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Profile of E-STATPHYS Assisted PBL Model on Static Fluid Material to Improve Problem-Solving Skills of High School Students

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ABSTRACT

Objective: *This study aims to analyze the problem-solving skills of high school students as a basis for considering the application of the Problem Based Learning (PBL) model assisted by the E-STATPHYS digital book on static fluid material.* ***Method:*** *This study used a qualitative descriptive method with 105 grade XI students at SMA Negeri 1 Kedungpring as subjects. Data collection techniques included a preliminary survey in the form of a problem-solving skills test, student response questionnaires, and interviews with physics teachers. Data were analyzed to identify the level of students problem-solving skills.* ***Results:*** *The results showed that 98 students were in the low problem-solving skills category, 7 students were in the medium category, and there were no students in the high category. These findings indicate that students problem-solving skills on static fluid material still need to be significantly improved.* ***Novelty:*** *The novelty of this study lies in the use of the results of the initial analysis of problem-solving skills as a basis for the development and application of the Problem Based Learning model assisted by the E-STATPHYS digital book, which is specifically designed to support physics learning on static fluid material and facilitate the improvement of students problem-solving skills.*

INTRODUCTION

Education is a vital part of human life because it plays a role in developing individual potential through planned guidance, teaching, and training. Education aims to help students develop thinking skills, creativity, and the skills needed to face life's challenges (Trianto, 2010; Khorchani et al., 2019; Yelavarthi, 2022). The learning process will be able to develop quality human resources if teachers are able to choose appropriate strategies, approaches, and learning models according to the characteristics of the material and learning objectives (Pratiwi et al., 2020; Fakhrini et al., 2024; Lestari et al., 2024; Maula et al., 2025). In this regard, teachers have a central role in facilitating active learning that can optimize the full potential of students.

With the rapid development of information and communication technology, learning at both school and university levels is required to continuously innovate to remain relevant to the demands of 21st-century competencies (Anwar et al., 2022; Riskasari et al., 2022; Kumar, 2023; Prihantini et al., 2023; Budiarto et al., 2024). One important competency that must be developed in physics learning is problem-solving skills. In static fluid topics, such as hydrostatic pressure, buoyancy, Archimedes' principle, and Pascal's principle, students are not simply required to memorize formulas; they must also be able to analyze physical phenomena and apply concepts appropriately in various new situations (Rizal et al., 2020). The development of these problem-solving skills aligns with one of the Sustainable Development Goals (SDGs) issues, namely quality education, where one of the main quality aspects is the mastery of 21st-century skills, particularly problem-solving skills (Miriam et al., 2023). Therefore, a learning approach is needed that can facilitate students to actively build knowledge through solving contextual problems close to everyday life. Contextually designed and problem-oriented physics learning not only helps students understand static fluid concepts more deeply but also trains critical, analytical, and systematic thinking skills. Thus, the learning process focuses not only on achieving cognitive learning outcomes but also contributes to improving the quality of education, as emphasized in the SDGs, particularly in the development of sustainable 21st-century skills.

According to Heller, Keith, and Anderson (1992), problem-solving in physics involves five main stages: visualizing the problem, describing the physics, planning a solution, executing the plan, and checking and evaluating. A learning model that aligns with these stages is Problem-Based Learning (PBL). In PBL, students are confronted with contextual problems as triggers for knowledge construction, working collaboratively to analyze, design solutions, implement strategies, and evaluate the results (Sudarsono et al., 2021). This effectively improves critical thinking and problem-solving skills compared to traditional learning (Marlina & Irawan, 2022).

In line with the digital transformation of education, digital books or digital modules (e-books) have become a highly potential medium for use in physics learning. They facilitate the integration of multimedia such as animations, experimental videos, and interactive simulations, and enable flexible and independent learning (Nastiti et al., 2023). In static fluids, interactive visualizations can help students understand abstract concepts, such as changes in pressure with depth and buoyancy under various conditions (Rahmawati et al., 2022).

Digital textbooks are not only passive learning resources but can also support the entire problem-solving process, from problem identification and concept exploration to solution evaluation (Ketut et al., 2023; Wulandari et al., 2023; Barlow et al., 2024; Tan, 2024). Therefore, implementing a PBL model assisted by digital textbooks is an appropriate learning alternative for improving physics problem-solving skills, particularly in static fluids (Yuliani et al., 2020).

