



The Application of the Quantum Teaching Model with a Deep Learning Approach to Improve Students' Problem-Solving Skills in the Topic of Static Fluids

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DOI: <https://doi.org/10.29303/goescienceed.v7i3.2066>

Article Info:

Received : May, 16 2026
Revised : May, 27 2026
Accepted : June, 07 2026
Published : June, 14 2026

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Abstract: This study aims to analyze students' problem-solving skills through the application of the Quantum Teaching model with a deep learning approach to static fluid. The research method used is a quantitative method with a between-group design, specifically a quasi-experimental research design. The type of quasi-experimental research design used in this study is a nonequivalent control group design, in which there are two classes used, namely a control class and an experimental class. The research instrument used is a problem-solving ability instrument developed based on Polya's indicators, consisting of three items. The data analysis employed N-Gain scores and a t-test hypothesis test, which met the prerequisites of normality and homogeneity. The results indicate that the N-Gain scores in the experimental class were higher than those in the control class, with respective values of 0.71 and 0.42. These results were supported by the t-test hypothesis test, which showed an Asymp sig (2-tailed) value—under the assumption of unequal variances—of <0.05. This indicates a significant difference in the improvement of problem-solving skills between students in the experimental and control classes. Thus, the Quantum Teaching model with a deep learning approach can serve as an alternative for enhancing problem-solving skills students, particularly in the area of static fluids.

Keywords: Quantum Teaching; Deep Learning; Static Fluid

Citation: Fauziah, D. K., Muslim, Novia, H., & Eliviani, D. (2026). The Application of the Quantum Teaching Model with a Deep Learning Approach to Improve Students' Problem-Solving Skills in the Topic of Static Fluids. *Jurnal Pendidikan, Sains, Geologi, Dan Geofisika (GeoScienceEd Journal)*, 7(3), 2434–2439. <https://doi.org/10.29303/goescienceed.v7i3.2066>

Introduction

Education is a series of systematically organized processes designed to help individuals develop their various potentials so that they can better face future challenges and obstacles (Ayu et al., 2019). Through education, humans are guided to undergo a process of humanism that is, the process of humanizing humanity (Pristiwanti et al., 2022). This implies that education is a process that leads humans to achieve stability in life, namely by possessing knowledge, various skills, and noble character that upholds the principle of benefit (Makkawaru, 2019).

In addition, education is inherently flexible and dynamic, adapting to the changing times and advancements in science and technology. One of the

advancements in the world of education resulting from these changing times is the emergence of 21st-century learning. 21st-century learning is an approach that prioritizes innovation and skills, shifting the focus from teacher-centered to student-centered learning (Rosnaeni, 2021). 21st-century learning encompasses a set of skills known as the 4Cs: 1) critical thinking skills, 2) creative and innovative thinking skills, 3) communication skills, and 4) collaboration skills (Zubaidah, 2016). 21st-century learning also emphasizes student engagement in the pursuit of knowledge (Wulandari et al., 2022), making students' problem-solving abilities essential to meet these demands.

Problem-solving skills are considered a fundamental component of science education in schools

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(Datur, 2017). However, field data indicate that students' problem-solving skills remain low, particularly regarding static fluid concepts (Purnamasari et al., 2017). This is supported by research conducted by Yadaeni (2016), which found that students struggle to solve problems related to the concepts of hydrostatic pressure and Pascal's principle in the static fluid curriculum.

A preliminary study has shown that students' average problem-solving skills remain low, particularly in the area of static fluids. This is evidenced by the average score of 38 out of 40 students. These results indicate that students' problem-solving skills in physics are still low. The large number of students scoring below average is attributed to a lack of student engagement during the learning process and insufficient problem-solving skills, causing them to struggle with the assigned problems. Additionally, the current teaching approach remains teacher-centered; during the two-hour class, students are only actively involved when solving problems, while the delivery of content is conducted through direct instruction by the teacher. This is supported by a preliminary study conducted by Ayu et al. (2019) at a vocational high school, which stated that the learning process at that school was not yet optimal. The learning model used was still conventional and focused solely on the teacher (teacher-centered), resulting in students' knowledge of physics material being limited to verbal understanding.

Based on the literature review conducted above, teachers need to explore various models and approaches to learning. One such model that can be applied is the Quantum Teaching model. The Quantum Teaching model is a learning model that provides students with the freedom to learn, interact, communicate, and access a variety of learning resources (Nahar, 2022). Research conducted by Cahyaningrum et al. (2019) indicates that there was an improvement in student learning outcomes following the implementation of the Quantum Teaching model.

