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The Effect of Implementing the CoCoAER and Jigsaw Learning Models on Enhancing Students' Understanding of Concepts in Static Fluid

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Abstract – *The increasing complexity of physics learning in the Industrial Revolution 4.0 era demands innovative pedagogical strategies to address students' conceptual difficulties, particularly in abstract topics like static fluid. Misconceptions about hydrostatic pressure remain prevalent due to traditional, non-contextual instructional approaches. This study aims to compare the effectiveness of two cooperative learning models CoCoAER and Jigsaw in improving students' conceptual understanding of static fluid and to examine students' perceptions of both methods. A quasi-experimental design with a non-equivalent control group was applied to 90 eleventh-grade students at MAN 3 Banda Aceh, divided into CoCoAER, Jigsaw, and conventional lecture groups. Data were collected through pre-and post-tests and student response questionnaires. Results from ANOVA and N-Gain analysis indicated that the CoCoAER model significantly outperformed both the Jigsaw and lecture models ($p < 0.05$), with 73.3% of students showing high improvement and an average post-test score of 86. Students' satisfaction also favored CoCoAER, with 96% indicating a "very satisfied" rating, compared to 50% and 40% for Jigsaw and conventional methods, respectively. The novelty of this study lies in applying the CoCoAER model to fluid dynamics, integrating contextual learning, collaboration, and error anticipation strategies. In conclusion, the CoCoAER model offers a highly effective and student-centered approach to teaching static fluid, contributing to the reduction of misconceptions and enhancing physics learning outcomes.*

Keywords: *CoCoAER; concept understanding; jigsaw learning; static fluid; student satisfaction level*

I. INTRODUCTION

Education plays a fundamental role in shaping high-quality human resources and guiding the progress of a nation (Kemendikbudristek, 2024). In the context of the Industrial Revolution 4.0 characterized by rapid technological and informational advancement the education system is compelled to adapt and innovate to stay relevant to contemporary demands (Haris et al., 2024). Accelerating educational transformation has become imperative, by integrating these changes synergistically with social revolutions and continuously evolving technological advancements (Souza & Debs, 2024; Maison et al., 2021). This technological revolution has given rise to future-oriented educational models that are increasingly personalized, hyperactive, intelligent, portable, global, and virtual (Benešová & Tupa, 2017; Shahroom & Hussin, 2018). In response to these evolving demands, continuous efforts to enhance education quality are critical, particularly through research aimed at improving learning processes and outcomes (Ambon et al., 2024; Díez et al., 2020). Therefore, educational research especially studies focusing on enhancing the quality of students' learning experiences and achievements is of significant importance. This study seeks to address the issue of low student performance in physics, a subject widely acknowledged for its conceptual complexity. It is anticipated that this research will offer effective and applicable pedagogical strategies to improve students' conceptual understanding in physics.

One prominent issue in secondary-level physics education is poor student performance in hydrostatic pressure topics. This problem stems from ineffective teaching strategies, limited laboratory usage, teacher-centered approaches, non-contextual material, and students' insufficient prior knowledge (Kuntara & Mansyur., 2022; Wangchuk et al., 2023; Zakirman et al., 2023). Misconceptions in this area are widespread, with an average rate of 54.80% among high school students (Zainuddin, 2016). Physics is often perceived as abstract and difficult due to its heavy reliance on mathematical formulations (Kokkonen & Schalk, 2021; Royani et al., 2025). Conceptual understanding, especially in static fluid topics, is a crucial element in physics education, yet is frequently hindered by student misconceptions (Irawan et al., 2025; Alatas & Astuti, 2019; Goszewski et al., 2013; Soeharto & Csapó, 2021; Wijaya et al., 2016). Such misconceptions often originate from prior knowledge, associative reasoning, flawed intuition, developmental stages, and individual cognitive limitations (Haryono et al., 2020). Furthermore, the continued dominance of conventional, teacher-centered teaching discourages active student participation, leading to disengagement (Al-shehri & Alaudan, 2024; Nazim et al., 2024). These methods fail to stimulate students' interest and interaction, thus necessitating the adoption of more interactive and contextual learning strategies (Tang et al., 2022; Tong et al., 2022).

Findings from interviews and observations conducted at MAN 3 Banda Aceh reveal that students' understanding of hydrostatic pressure remains significantly low. Misconceptions persist, such as the belief that pressure increases in narrower sections or wider pipe openings. Teachers report that students often rely on rote memorization without truly grasping the underlying physical principles. Diagnostic assessments indicate that over 60% of students misunderstand the correlation between depth and pressure in fluids. Contributing factors include a lack of visual media, simple experiments, and the inability of students to relate theoretical content to real-life phenomena due to the unidirectional nature of instruction. These observations underscore the urgent need for interactive and contextualized instructional models. However, a gap remains between empirical research and actual classroom practice. Many teachers have not consistently adopted innovative methods due to time constraints, lack of training, and limited pedagogical knowledge. Moreover, few studies have directly compared the effectiveness of the CoCoAER and Jigsaw learning models in the context of teaching static fluids in resource-constrained schools such as MAN 3 Banda Aceh. Hence, further investigation is necessary to evaluate these two instructional models and to provide empirical support for selecting appropriate strategies based on student characteristics and subject content.