Despite its many advantages, the implementation of this model still faces several challenges, such as students' initial readiness in mastering basic concepts, the design quality and accessibility of digital textbooks, and teachers' ability to optimally facilitate the PBL process (Astuti et al., 2022). Therefore, the implementation of PBL assisted by digital textbooks needs to be carefully designed to improve students' conceptual understanding and problem-solving abilities comprehensively. Based on this description, the purpose of this study is to analyze high school students' physics problem-solving skills as a basis or reference for implementing the problem-based learning model assisted by digital textbooks (E-STATPHYS) on static fluid material. This problem-based learning model assisted by E-StatPhys is expected to improve students' problem-solving skills.

RESEARCH METHOD

This study uses a qualitative descriptive analysis method. This is because the researcher analyzes by describing the data obtained from the subjects studied so that conclusions can be drawn (Nababa 2022). Data obtained from research respondents will be categorized into three groups: low, medium, and high. The results of this study can be used as consideration for models and learning environments that can improve high school students' problem-solving abilities. This research was conducted in a public school in Lamongan Regency consisting of 3 classes; 1 class consists of 33 students and 2 classes consist of 36 students each class. Thus, the number of subjects in this study was 105 students. The instruments used to obtain data were (1) problem-based essay questions consisting of 5 indicators: visualizing problems, describing problems into physics concepts, planning solutions, using solutions, evaluating solutions (Heller, 1992). (2) Student response questionnaires, (3) Teacher interview sheets. All instruments used in this study have been validated by experts. The essay questions given to students have been validated by 3 validators and have been revised according to suggestions. The selection of essay questions was based on real-life problems they might encounter in their daily lives. Questionnaires and interviews administered to students and teachers aimed to determine the learning conditions in the classroom, the effectiveness of the learning models and media used in the classroom, and the student atmosphere and motivation in learning physics, which could influence their problem-solving skills. The analysis method used was descriptive qualitative. Researchers were able to determine the factual situation regarding the problem-solving skills of high school students through test results, questionnaires, and interviews with teachers. The following are the research stages used in Figure 1.

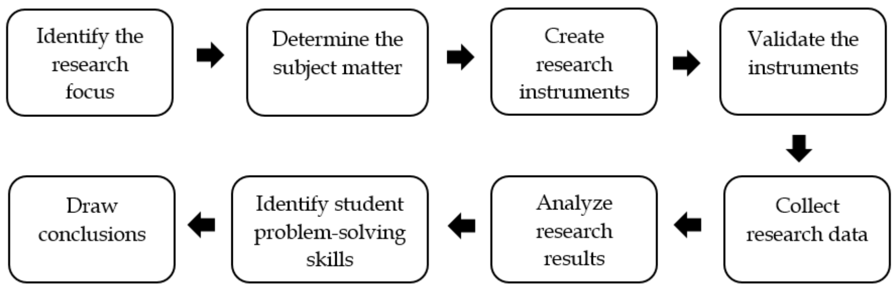


Figure 1. Method

RESULTS AND DISCUSSION

Results

Students problem-solving skills in static fluid material

Problem-solving skills are an important aspect of physics learning, as they encourage students to deeply understand concepts and apply them to various real-world situations. In this study, students were given five essay questions to test their physics problem-solving skills on static fluids. Students were expected to be able to visualize, describe problems in terms of physics concepts, plan, use, and evaluate solutions to the given problems. After conducting the study, the results of physics problem-solving skills on static fluids are shown in Figure 2.