In addition to instructional models, it is also necessary to integrate learning approaches that contribute to the effective implementation of the applied instructional models. Deep learning is a learning approach that fosters deep understanding, in which students do not merely memorize the concepts being studied but construct knowledge in a more meaningful way (Santiani, 2025). The Deep Learning approach can shift traditional learning, which is oriented toward the teacher's verbal activities, into student-centered learning (Suwandi et al., 2024). This is because the Deep Learning approach has three main indicators that require students to be involved in the learning process, namely: 1) understanding; 2) applying; and 3) reflecting (Feriyanto & Anjariyah, 2024). Research conducted by Wibowo and Jaya (2025) states that the Deep Learning approach can

improve students' problem-solving skills. Based on the above discussion, the researcher is interested in conducting a study on the use of the Quantum Teaching model with a deep learning approach, with the aim of developing an alternative solution capable of improving students' problem-solving skills, particularly in the area of static fluids.

Method

The research method used was a quantitative method. This research method involves several stages, namely collecting and interpreting data, and presenting the data in the form of tables, graphs, charts, and figures with the aim of supporting the data being analyzed. The research design used is a between-group design, specifically a quasi-experimental research design. The type of quasi-experimental research design used in this study is a nonequivalent control group design, in which two classes are used: a control class and an experimental class. The research design used is shown in Table 1.

Table 1. Design Research

Class	Pre-test	Treatment	Post-test
Eksperimen	O ₁	X ₁	O ₂
Kontrol	O ₃	X ₂	O ₄

Notes:

- O₁ = Pretest scores of the experimental group
- O₂ = Posttest scores of the experimental group
- X = Treatment
- O₃ = Pretest scores of the control group
- O₄ = Posttest scores of the control group

The participants in this study were 11th-grade science students at a public high school in Bandung Regency; the experimental class consisted of 30 students, while the control class had 34 students. The sampling technique used in this study was a non-probability sampling method, specifically convenience sampling, in which the sample was selected based on the availability provided by the school.

The test instrument used in this study is a problem-solving ability test developed based on Polya's indicators of problem-solving ability. A total of 3 test items were used in this study, which underwent validation analysis both construct validity and field data-based analysis prior to use. Additionally, the test items underwent reliability analysis, item difficulty testing, and item discrimination testing using the Rasch Model with the assistance of Ministep software.

The data analysis techniques used in this study included the N-Gain test to measure improvements in students' problem-solving skills, as well as an

independent samples t-test to determine the extent of the impact of implementing the Quantum Teaching model with a deep learning approach on students' problem-solving skills in the area of static fluids.

Result and Discussion

The findings of this study include the results of the N-Gain analysis, hypothesis testing, and tests of normality and homogeneity.

Improvements in problem-solving skills in both the control and experimental classes were observed after the learning models were implemented in both classes. In the experimental class, the Quantum Teaching model was implemented using a deep learning approach. In the control class, learning was conducted by implementing the Quantum Teaching model alone. The following are the pretest and posttest results obtained from the experimental and control classes, as shown in Figure 1 and Figure 2.

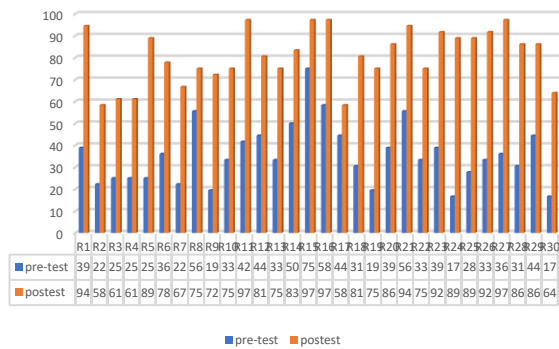


Figure 1. Data from the pretest and posttest in the experimental class

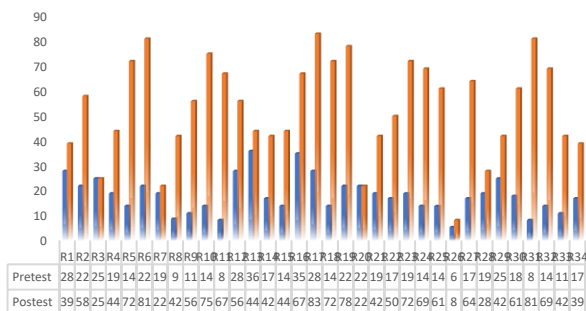


Figure 2. Data from the pretest and posttest in the control class

Based on Figures 1 and 2, it was found that, in general, students in both the control and experimental classes showed an improvement in problem-solving skills following the instruction. This is indicated by posttest scores that were generally higher than pretest

scores. The data obtained was then further analyzed using N-Gain analysis. The following is a summary of the average N-Gain scores for the control and experimental classes, as shown in Table 2.

