Implementation of Case-based Learning with Contextual Approach to Improve students' Problem-Solving Skills

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Abstract *– This research aimed to investigate the implementation of Case-Based Learning (CBL) with a contextual approach to enhance students' problem-solving skills in dynamic fluids. The study employed a pre-experimental design with a one-group pretest-posttest, involving 33 eleventh-grade students from a senior high school in Bandung. A 20-item essay test assessed five aspects of problem-solving skills based on Heller's (1992) framework: visualize the problem, physics description, plan a solution, execute the plan and check and evaluate. Data analysis included N-gain, Wilcoxon signed-rank test, and effect size (Cohen's d). Results indicated that students' problem-solving skills improved moderately across all aspects, with an average N-gain of 0.5. The Wilcoxon test revealed a significant increase in posttest scores ($p < 0.05$), and the effect size was very high ($d = 2.6$), indicating a strong impact of the intervention. These findings demonstrate that the implementation of CBL with a contextual approach is effective in enhancing students' problem-solving skills, fostering deeper understanding, and promoting active engagement in learning dynamic fluids. Furthermore, this study provides empirical evidence of the use of case-based learning model in physics and offers practical guidance for teachers to strengthen students' problem-solving skills, particularly in dynamic fluid topics.*

Keywords: *Case-Based Learning; Problem-Solving Skills; Dynamic Fluids*

INTRODUCTION

The 21st century is marked by rapid advances in science, technology, and globalization (Mahrunnisya, 2023). These changes require individuals to continuously improve their quality in order to remain competitive in this new era. Education plays an important role in preparing a generation that is not only academically competent but also equipped with 21st-century skills necessary to contribute to the improvement of human resources (Awaluddin, 2021). Creativity, Critical Thinking (Problem-Solving), Collaboration, and Communication, commonly referred to as the 4C skills, are recognized as core competencies required in the 21st century (Herlinawati et al., 2024).

In the physics learning process within the Merdeka Curriculum, students are trained to develop scientific reasoning, which includes critical thinking and problem-solving skills (Kemendikbud-ristek, 2024). Problem solving skills is a fundamental skill that students must possess in order to address real and systematical problem (Asri et al., 2021). Heller et al. (1992) stated that problem solving is primary tool in learning physics not only to master concepts but also to understand various situations and problems in different contexts. Therefore, problem-solving ability in physics learning is essential for students as it serves as a bridge between theoretical knowledge and its application in everyday life.

Despite its importance, students' problem-solving skills in physics are often below expectations. Several studies have reported that high school students still struggle to solve physics problems effectively. This issue was also observed in an eleventh-grade class at a senior high school in Bandung, where 55.5% of students did not meet the minimum competency criteria (KKM), particularly in the topic of dynamic fluids. Classroom observations indicated that instruction on dynamic fluids tends to focus on practicing mathematical equations rather than engaging students in problem-solving processes. As a result, students face difficulties when confronted with more complex problems, as they are accustomed to memorizing previous problem-solving procedures rather than analyzing concepts critically. This issue is significant because dynamic fluids concepts are closely related to everyday phenomena, offering opportunities for meaningful learning if taught appropriately.

This result aligns with the outcomes of the preliminary study by Santoso et al. (2020), which indicated that students' problem-solving skills remain low, likely due to teacher-centered instruction, where students mainly listen and are then given problems to solve without actively engaging in the reasoning process. Physics learning that is predominantly teacher-centered, where students only listen and take notes, has an impact on their problem-solving skills (Agustina et al., 2018).

This condition indicates a gap between the ideal competencies expected and students' actual performance. An approach to resolving this problem is to transition the learning process from a teacher-centered model to a student-centered model, supported by an appropriate instructional model that helps students develop better problem-solving skills. In this study, case-based learning model was employed to foster such skills. Case-Based Learning is a learning model that encourages active participation while promoting the development of higher-order thinking skills, including critical thinking and problem-solving (Mesthrige et al., 2021). Previous finding from Irwanto et al. (2024) shows that applying this model in classroom leads to a significantly improves students' problem-solving skills.

To ensure the implementation of case-based learning can develop student's skill, it needs to be supported by an appropriate instructional approach. In this context, the contextual approach is considered relevant, as it enables students to connect learning materials with real-life situations to develop meaningful understanding (Johnson, 2002). The study conducted by Haryadi (2015) highlighted that contextual-based instruction supports the development of students' problem-solving capacity.