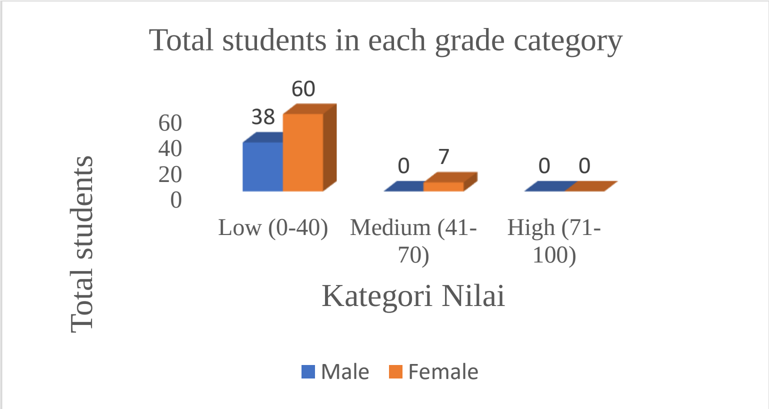


Figure 2. Level of problem solving skills of male and female students

Figure 2 shows the problem-solving skills of male and female students. There were 38 male students and 60 female students in the low category, while in the medium category, there were only 7 female students, and no male or female students reached the high category. Overall, these results indicate that students' problem-solving skills are still relatively low, because most students have not been able to apply physics concepts systematically in solving problem-solving problems. This condition indicates that students still have difficulty understanding the concept of static fluids that require analytical skills, mathematical representation, and the application of physics principles in real situations. Therefore, more interactive and contextual learning strategies are needed to improve students' higher-order thinking skills. One solution that can be implemented is the use of digital books as a learning medium, which is expected to increase student engagement, strengthen conceptual understanding, and develop problem-solving skills more effectively in physics learning.

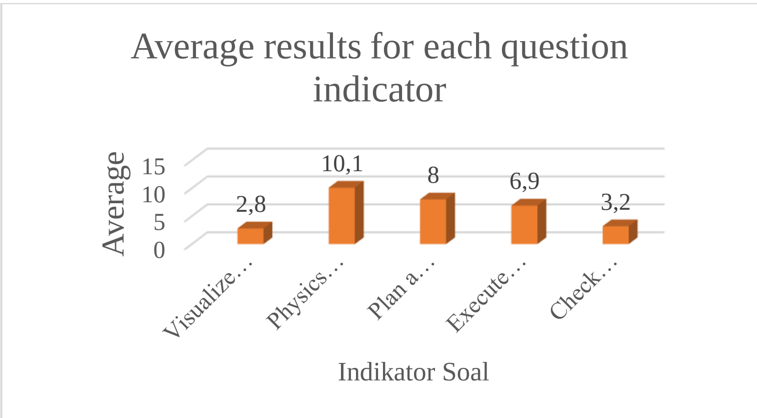
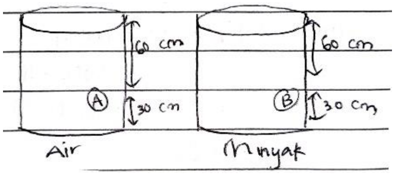


Figure 3. Average student score on each indicator

Figure 3 shows that most students are still weak in the initial and final stages of the problem-solving process. Difficulty in conceptually understanding problems and a lack of ability to evaluate results indicate that students' problem-solving skills have not fully developed at each stage.

The following is an analysis of student responses for each problem-solving skill indicator.

1. *Visualize the problem,* In this indicator, students are asked to visualize the problem in the form of a picture, rewrite the question, and identify concepts and principles that correspond to the problem concept in the question.



2. *Physics description,* In this indicator, students are asked to write down known and unknown variables using physics symbols and also write down the variables in question.

$P_{hA} = \rho_{air} \cdot g \cdot h$	$P_{hB} = \rho_{minyak} \cdot g \cdot h$

3. *Plan a solution,* In this indicator, students are asked to identify physics concepts and principles into an equation correctly and apply the principles systematically into the form of an equation correctly.

$P_{hA} = \rho_{air} \cdot g \cdot h$	$P_{hB} = \rho_{minyak} \cdot g \cdot h$
$= 1000 \cdot 10 \cdot 0{,}3$	$= 800 \cdot 10 \cdot 0{,}3$
$= 3000$ Pa	$= 2400$ Pa

4. *Execute the plan,* In this indicator, students are asked to substitute the values of the variables into the physics equation correctly.