Table 2. Summary of Problem-Solving Skills Development

	Eksperiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
N		30		34
Minimal score	17	58	6	8
Maximal score	75	97	36	83
Average Score	35,70	80,80	18,38	53,44
N-Gain	0,71		0,42	
Category	High		Medium	

Based on Table 2, it was found that the experimental class had a higher N-Gain value than the control class. The N-Gain value for the experimental class was 0.71, which falls into the high category, indicating that students' understanding particularly their problem-solving skills improved significantly. Meanwhile, the control class has an N-Gain value of 0.42, which falls into the moderate category. This indicates that there has been a good improvement in students' problem-solving skills.

After conducting the analysis and obtaining the average N-Gain scores for the control and experimental classes, the N-Gain analysis was then continued for each problem-solving ability indicator. The problem-solving ability indicators, as defined by Polya (1985), are: 1) understanding the problem context; 2) formulating a plan; 3) implementing the plan; and 4) reviewing the solution. Figure 3 presents the results of the N-Gain analysis for each problem-solving ability indicator in both the control and experimental classes.

Figure 3 shows that, overall, the experimental class had higher N-Gain scores for each problem-solving ability indicator compared to the control class. For the indicator of understanding the context of a problem, the experimental class had an N-Gain score of 0.68, which falls into the moderate category. Meanwhile, for the same indicator, the control class had an N-Gain score of 0.58, which also falls into the moderate category. Next, for the "developing a plan" indicator, the experimental class had an N-Gain value of 0.56, classified as moderate. For the control class, the N-Gain value was 0.25, classified as low. Furthermore, for the "implementing the plan" indicator, the experimental class had an N-Gain value of 0.86, interpreted as high. Meanwhile, for the control class, the N-Gain value for this indicator is

0.58, falling into the moderate category. Meanwhile, for the indicator of reviewing solutions to problems, the experimental class has an N-Gain value of 0.65, falling into the moderate category. The control class has an N-Gain value of 0.32, also falling into the moderate category for this indicator.

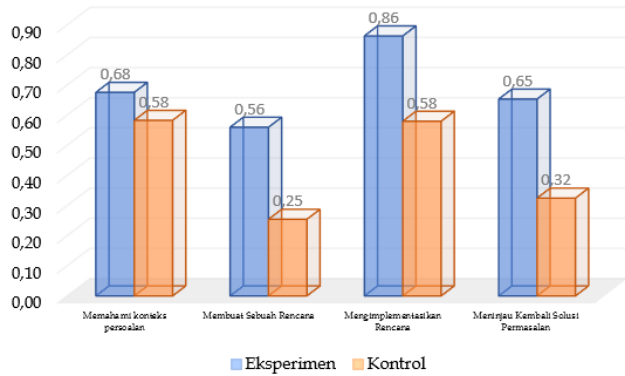


Figure 3. Diagram of the average N-Gain scores for each Problem-Solving Ability Indicator in the control class and the experimental class

Thus, in general, both the control and experimental classes showed an improvement in problem-solving skills, with average N-Gain scores falling into the moderate category. Nevertheless, the experimental class had higher average N-Gain scores for each problem-solving skill indicator compared to the control class.

In addition to the N-Gain analysis, the research data was also analyzed using hypothesis testing to determine the magnitude of the impact of applying the Quantum Teaching model with a deep learning approach on the improvement of students' problem-solving skills, particularly regarding static fluid mechanics. Before conducting the hypothesis test, the research data had to meet the prerequisites of normality and homogeneity. The results of the normality test for the experimental class are shown in Table 3.

Table 3. Results of the Normality Test for the Experimental Class

	Pretest	Posttest
Asymp sig (2 tailed)	0,2	0,2
Notes	H ₀ accepted	H ₀ accepted

Based on Table 3, the asymptotic significance value (two-tailed) was found to be 0.2 for both the pretest and posttest data. This indicates that both datasets are normally distributed. Thus, the data from the experimental class are considered to be normally distributed. As for the control class, the results of the normality test are shown in Table 4. Based on Table 4, different asymptotic significance (two-tailed) values

were obtained for the pretest and posttest data. The asymptotic significance (two-tailed) value for the pretest data was 0.079. Meanwhile, for the posttest data, the asymptotic significance (two-tailed) value obtained was 0.175. Both Asymp sig (2-tailed) values for both the pretest and posttest data are > 0.0, indicating that both datasets are normally distributed. Thus, it can be concluded that the data from the control class fall within a normally distributed dataset.

Table 4. Results of the Normality Test for the Control Group

	Pretest	Posttest
Asymp sig (2 tailed)	0,079	0,175
Notes	H ₀ accepted	H ₀ accepted

Next, a homogeneity test was conducted to determine whether the data obtained came from the same population or not. The results of the homogeneity test for the experimental class are shown in Table 5 and Table 6.