Therefore, by applying Case-based Learning with contextual approach, students' problem-solving skills are expected to improve. This study aims to enhance students' ability to solve problems by implementing a case-based learning model supported by a contextual learning approach in the topic of dynamic fluids.

RESEARCH METHODS

This research employed a pre-experimental design using a one-group pretest–posttest approach. The study involved one group of students as experiment class consisting of 33 students from an 11th-grade class at a senior high school in Bandung, selected purposively based on the class's alignment with the research objectives.

The research procedure consisted of three stages. (1) Preparation stages included a preliminary study, literature review, problem identification, instrument development, instrument judgement, validation construct, and revision. (2) Implementation stage consisted of conducting the pretest, applying the treatment, and conducting the posttest (3) Final stage involved processing and analyzing the data obtained from the implementation stage.

An essay test was used as the instrument for measuring students' problem-solving skills in this study. The test consisted of four essay questions developed based on the framework by Heller et al. (1992), which includes five aspects of problem solving visualizing the problem, physics description, planning a solution, executing the plan, checking and evaluating.

Before implementation, the instrument was tested for its validity and reliability. Content validity was examined by experts and analyzed using Aiken's validity coefficient, which showed that all items met the required validity criteria. Furthermore, the reliability test was analyzed using Rasch model, resulting in a Cronbach Alpha value of 0.81 and an item reliability of 0.90 interpreted as very good.

This instrument then administered to students before and after the treatment to measure the improvement in problem-solving skills. The Data collected were analyzed using several techniques, including the N-gain test, which was used to determine the level improvement in students' problem-solving skills after the implementation of the learning model. N-gain scores were interpreted based on Hake (1998) criteria, where an N-gain value of < 0.3 indicates a low, $0.3 \leq g < 0.7$ indicates a moderate improvement, and $g \geq 0.7$ indicates a high improvement.

Therefore, the normality test was conducted to examine whether the data were normally distributed. Because the data did not meet the normality assumption, a non-parametric hypothesis test (Wilcoxon signed-rank test) was employed to assess the significance of differences between the pretest and posttest scores. Lastly, the effect size was calculated to measure the strength of the treatment's influence on students' problem-solving skills.

RESULTS AND DISCUSSION

Results

To measure improvement, the pretest and posttest data were processed using the N-gain analysis. This analysis aims to determine the extent of students' improvement in problem-solving skills by comparing their scores between the pretest and posttest. The recapitulation of N-gain analysis results is summarized in Table 1.

Table 1. N-gain Average Result

	Score	N-gain	Category
Pretest	18,3	0,5	Moderate
Posttest	59,53		

Based on Table 1, N-gain score was 0,5. Referring to (Hake, 1998) since the value is greater than 0.3 and less than 0.7, it falls into the moderate category. Analysis of the improvement in students' problem-solving skills was carried out using the overall N-gain together with the N-gain of individual aspects, as detailed in the following section.

Aspect of Visualize the Problem

Visualizing the problem represents the initial aspect of problem-solving skills, which is related to students' ability to understand the given problem and construct a visual representation that illustrates the physical quantities involved (Heller et al., 1992). This aspect was measured using items 1a, 2a, 3a, and 4a. The average N-gain of students on this aspect is presented in Table 2.

Table 2. N-gain of Visualize the Problem Aspect

	Score	N-gain	Category
Pretest	44	0,5	Moderate
Posttest	72		

Based on Table 2, problem solving ability on the aspect of visualizing the problem has increased with 0,5 N-gain value in moderate category.

Aspect of Physics Description

The aspect of physics description refers to students' ability to describe a problem in terms of physics concepts or to express the known and unknown variables as physical quantities. This aspect was measured through items 1b, 2b, 3b, and 4b, and the improvement is presented in Table 3.

Table 3. N-gain of Physics Description Aspect

	Score	N-gain	Category
Pretest	37,5	0,58	Moderate
Posttest	73,86		

The average pretest score for this aspect was 37.5, while the average posttest score reached 73.86, indicating a significant improvement after the implementation of contextual case-based learning. Based on the N-gain analysis, the improvement obtained a score of 0.58 in moderate category.