$P_{hA} = \rho_{air} \cdot g \cdot h$	$P_{hB} = \rho_{minyak} \cdot g \cdot h$
$= 1000 \cdot 10 \cdot 0{,}3$	$= 800 \cdot 10 \cdot 0{,}3$
$= 3000$ Pa	$= 2400$ Pa

5. *Check and evaluate,* In this indicator, students are asked to check the answer to see whether the solution is complete and correct, the answer is correct and whether the answer is a logical answer.

Karena 3000 Pa $>$ 2400 Pa. maka tekanan hidrostatis
pada bola A lebih besar daripada tekanan hidrostatis pada
bola B. Alasannya adalah karena tekanan hidrostatis dipenga-
ruhi oleh massa jenis fluida, percepatan gravitasi, dan kedalaman.

Student response questionnaire results

The student response questionnaire in this study aims to explore students' responses regarding their ability to solve physics problem-solving skills, obstacles experienced during learning, methods applied by teachers, and their responses to the use of digital media such as digital books (E-STATPHYS). This instrument contains ten statements related to problem-solving skills and learning activities in the classroom. The assessment scale used consists of four categories: Strongly Disagree (STS), Disagree (TS), Agree (S), and Strongly Agree (SS). The results of the questionnaire responses by 105 students are shown in Table 1 below.

Table 1. Results of student response questionnaire

Statement	Answers (105 students)			
	Strongly Disagree	Don't agree	Agree	Strongly agree
I feel that physics is a difficult subject to understand.	19% (20)	54.3% (57)	25.7% (27)	1 (1%)
I like it when teachers connect physics material with everyday life.	1.9% (2)	7.6% (8)	48.6% (51)	41.9% (44)
I am used to looking for solutions to problems given by teachers.	3.8% (4)	25.7% (27)	60% (63)	10.5% (11)
I feel less confident when I have to answer physics questions in class.	10.5% (11)	31.4% (33)	44.8% (47)	13.3% (14)
During learning. I often listen rather than actively participate.	10.5% (11)	36.2% (38)	41.9% (44)	11.4% (12)
I am more active in group learning activities.	9.5% (10)	29.5% (31)	47.6% (50)	13.3% (14)
Problem-based learning trains my ability in physics problem-solving skills.	1% (1)	18.1% (19)	59% (62)	21.9% (23)
The learning media used in physics is still limited to printed books or blackboards.	10.5% (11)	41% (43)	42.9% (45)	5.7% (6)
I rarely use technology or digital resources in physics learning in class.	16.2% (17)	52% (55)	29.5% (31)	1.9% (2)
I feel more motivated to learn physics if I use digital media (digital books)	7.6% (8)	16.2% (17)	50.5% (53)	25.7% (27)

Based on Table 1. the questionnaire results indicate that students have a positive perception of physics. Most students do not consider physics difficult. Teachers are also considered capable of linking static fluids material to everyday life. which aligns with the characteristics of Problem-Based Learning (PBL) in presenting contextual problems to facilitate student understanding of concepts. However. student learning independence still needs to be improved because not all are accustomed to seeking additional learning resources. Self-confidence in asking questions is also still low. indicating that students still feel hesitant to participate actively. Learning still tends to be teacher-dominated. so efforts to implement more student-centered learning must be continuously strengthened. Furthermore. the majority of students feel that the implementation of PBL can improve conceptual understanding and problem-solving skills. PBL is considered to make a positive contribution to physics learning objectives. particularly in static fluids material. However. the use of technology in the classroom is still minimal and learning media still focus on printed textbooks. However. students show very high interest in digital learning media such as e-books. The implementation of PBL is considered appropriate and provides benefits for students. especially in improving problem-solving skills with support in the form of more optimal use of digital media to make learning more interesting. interactive. and in line with the needs of today's technological developments.

