated as excellent, demonstrating a cohesive application of the model's syntax.

The closing activity obtained a percentage of 71.11% in the excellent category. In this case, aspects of teacher activities, including summarizing learning activities, conveying the agenda for the next meeting, and closing learning with prayer, have been carried out but are done quickly because the learning time has run out. However, this did not significantly impact the students' problem-solving abilities, as the IDEAL model was generally implemented effectively, as evidenced by the successful execution of its stages.

Table 3. Results of the implementation of the IDEAL Problem-Solving Learning Model

Learning Activities	Percentage (%)	Catgeory
Introduction	90	Very Good
Identify Problem and Opportunities	97.75	Very Good
Define Goals	98.34	Very Good
Explore Possible Strategies	100	Very Good
Anticipate Outcomes and Act	100	Very Good
Look back and Learn	95	Very Good
Closing	71.11	Good
Average Total	**93,13**	**Very Good**

Posttest Data of Problem-Solving Ability

After implementing learning with the IDEAL problem-solving model in the experimental class and the Direct Instruction model in the control class on the elasticity material, a posttest was conducted using 7 test questions to measure students' problem-solving abilities. The results of the posttest data analysis that have been carried out are summarized in Table 4. Based on Table 4, it is evident that each class has 36 data. The ideal score if students in both classes correctly answer one question is 12, meaning that the maximum possible score for answering all questions correctly is 84. The experimental class achieved a higher average score, showing an 8.36-point difference, which suggests superior performance in problem-solving skills relative to the control class. The variance in both classes is similar; however, the control class exhibits a more significant variance than the experimental class, suggesting that the data in the control class are more varied. Additionally, the experimental class has a smaller standard deviation than the control class, suggesting that the data distribution in the experimental class is more closely clustered around the average score than in the control class.

The assessment of students' problem-solving skills is based on the percentage for each indicator. These results are presented in Table 5. The table indicates that students in the experimental class generally demonstrate stronger problem-solving abilities than those in the control group. The experimental class obtained a higher percentage on all indicators. This suggests that the learning approach applied in the experimental group is more effective at enhancing students' problem-solving skills.

After collecting post-test data from both groups, a prerequisite test was conducted: homogeneity and normality. The normality test uses the Chi-square formula. The normality test results show that both classes are normally distributed (Table 6). Homogeneity testing with the F test shows that both variances are homogeneous (Table 7). Normality testing of both groups shows that the data is normally distributed. This is based on the acquisition x^2_{count} from both groups, namely 8.48 and 3.07 which is less than x^2_{table} which is 12.8. Homogeneity testing with the F test shows that both variances are homogeneous. This is based on acquiring the value of $F_{count} < F_{table}$, namely 1,07 <1,77. The hypothesis test was carried out using an independent sample t-test. Since the data was confirmed to be normally distributed and homogenous, this test was appropriate. With a $t_{count} > t_{table}$ with a value of 6,28>1,67 then H_o was rejected and H_a was accepted. This outcome indicates that the IDEAL model has a significant impact on problem-solving skills.

Table 4. Posttest data of problem-solving Skills

Class	n	Score			Average	Variance	Standard Deviation
		Ideal	Highest	Lowest			
Experimental	36	84	82	54	69,41	54,25	7,36
Control	36		75	47	61,06	58,45	7,65

Table 5. Average Posttest Score Per Indicator of Problem-Solving Skills

Indicators	Experimental Class		Control Class	
	Percentage (%)	Catgeory	Percentage (%)	Catgeory
Understanding the problem	88,10	Very Good	77,38	Good
Devising a plan	78,57	Good	69,31	Simply

Indicators	Experimental Class		Control Class	
	Percentage (%)	Catgeory	Percentage (%)	Catgeory
Carrying out the plan	83,07	Very Good	73,94	Good
Looking back	80,82	Very Good	70,11	Good
Average	**82,64**	Very Good	**72,69**	Good

Table 6. Normality Test Results

Problem Solving Skills Score	$\chi^2_{observed}$	χ^2_{table}	Conclusion
Experimental class	8,48	12,8	Data is normally distributed
Control class	3,07	12,8	

Table 7. Homogeneity Test Results

Problem Solving Skills Score	α	$F_{observed}$	F_{table}	Conclusion
experimental and control classes	0,05	1,07	1,77	Both variances are homogeneous

Discussion

The analysis results indicate that the IDEAL Problem-Solving positively influences students' problem-solving abilities in elasticity topics. This is demonstrated by higher average post-test scores across all problem-solving indicators students taught with the IDEAL model compared to those taught with direct instruction.