Aspect of Plan a Solution

The third aspect of problem-solving skills is planning a solution, which refers to students' ability to formulate appropriate steps or strategies to solve a given problem. This aspect was measured through items 1c, 2c, 3c, and 4c. The improvement of this aspect is displayed in Table 4.

Table 4. N-gain of Plan a Solution Aspect

	Score	N-gain	Category
Pretest	8,83	0,5	Moderate
Posttest	55,05		

In this aspect, students obtained an average score of 8.83 in the pretest and 55.05 in the posttest. This indicates an improvement in problem-solving skills in the planning a solution aspect, with an N-gain value of 0.5, which is in the moderate category.

Aspect of Execute the Plan

The fourth aspect is executing the plan is related to students' ability to implement the solution strategies that were previously designed to solve a problem. This aspect was measured through items 1d, 2d, 3d, and 4d. Students' average score and improvement are provided in Table 5.

Table 5. N-gain of Execute the Plan Aspect

	Score	N-gain	Category
Pretest	6,81	0,48	Moderate
Posttest	51,76		

In this aspect, students obtained an average pretest score of 6.81 and an average posttest score of 51.76. This indicates an improvement in problem-solving skills in the executing the plan aspect, with an N-gain value of 0.48, which is categorized as moderate.

Aspect of Check and Evaluate

Last aspect of problem solving is checking and evaluating stage it is related to students' ability to confirm the accuracy and completeness of their solutions as well as to judge whether the results are reasonable. This aspect was assessed through items 1e, 2e, 3e, and 4e, with details of the improvement presented in Table 6.

Table 6. N-gain of Check and Evaluate Aspect

	Score	N-gain	Category
Pretest	4,92	0,49	Moderate
Posttest	51,51		

In this aspect the results show that the average score rose from 4.92 in the pretest to 51.51 in the posttest. The findings demonstrate a notable increase in students' problem-solving ability for the solution evaluation aspect, with an N-gain of 0.49, classified as moderate.

The implementation of the case-based learning model on problem-solving skills was also analyzed using normality test, hypothesis testing, and effect size. Normality test was to determine whether data collected were normally distributed. The analysis was carried out using the Shapiro-Wilk test with assistance of SPSS software. The data normality was determined using the significance value (Sig.), where more than > 0.05 indicates that the data are normally distributed, while a value of data less than 0.05 that the data are not normally distributed. The results of the normality test in Table 7.

Table 7. Normality Test Result

	Shapiro-wilk		
	Statistic	df	Sig.
Pretest	.859	33	<,001
Posttest	.948	33	.118

Table 7 presents the results of the normality test, indicating that the pretest data had a significance value below 0.05, whereas the posttest data exceeded 0.05. This implies that the pretest scores were not normally distributed, while the posttest scores were considered normally distributed.

The normality test results determined the type of hypothesis to be used. As one of the datasets was not normally distributed, a non-parametric method was applied. The Wilcoxon Signed-Rank Test was conducted to examine the differences between pretest and posttest scores, with the assistance of SPSS software. Decision-making was based on the significance value (Asymp. Sig. 2-tailed); if the significance value is less than 0.05, it indicates a significant difference between pretest and posttest scores, meaning that the treatment had an effect. The results of the hypothesis testing are shown in Table 8.

Table 8. Wilcoxon Hypothesis Test Result

	Posttest-pretest
Z	5,013
Asymp. Sig	< 0,001

The result showed a significance value of 0.001 less than 0.05. This proves that there is a significant improvement between pretest and posttest in students' problem-solving ability after the implementation case-based learning model with contextual approach on dynamic fluid material.

Once the Wilcoxon test indicated a difference between the average pretest and posttest scores, the effect size was calculated to assess the effectiveness of the CBL model in developing students' problem-solving skills. The analysis was performed using Cohen's d formula based on the pretest and posttest mean scores, and the results are summarized in Table 9.

Table 9. Effect Size d Value Result

	Score	Standard Deviation	d	Category
Pretest	18,56	9,6	2,6	Very High
Posttest	59,28	19,87		

Based on Table 9, it was found that the obtained effect size (d) was 2.6, which falls into the very high category (Cohen, 1988). Therefore, the case-based learning model had a significant impact on improving students' problem-solving skills.