Teacher interview results

This study. in addition to providing students with test instruments and a response questionnaire. also involved interviews with teachers regarding the implementation of Physics learning in schools. Based on teacher interviews. information was obtained regarding the physics learning process currently being implemented. indicating that the strategies and methods used include direct instruction. problem-based learning. discussions. and lectures. Students consider physics learning to be difficult but still engaging. as the material covered is quite extensive and requires a deep understanding of concepts. In practice. students' attention spans generally only last about 10–15 minutes. after which some students begin to feel bored and distracted. although some still pay attention to the teacher's explanation. To increase student interest and attention. teachers typically divide the learning time into 15 minutes of instruction and 25 minutes of independent practice. The questions given are generally descriptive. sometimes conceptual. but this often results in low student grades. Teachers also frequently relate questions to everyday life phenomena. although specific problem-solving skills measurements have not been conducted routinely. but rather more of a habit-forming approach. Some obstacles faced by students in solving problem-solving questions include difficulty understanding concepts. connecting prerequisite concepts. converting units. performing calculations. and transferring concepts into mathematical formulas. Teachers believe that problem-solving skills are crucial because they are survival skills that every individual should possess. Therefore. the learning models deemed most appropriate for developing these skills are Problem-Based Learning and Project-Based Learning. However. teachers have not yet utilized digital technology as a learning medium because they believe students' motor skills are still low. The most frequently used learning medium so far has been teacher notes written on the board.

Table 2. Article review

Writer	Research Purposes	Research Design	Research Result
Siregar. Sirait & Audina (2022) 9	Systematically examine the influence of the Problem-Based Learning (PBL) learning model on students' physics problem-solving abilities. especially in fluid material.	The research used a meta-analysis method by collecting 10 relevant articles regarding PBL on fluid material. then analyzed to determine the effect of the model on students' problem-solving abilities.	The results of the study showed that the implementation of PBL had a positive influence on students' physics problem-solving abilities. Students taught using PBL showed improved critical thinking and analytical skills compared to conventional methods.
Annisa & Haryadi (2023)	To examine the influence of the PBL learning model on students' problem-solving abilities in static fluid material through	A meta-analysis was conducted on four research articles discussing the application of PBL to static fluids. The analysis	The results showed a positive impact of PBL. Students experienced improved problem-solving skills in a systematic and structured manner. This

Writer	Research Purposes	Research Design	Research Result
	the synthesis of previous research data.	was conducted to assess the influence of the PBL model on students' problem-solving abilities.	study confirms that PBL is effective in improving problem-solving skills in static fluids.
Yusal. Nurazmi & Harnipa (2023)	To determine whether the application of the PBL model can improve students' problem-solving abilities in static fluid material. and to assess the differences before and after application.	A pre-experimental study using a one-group pretest–posttest design. The sample consisted of 33 high school students. The instrument was a descriptive test to assess problem-solving abilities before and after the implementation of PBL.	The average problem-solving ability score increased significantly from 59.81 (pretest) to 194.15 (posttest). Statistical analysis using the t-test showed $p < 0.05$. indicating a significant improvement. PBL effectively helps students think critically and solve static fluid problems more systematically.
Silvia Wulandari & Nana (2021) 7	Describes the results of a literature study on the use of video-based PBL learning models to improve students' problem-solving abilities in the concept of static fluids.	Literature study type research (library research): reviewing previous literature regarding video-based PBL.	The results showed that the implementation of video-based PBL successfully improved problem-solving skills both individually and in groups. Video. as an initial stimulus. motivated and engaged students in physics learning.
Mila Candra Pristianti & Binar Kurnia Prahani (2022) 13	Analyzing the profile of students' physics problem-solving skills as a consideration for implementing a website-based PBL model on the kinetic theory of gases material.	Qualitative descriptive. subjects 162 high school students of grade XI (purposive sampling). problem-solving ability test instruments (ACCES indicators). student questionnaires. teacher interviews.	It was found that 159 students were in the low category and only 3 students were in the medium category; on average. students only answered the indicator "E Execute the solution". The author concluded that students tend to memorize formulas. are not yet accustomed to problem-solving strategies; the website-based PBL model can be applied for improvement.
N. A. Qotrunnada & Binar Kurnia Prahani (2022) 18	To determine the profile of the PBL model assisted by digital books in improving the problem-solving abilities of high school students in the material of fluid dynamics.	Profile analysis and application of PBL model assisted by digital books; high school students as subjects. fluid dynamics material; problem-solving test instruments (example: 5 questions on fluid dynamics material) and questionnaires.	The results show that the digital book-assisted PBL model is effective in improving problem-solving skills in fluid dynamics material — students showed improvements in problem-solving indicators related to fluid dynamics.