The improvement in students' problem-solving skills using the IDEAL model is attributed to its effectiveness in maintaining student focus, developing conceptual understanding, and fostering active engagement with the material. This supports the findings of Purnomo & Prasetyo (2016), who noted the IDEAL model's positive effect on students' problem-solving abilities. Nindyana et al. (2021) further suggested that the IDEAL model simplifies students' comprehension and enhances their problem-solving skills. These conclusions are consistent with Susiana (2018), perspective, asserting that the IDEAL model can foster improvements in thinking and problem-solving skills.

In this study, problem-solving skills were assessed using Polya (1973) problem-solving steps, which consist of four indicators: understanding the problem, devising a plan, carrying out the plan, and looking back. Data analysis indicated that students excelled in understanding the problem, achieving a "very good" rating in this area. t this stage, students effectively analyzed the known and unknown information. The IDEAL model particularly supported students in identifying problems and opportunities, allowing them to delve into the initial materials provided in the Student Worksheet. According to Amin et al., (2015), the IDEAL can be combined with cooperative learning, where students work in groups to explore the right solution.

Next, the teacher presents everyday problems relevant to the material being studied, such as problems with tension, strain, and modulus of elasticity on fishing lines that break easily. The teacher also discusses issues related to Hooke's law and spring arrangements, such as the comfort of riding a motorbike, which is associated with the number and arrangement of shock absorbers. In this activity, students are focused on understanding and identifying the problems presented by the teacher. The question-and-answer interaction between the teacher and students helps deepen their understanding. Most students actively answer the teacher's questions about identifying problems they must solve. This contributes to achieving the outstanding category in understanding the problem. This finding is in line with the research of Sofia et al., (2021), which shows that all subjects in their study were able to understand the problem and collect relevant information.

The devising a plan indicator in this study is in a good category. Students can find the relationship between known and asked data at this stage and formulate a solution plan by mentioning the right concepts and equations. Students' abilities at this stage are facilitated by the steps defined goals stage. Students are focused on observing the variables in the problem and determining the goals of solving the problem. Students actively express their opinions, producing various goals for solving. Teacher guidance is needed to help students choose the most relevant goals at this stage. According to Sofia et al. (2021), differences in determining goals can lead students to explore different problem-solving strategies. Therefore, teacher guidance is crucial so that students have the same goal agreement in solving the problems given.

This aligns with Wahyu Indriyani & Masriyah (2016) findings, which show that the IDEAL model can train students to express ideas and interact with friends and teachers. As a result, the planning indicator is in a suitable category, although the percentage is still the lowest compared to other indicators. One of the reasons is that students cannot determine the most appropriate goals to solve problems. From the posttest answers, some students are still less than optimal in writing concepts entirely in the experimental class. However, they tend to be able to write mathematical equations correctly. More detailed teacher guidance is needed to explain learning materials and help students understand concepts more deeply to improve the planning indicator for the verry good category. In line with Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher (2020), teachers act as facilitators who help students overcome challenges in active learning and problem-solving through appropriate interventions at the right time.

The carrying out the plan indicator in this study is in the outstanding category. Students can carry out the solution plan and check each step at this stage. Students' abilities at this stage are facilitated by two steps in the syntax of the IDEAL model, namely exploring possible strategies and anticipating outcomes and acting. Students are directed to explore various problem-solving strategies at the exploring possible strategies stage. Each group is given 10 minutes to discuss and write down three alternative solutions related to the given problem, such as why fishing lines break easily due to the weight of the fish being too large. The teacher plays a role in guiding, monitoring group discussions, and evaluating each strategy proposed. When the discussion process takes place, differences in strategies between groups of students emerge, triggering deeper discussions within the group.

In line with the findings of Nurhafifah et al. (2018), students at this stage can develop critical thinking skills to solve problems. They build an understanding of the concepts of cross-sectional area and tension, as shown in the use of the words "big" or "small" for strings and the "strength" of strings, which begin to approach the fundamental physics concept. Next, students are directed to determine one alternative solution through practical activities at the anticipated outcomes and act stage.