Table 5. Results of the Homogeneity Test for the Experimental Class

Asymp sig (2 tailed)	0,96
Notes	H ₀ accepted

Table 6. Results of the Homogeneity Test for the Control Group

Asymp sig (2 tailed)	< 0,01
Notes	H ₀ rejected

Based on Table 5 and Table 6, it was found that there were differences in the asymptotic significance (two-tailed) values in both the control and experimental groups. In the experimental group, the asymptotic significance (two-tailed) value was 0.96, which is > 0.05; therefore, it can be concluded that the data in the experimental group come from a homogeneous population. Meanwhile, the asymptotic significance (two-tailed) value in the control group is < 0.01, which is < 0.05; therefore, it can be concluded that the data in the control group comes from a non-homogeneous population.

Based on the prerequisite tests conducted earlier for both the control and experimental groups, it was determined that the data in the experimental group is normally distributed and homogeneous, allowing the parametric Independent t-test to be performed. As for the control group, the data is known to be normally distributed but not homogeneous. According to testing guidelines, when data is normal but non-homogeneous, the Independent t-test can still be performed with decision-making based on the assumption that equal variances are not assumed. In this study, the analysis

was conducted using SPSS 27 software. The results of the t-test are shown in Table 7.

Based on Table 7, it is evident that the Asymp sig (2-tailed) value, which assumes equal variances, is less than 0.05. This indicates that there is a significant difference in the improvement of problem-solving skills between

students in the experimental class and the control class. This suggests that the Quantum Teaching model can serve as an alternative for enhancing problem-solving skills in both the control and experimental classes. However, the Deep Learning approach also makes a significant contribution to improving students' problem-solving skills.

Table 7. Results of the Independent t-test

	t	df	Sig 2 tailed	T-test for equality of means	
				Mean difference	Std error difference
Equal variances assumed	-6.607	62	<,001	-27,359	4,141
Equal variances not assumed	-6,785	56,829	<,001	-27,359	4,032

This is demonstrated by the experimental class showing a higher improvement in problem-solving skills compared to the control class. This is further

supported by the results of the Independent t-test on each problem-solving skill indicator for both the control and experimental classes, as shown in Table 8.

Table 8. Results of the t-test for Each PSS Indicator

Problem-solving indicators	skills	Nilai	Sig 2 tailed	Mean difference
Understanding the context of the issue		Equal variances assumed	0,006	4,396
		Equal variances not assumed	0,006	4,545
Making a plan		Equal variances assumed	0,000	22,354
		Equal variances not assumed	0,000	22,524
Implementing the plan		Equal variances assumed	0,000	16,094
		Equal variances not assumed	0,000	16,595
Reexamining Solutions to Problems		Equal variances assumed	0,000	23,192
		Equal variances not assumed	0,000	23,358

Table 8 indicates that, in general, there is a significant difference in the improvement of problem-solving skills between the control and experimental classes. This is evidenced by a Sig (two-tailed) value of < 0.05 for three indicators: creating a plan, implementing the plan, and reviewing the solution to the problem. However, for the indicator of understanding the context of the problem, the Sig value (two-tailed) is 0.06, which is > 0.05. Thus, the control class and the experimental class show relatively similar improvements in the indicator of understanding the context of the problem. This is consistent with the N-Gain values, which are not significantly different between the control and experimental classes for this indicator, with values of 0.58 and 0.68, respectively.

Thus, overall, it can be concluded that there is a significant difference in the improvement of problem-solving skills between the control and experimental classes, with the experimental class showing a greater improvement. This implies that the implementation of the Quantum Teaching model combined with the Deep

Learning approach is more effective in improving students' problem-solving skills than implementing the Quantum Teaching model alone. The results of this study align with research conducted by Sujana & Asiah (2018), which stated that students' problem-solving skills improved following the implementation of the Quantum Teaching model. Similarly, research conducted by Nasution et al. (2023) indicated that there was an improvement in learning outcomes following the implementation of the Quantum Teaching learning model.

Conclusion

Based on the research results, it can be concluded that students' problem-solving skills in static fluid mechanics improved in both the experimental and control classes following the implementation of the Quantum Teaching model. However, the experimental class demonstrated a greater improvement in problem-solving skills compared to the control class due to the integration of the deep learning approach into the

learning process. This is indicated by the N-Gain score in the experimental class, which was 0.71, while in the control class it was 0.42. These results are supported by a t-test, which showed an Asymp sig (2-tailed) valuereferring to the "Equal variances not assumed" condition with a p-value < 0.05. This implies that there is a significant difference in the improvement of problem-solving skills between students in the experimental class and the control class. Thus, the Quantum Teaching model with a deep learning approach can serve as an alternative for enhancing problem-solving skills.

Acknowledgements

Thank you to everyone who contributed to the preparation of this article.

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