Writer	Research Purposes	Research Design	Research Result
Junika Purnama . Nehru N.. Febri Berthalita Pujaningsih & Cicyn Riantoni (2021) 14	Reviewing the literature on the Problem Based Learning (PBL) model on students' problem-solving abilities.	Literature study/library research — collecting related books & journals and then analyzing them qualitatively.	It was found that the PBL model is very good for use in physics learning and has been proven to be able to improve students' problem-solving abilities.
O. Jumar Rachmawati. Binar Kurnia Prahani & H. Mubarok (2022) 17	Describes the profile of students' physics problem-solving abilities and the application of the Quizizz based Team Games Tournament (QTGT) method in physics learning.	Descriptive profile + application of QTGT method; physics student subject; problem solving ability test instrument.	The results show that there is a certain profile in students' problem-solving abilities and that the QTGT method in physics learning has an influence on these abilities.
Asni Nuningsih. Muh. Nasir & Olahairullah (2022) 21	To find out how effective the PBL learning model is in improving the problem-solving abilities of class VII students at SMP Negeri 2 Wera.	Classroom action research (CAR) with two cycles; subjects: 28 students; instrument: problem-solving ability test.	There was an increase in each aspect of problem solving from cycle I to cycle II: understanding the problem rose from ~71.42% to ~76.19%; planned settlement increases from ~60.71% to ~75.00%; executed settlement rose from ~58.33% to ~60.71%; rechecking/drawing conclusions rose from ~50.00% to ~57.14%.
Hasan Nuurul Hidaayatullaah & Dwikoranto (2019) 28	Describe the implementation of PBL learning model and assess how well the learning is implemented in high school physics classes.	Pre-experiment with one group pretest posttest design in one experimental class and two replication classes; instrument: learning implementation observation sheet.	Physics learning with the PBL model was implemented very well. with the implementation percentages: 88.47% for the experimental class; 85.80% and 87.43% for the replication class.
I. Ripai & Nana Sutarna (2019) 20	Analyzing students' problem-solving abilities using the PBL learning model.	Proceedings-based study: "Analysis of problem-solving abilities in elementary school students using the PBL model".	It was found that the implementation of the PBL model provided a positive impact on problem-solving abilities—although the level of student participation or readiness still varied.

Writer	Research Purposes	Research Design	Research Result
Handayani. E.. & Simamora. P. (2019) 29	To determine the influence of the Discovery Learning model assisted by PhET simulation media on students' problem-solving abilities in fluid dynamics material.	Quasi-experimental with pretest-posttest control group design; high school students as subjects; problem-solving test instrument.	The results show that the PhET-assisted Discovery Learning model significantly improves students' problem-solving abilities in fluid dynamics material compared to the control group.
Elcane. D. C. O.. Johan. H.. & Mayub. A. (2022) 30	Analyzing the need for developing AR-based learning units to improve students' problem-solving skills related to global warming.	Research & Development (R&D) research needs analysis stage; teachers and students as respondents; questionnaire and interview instruments.	The results indicate a high need for the development of AR-based learning units; students need visualization and interactivity to improve problem-solving skills.
Asuri. A. R.. Suhermann. A.. & D. D. R. (2021) 33	To determine the effectiveness of PBL assisted by mind mapping in improving students' problem-solving abilities in the material of work and energy.	Classroom action research (CAR) with cycles; problem-solving test instruments and observation of the learning process.	The application of PBL assisted by mind mapping improves students' problem solving abilities. both in the aspects of understanding problems. planning solutions. implementing solutions. and drawing conclusions.
H. V.. Rizki. I. A. Alfarizy. Y.. Saputri. A. D.. Ramadani. R.. & Suprapto. N. (2022) 10	Examining the profile of students' critical thinking abilities in physics learning and the initial influence of AR integrated game applications on these abilities.	Preliminary study/ student profile survey; using critical thinking skills data and initial observations of game + AR applications	The results show that most students are still at a low level of critical thinking skills; the use of games + AR can support the development of students' critical thinking.
B. K. Prahani. I. A. Rizki. K. Nisa. N. F. Citra. H. Z. Alhusni. & F. C. Wibowo (2022) 23	Applying an online PBL model assisted by 3D animated digital books to improve students' problem solving abilities on magnetic field material	Quasi-experimental non-equivalent control group; subjects: high school students; instruments: pre-test & post-test problem-solving questions. student response questionnaire	The OPBL model assisted by animated 3D digital books has been proven valid. reliable. and effective in improving problem-solving skills; students' responses have been positive.
Mashurin A. H..	Applying an online PBL model assisted by 3D	Quasi-experimental non-equivalent control group;	The OPBL model assisted by animated 3D digital books