Discussion

The result shows that the implementation of CBL has a significant impact on students' problem-solving skills. This is supported by the Wilcoxon test, which revealed a significant difference between pretest and posttest scores. The N-Gain value of 0.5 in the moderate category, suggesting that CBL is moderately effective in improving students' problem-solving skills. Furthermore, the effect size analysis using Cohen's d yielded a value of 2.6, categorized as very high, which confirms that CBL strongly influences the improvement of students' problem-solving skills. The findings are in line with Irwanto et al. (2024) who reported that the implementation of case-based learning (CBL) was effective in improving students' problem-solving skills, with the effect size categorized as very high.

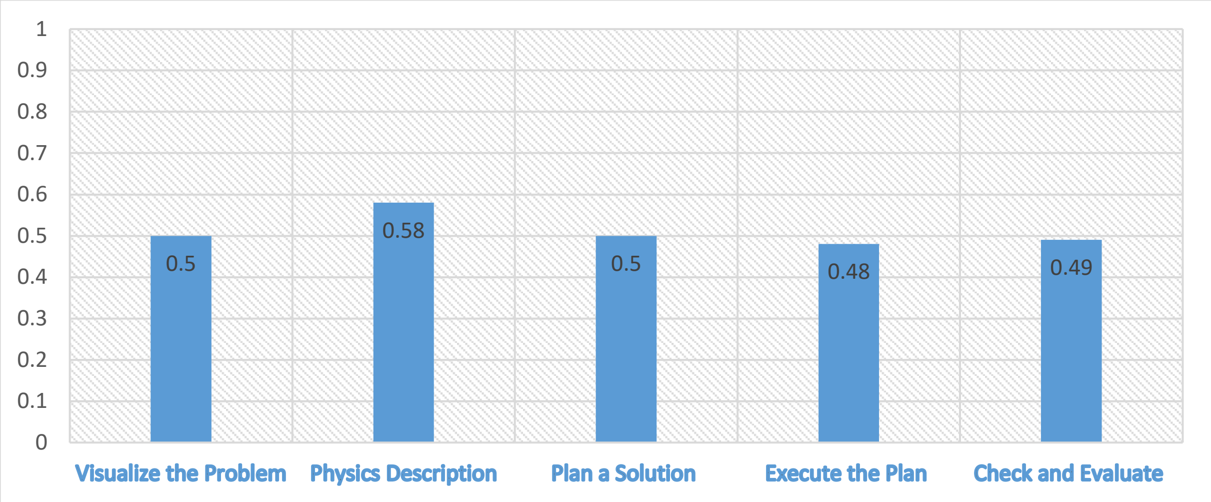

Figure 1. Diagram N-gain of Each Aspect of Problem Solving

If N-gain were analysed based on each aspect of problem-solving skills, all aspect has increased in moderate category, the highest improvement occurred in the aspect of describing the problem. The use of real-life cases provided students with meaningful context, making it easier to understand the problems presented. The plan a solution aspect also showed notable improvement, as students were encouraged to design strategies before attempting solutions. However, the lowest improvement was found in the execute the plan, which may be attributed to the mathematical complexity of dynamic fluid problems. Despite this, students were still able to perform evaluation, although not optimally.

These findings are consistent with Arliza & Warty (2024) who reported that students encountered difficulties in the execute the plan in dynamic fluid. Although the students had understood the basic concepts and the relationships among variables, not all of them were able to execute the calculations or apply the solutions accurately.

The pattern of improvement can be explained from a constructivist perspective, when students engage with real and significant experiences, they develop a deeper comprehension. The higher gains in defining and comprehending the problem are supported by the contextual scenarios used in case-based learning, which enabled student to connect abstract concept of dynamic fluids with familiar real-life situation. This is also consistent with the theory of contextual learning, which holds that learning becomes more effective when concepts are presented within relevant life situations.

Furthermore, the stages of CBL mirror Heller's model of problem-solving, which includes describing the problem, planning a solution, executing the plan, and evaluating the result. Because CBL heavily supports the analytical and planning phases through case exploration and group discussion, these indicators showed more substantial gains. Meanwhile, the execution stage demands higher procedural fluency and mathematical accuracy areas that are widely recognized as challenging in dynamic fluid topics explaining the lower improvement observed in that indicator.

Moreover, the success of CBL in this study was supported by several factors, including the use of relevant real-life cases, group discussions that promoted peer interaction, and case-based worksheets that guided systematic thinking. Nevertheless, challenges such as limited discussion time and the passive participation of some students were also observed. To address this, teachers need to adopt strategies that maximize student engagement and ensure balanced skill development.