At the anticipated outcomes and act stage, students implement the chosen strategy by predicting the results to be obtained so that the resulting solution is the purpose of solving the problem. Dwianjani & Candiasa (2018) stated that this stage continues the previous step, where students apply the chosen strategy to find the right solution. For example, in the problem of a fishing line that breaks easily, students are asked to experiment to analyze the effect of cross-sectional area on tension using simple tools and materials, such as styrofoam, mask strings, objects of different masses, pins, and meters. The experimental procedure involves alternating hanging objects with the same mass on one and two mask strings to observe the tension and strain on the string.

The masked string is analogous to a fishing line, while the object being hung is analogous to a fish. All students are active and responsible for their respective tasks so that the experiments and questions in the worksheet can be completed properly. These two steps, namely exploring possible strategies, anticipating outcomes, and acting, contributed to the excellent results in the indicator of implementing plans in the experimental class. In line with Gijlers & De Jong (2005), it is shown that practical activities and group discussions help students apply their knowledge to solve problems.

The Looking Back indicator is in the outstanding category. Students are able to review their problem-solving process, draw conclusions, and present their findings to the class. Students' abilities at this stage are facilitated by the step Look Back and Learn. At this stage, students evaluate whether the previously set goals are based on the results obtained. Additionally, they are encouraged to summarize the results of the experiments they conducted.

In the problem related to fishing lines that break easily, students conclude that when an object with a different cross-sectional area is given a force, the object will experience different tensions. Objects with a smaller cross-sectional area will experience more significant stress than larger ones. Therefore, the most appropriate strategy to overcome the problem of fishing lines that break easily is to double the fishing lines so that the tension becomes smaller. Students successfully identified and presented the most appropriate problem-solving strategy using their language, demonstrating a deep understanding.

The student's success in this stage shows that applying the IDEAL model effectively improves problem-solving skills in physics learning for class XI MIPA students at SMA Negeri Cicalengka. This can also be seen from the average post-test score of students who used the IDEAL problem-solving model, which was higher than that of students who used the Direct Instruction model.

This finding aligns with Prasetya et al. (2012), that applying the IDEAL model positively influenced problem-solving in the experimental group. Furthermore, the study by Purnomo et al. (2014) demonstrated that applying the IDEAL model positively influenced problem-solving in the experimental group. Furthermore, Siswanto et al. (2013) found that learning through the IDEAL model positively affected students' problem-solving.

Several obstacles are faced in the study of the IDEAL Problem-Solving learning model. First, students tend to be accustomed to traditional learning methods, so they are unfamiliar with the problem-solving approach (Dabbagh & Kitsantas, 2012). Second, variations in student abilities can affect their understanding of the material. This can be seen from the still good value at the devising plan stage, which shows the need for the role of teachers in improving students' problem-solving abilities. In addition, time constraints in implementing each step of the model can hinder the depth of students' understanding. Inadequate learning resources, such as the unavailability of projectors in the classroom, are also obstacles; as Osei-Himah & Adu-Gyamfi (2022) stated, supporting facilities such as technology are very important for the effectiveness of science teaching in schools.

The hope for future research related to the IDEAL Problem-Solving learning model includes several essential aspects. First, it is hoped that learning methods more readily accepted by students accustomed to traditional learning will be developed. Research also needs to focus on strategies to overcome variations in student abilities by creating better assessment instruments. In addition, effective time management for each step of the model is needed so that student understanding is not hampered. The availability of adequate educational resources must be further studied to improve learning effectiveness. Furthermore, collaboration between researchers and academic practitioners to apply research findings into daily practice. With that hope, future research can significantly enhance student problem-solving skills.

CONCLUSION

Based on the problem statement, proposed hypothesis, and results from data analysis and hypothesis testing, it can be concluded that the IDEAL Problem-Solving has a significant impact on enhancing problem-solving skills in elasticity material for Grade XI MIPA students at a State Senior High School in Cicalengka during the 2023/2024 academic year. This study emphasizes the positive effect of implementing this model, though it did not directly measure improvements in student capabilities. Thus, the IDEAL Problem-Solving can serve as an alternative approach in physics education, helping students to build their problem-solving abilities. These results highlight the importance of implementing effective learning methods to meet educational goals.

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