Writer	Research Purposes	Research Design	Research Result
H. Mubarok . & B. K. Prahani (2022) 24	animated digital books to improve students' problem solving abilities on magnetic field material	subjects: high school students; instruments: pre-test & post-test problem-solving questions. student response questionnaire	has been proven valid. reliable. and effective in improving problem-solving skills; students' responses have been positive.
K. A. Arzak & B. K. Prahani (2023)	Knowing the profile of students' problem-solving abilities on elasticity material and the application of the PBL model assisted by AR books	Profile research design + implementation of AR-assisted PBL; high school students as subjects. instruments: problem-solving ability test and learning observation	PBL assisted by AR books effectively improves students' problem-solving abilities on elasticity material; students show significant improvements in problem-solving indicators.

Discussion

Students' problem-solving skills in static fluid material

The results of this study indicate that students' problem-solving skills in static fluid material are still low. Most students are unable to systematically apply physics concepts to solve the problems presented. This is evident from the distribution of student ability categories in Figure 2, where the majority of students fall into the low category, with no students reaching the high category. This condition indicates that students still struggle to deeply understand static fluid concepts, particularly in linking physics concepts to mathematical representations and their application in real-world situations. This low problem-solving ability may also be influenced by a learning approach that focuses on theoretical delivery. Students tend to memorize formulas without understanding the underlying concepts, thus experiencing difficulties when faced with problems that require analysis and reasoning. This finding aligns with research conducted by Prahani et al. (2022), which showed that most students still fall into the low category in problem-solving skills because they are not accustomed to using systematic problem-solving strategies.

Furthermore, the results also indicate that students experience difficulties in the initial and final stages of the problem-solving process. In the initial stage, students were unable to conceptually understand the problem, while in the final stage, students still struggled to evaluate the solutions obtained. This condition indicates that students' problem-solving thinking processes have not fully developed at each stage of problem-solving.

Analysis of problem-solving skill indicators

Based on the analysis of each problem-solving skill indicator, it was found that students' abilities at each stage have not yet developed optimally. In the "visualize the problem" indicator, students were asked to visualize the problem in the form of a picture, rewrite the problem, and identify relevant physics concepts. However, most students still had difficulty identifying the main concepts relevant to the given problem. In the "physics description" indicator, students were asked to write the known variables and the variables being questioned using physics symbols. The results showed that some students were still unfamiliar with using physics symbols correctly, resulting in frequent errors in describing variables related to the problem. In the "plan a solution" indicator, students were asked to determine the appropriate physics concepts and principles and plan a solution to the problem using appropriate physics equations. This stage is quite challenging for students because it requires a good conceptual understanding and the ability to connect concepts to mathematical equations.

In the "execute the plan" indicator, students are asked to substitute variable values into a predetermined physics equation. While some students performed this step well, others still made errors in calculations and unit conversions. In the "check and evaluate" indicator, students are asked to double-check their solutions and evaluate whether the resulting answers are logical and align with physics concepts. This is the stage that is least frequently performed by students, as most students stop immediately after obtaining a numerical answer without double-checking their results.

Student response questionnaire results

The questionnaire results indicate that most students have a fairly positive perception of physics learning. Most students stated that they enjoy learning that connects physics concepts to everyday phenomena. This indicates that a contextual learning approach can help students better understand physics concepts. However, the questionnaire results also indicate that students' confidence in answering physics questions is still relatively low. Many students feel hesitant to express their opinions or answer questions in class. This situation indicates that learning still tends to be teacher-centered, so active student participation in the learning process still needs to be improved.

Furthermore, the questionnaire results also showed that the use of technology in physics learning remains relatively low. The learning media used mostly consist of printed textbooks or teacher explanations on the blackboard. Yet, most students stated that they feel more motivated to learn physics when using digital learning media.