CONCLUSION

The result of data analysis and this study shows that the implementation of CBL with a contextual approach is effective in improving students' problem-solving skills in the topic of dynamic fluids. The improvement is indicated by the increase in average posttest scores compared to pretest scores, with an N-gain value categorized as moderate. Furthermore, the effect size analysis using d value by Cohen's d obtained a value of 2.6, which is categorized as very high, indicating that the application of case-based learning provides a significant contribution to enhancing students' problem-solving abilities.

All aspects of problem-solving skills showed improvement. In the aspect of visualizing the problem, students' average score increased from 44 in the pretest to 72 in the posttest, yielding an N-gain of 0.50, classified as moderate. In the aspect of physics description, the average score improved from 37.5 to 73.8, with an N-gain of 0.58, also in the moderate range. The aspect of planning a solution showed an increase from 8.83 to 55.05, corresponding to an N-gain of 0.50, categorized as moderate. In the aspect of executing the plan, students' average score rose from 6.81 to 51.76, with an N-gain of 0.48, again in the moderate category. Lastly, the checking and evaluating aspect saw an improvement from 4.92 to 51.51, with an N-gain of 0.49, which is likewise classified as moderate.

Additionally, the significant change from pretest to posttest implies that the positive effect of this learning model on enhancing problem-solving abilities. Based on these findings, it is recommended that teachers integrate Case-Based Learning with a contextual approach in teaching dynamic fluids and physics in general. Future investigations may consider to adjust the allocation of learning time according to class conditions to ensure optimal implementation of the CBL model and maximize the improvement in problem-solving skills.

REFERENCES

Agustina, A., Yani, A., & Herman. (2018). Analisis Kesulitan Menyelesaikan Soal Pemecahan Masalah Fisika Bagi Peserta Didik MAN 3 Bone. *Jurnal Sains Dan Pendidikan Fisika.*, *14*, 1–7.

Arliza, W., & Warty, Y. (2024). Analysis of Student Difficulties in Solve Questions Problem Solving Ability based on Dynamic Fluid Material in SMA/MA Medan City. *Physics Education Research*, *5*(1), 9–15.

Asri, D., Maria Silitonga, H., & Arsyid, S. B. (2021). *Deskripsi Kemampuan Pemecahan Masalah Pada Materi Momentum dan Impuls Peserta Didik di SMA Negeri 3 Pontianak*.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences Second Edition* (2nd ed.). Lawrence Erlbaum Associates.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving. *American Journal of Physics*, *60*(7), 627–636. https://doi.org/10.1119/1.17117

Herlinawati, H., Marwa, M., Ismail, N., Junaidi, Liza, O. L., & Situmorang, D. D. B. (2024). The Integration of 21st Century Skills in the Curriculum of Education. *Heliyon*, *10*.

Irwanto, Pratiwi, Y., & Rizyani, H. (2024). The Effect of Case-Based Learning on Students' Problem-Solving Ability. *International Journal of Religion*, *5*(6), 235–242. https://doi.org/10.61707/wbare032

Johnson, E. B. (2002). *Contextual Teaching and Learning:What It Is and Why It Is Here to Stay*. Corwin Press.

Kemendikbud-ristek. (2024). *Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah pada Kurikulum Merdeka*.

Mahrunnisya, D. (2023). *Keterampilan Pembelajar Di Abad Ke-21*. *2*(1). https://jurnal.jomparnd.com/index.php/jupenji

Mesthrige, J. W., Lam, P. T. I., Chiang, Y.-H., & Samarasinghalage, T. I. (2021). Effectiveness of Case-based Learning: Views of Construction and Real Estate Students. *International Journal of Construction Education and Research*, *17*(4), 318–332. https://doi.org/10.1080/15578771.2020.1758254

Santoso, B., Putri, D. H., & Medriati, R. (2020). Upaya Meningkatkan Motivasi Belajar Dan Kemampuan Pemecahan Masalah Siswa Melalui Model Problem Based Learning Berbantu Alat Peraga Konsep Gerak Lurus. *Jurnal Kumparan Fisika*, *3*(1), 11–18. https://doi.org/10.33369/jkf.3.1.11-18