Teacher interview results

Interviews with teachers indicate that physics learning in schools still utilizes various methods such as lectures, discussions, hands-on learning, and problem-based learning. However, teachers stated that students often experience difficulty understanding abstract physics concepts. Teachers also reported that students' attention spans typically only last about 10 to 15 minutes before waning. To address this, teachers typically divide the learning time into short explanation sessions followed by independent practice problems. Some of the obstacles students face in solving problem-solving problems include difficulty understanding basic concepts, connecting prerequisite concepts, converting units, and translating physics concepts into mathematical equations. This situation indicates that students still need more intensive practice to develop problem-solving skills.

Teachers also stated that problem-solving skills are essential for every individual because they are related to the ability to face various problems in everyday life. Therefore, learning models such as Problem-Based Learning and Project-Based Learning are considered appropriate approaches to developing these skills. However, the use of digital technology in physics learning is still suboptimal. The most frequently used media by teachers is still notes written on the whiteboard. This indicates that there is still opportunity to integrate digital technology in physics learning to improve the quality of the teaching and learning process.

Article review

Based on a review of several previous studies presented in Table 2, various studies have shown that the application of the Problem-Based Learning (PBL) model has a positive impact on improving students' problem-solving skills in physics learning. Research conducted by Siregar, Sirait, and Audina (2022) showed that the use of the PBL model can improve students' critical and analytical thinking skills compared to conventional learning methods. Furthermore, research conducted by Annisa and Haryadi (2023) also showed that the application of PBL to static fluids can systematically improve students' problem-solving skills. Similar findings were obtained in the study by Yusal, Nurazmi, and Harnipa (2023), which showed a significant increase in students' problem-solving abilities after implementing the PBL model.

Several other studies have also shown that the integration of technology in problem-based learning can have a positive impact on students' problem-solving skills. For example, research conducted by Prahani et al. (2022) showed that the use of three-dimensional animated digital books integrated with the PBL model significantly improved students' problem-solving skills. Furthermore, the use of technology-based learning media such as PhET simulations, instructional videos, and augmented reality-based applications has also been shown to increase student engagement in the learning process and help them understand abstract physics concepts.

Overall, the results of this literature review indicate that the application of a problem-based learning model supported by digital technology has significant potential to improve students' problem-solving skills in physics learning. Therefore, developing digital learning media, such as digital books integrated with the PBL approach, could be an effective solution to improve the quality of physics learning, particularly in developing students' problem-solving skills in static fluids.

CONCLUSION

Fundamental Finding: The results of the study indicate that the problem-solving skills of high school students are in the low category. Of the 105 students analyzed. 98 students are in the low category. 7 students are in the medium category. and there are no students in the high category. This finding indicates that most students still experience difficulties in solving physics problem-solving problems. especially in static fluid material. **Implication:** The study shows the need for learning innovations that can improve students' problem-solving skills. The application of the Problem Based Learning (PBL) model assisted by the E-STATPHYS digital book has the potential to be an alternative solution because it encourages active involvement of students in analyzing contextual problems and developing systematic solution strategies. **Limitation:** The research subjects only came from one school. so the generalization of the research results is still limited to similar contexts. **Future Research:** Implementation of the Problem Based Learning model assisted by the E-STATPHYS digital book on static fluid material is necessary to determine the improvement in students' problem-solving skills more clearly.

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AUTHOR CONTRIBUTIONS

Siska Agustin Sha Hareni contributed to the conceptualization, methodology development, data collection, data analysis, and manuscript drafting. **Binar Kurnia Prahani** contributed to the conceptual framework, research design, and validation of the study. **Nurul Muawiyah** contributed to data interpretation, literature review, and critical revision of the manuscript. **Nofri Hidayatin** contributed to data analysis and methodological review. **Elvia Reza Lutfiani** contributed to data curation, visualization, and preparation of figures and tables. **Dhea Wanda Irani** contributed to project administration. **Noer Risky Ramadhani** contributed to the data organization and manuscript editing.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest. either financial or personal. that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original. conducted with academic integrity. and free from any unethical practices. including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

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