Accordingly, this study aims to compare the effectiveness of the CoCoAER and Jigsaw cooperative learning models in enhancing students' conceptual understanding of static fluids, particularly hydrostatic pressure. Additionally, it seeks to examine students' perceptions of the implementation of both models. Based on these aims, the research addresses two primary questions: (1) Is there a significant difference in the improvement of conceptual understanding of hydrostatic pressure between students taught using the CoCoAER model and those taught using the Jigsaw model? and (2) What are students' perceptions of the CoCoAER and Jigsaw learning models in understanding hydrostatic pressure concepts?

II. METHODS

This study was conducted at MAN 3 Banda Aceh using a quantitative approach with a quasi-experimental design (Campbell & Stanley, 1963; Suranto & Nurlaela, 2021). A quasi-experiment shares similarities with true experimental designs in that the researcher has control over the treatment and control groups. However, participants are not randomly assigned to these groups (Ary et al., 2019; Cuppen, 2012). The research procedure began with problem identification, followed by a review of relevant theories and literature to establish a conceptual framework. After determining the research subjects, the researchers prepared the instruments used for data collection (Sugiyono, 2013). The procedural flow of the study is illustrated in Figure 1.

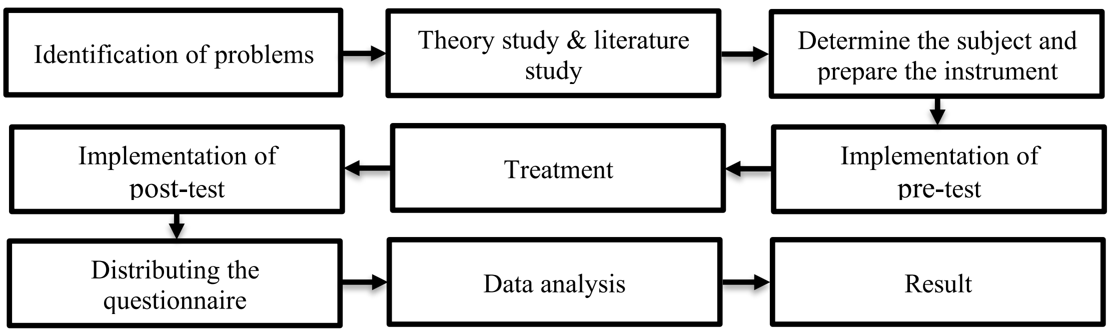

Figure 1. Stages of the quasi-experimental research process in this study

The design employed in this study was the pretest-posttest non-equivalent control group design, which involved two experimental classes and one control class. The research design is presented in Table 1.

Table 1. Pretest-posttest non-equivalent control group design

Class	Pre-test	Treatment	Post-test
E-1	O1	X1	T1
E-2	O2	X2	T2
Control	O3	X3	T3

Table 1 describes experimental class 1 (E-1), experimental class 2 (E-2), and the control class. O1, O2, and O3 represent pre-tests for the experimental and control groups (E-1, E-2, control), while X1, X2, and X3 represent treatments applied in these groups (E-1, E-2, control). T1, T2, and T3 represent post-tests for the experimental and control groups (E-1, E-2, control).

Data collection methods included interviews, observations, and the use of specific instruments. Instruments are tools or facilities that facilitate data collection, enhancing the ease, precision, completeness, and systematization of the data, and making it easier to analyze (Arikunto, 2011). This study employed a 10-item concept understanding test and a student response questionnaire. The data collection process proceeded in two stages: the first stage involved a pre-test, in which students were given a test before engaging in the learning activities, both in the experimental and control classes. This pre-test aimed to assess students' prior understanding (pre-concept) of static fluid material and determine the statistical homogeneity of the students across the three classes, with a significance value > 0.05. Following this, treatment was applied in the experimental classes: class XI IPA-1 (E-1) used the CoCoAER learning model, class XI IPA-2 (E-2) employed the Jigsaw learning model, and class XI IPA-3 (control) followed a direct learning model using the lecture method (conventional). After treatment, a post-test was conducted, and students completed a response questionnaire to assess the effectiveness of the learning models applied.

Population refers to all individuals or elements that possess specific characteristics relevant to the study, while a sample is a subset of the population (Sulistiyowati & Astuti, 2017). The sample in this study consisted of all students from class XI IPA. Three classes were selected as research samples: class XI IPA-1, the first experimental class (E-1) using the CoCoAER learning model; class XI IPA-2, the second experimental class (E-2) using the Jigsaw learning model; and class XI IPA-3, the control class, using the conventional lecture method. Each class had 30 students, making the total sample size 90 students.

The process continued with the administration of the pre-test to assess initial conditions before applying the treatment. Following the treatment, a post-test was administered to measure any changes. Additionally, a student response questionnaire was distributed to gather further data from the respondents. The data analysis techniques used in this study included descriptive statistics, a post-conditional test (normality and homogeneity tests), hypothesis testing using the One-Way ANOVA test, and descriptive analysis of the questionnaire results using SPSS software version 21. The following is an explanation of each technique.

1. Descriptive Analysis

Descriptive analysis involves summarizing numerical data to explain its characteristics, providing a clear understanding of data distribution (Thompson, 2009). In this study, descriptive statistics such as the minimum, maximum, mean, and standard deviation values were calculated.

2. Prerequisite Test

The prerequisite test determines whether the data analysis for hypothesis testing can proceed. This test is conducted using normality and homogeneity tests (Yuliawati et al., 2020). The normality test assesses whether the learning outcome data follow a normal distribution across the three classes. The homogeneity test determines whether the variance across the three sample groups is equal.

3. N-Gain Analysis

N-gain score analysis is used to evaluate whether there has been an improvement in students' concept understanding before and after the application of the learning models (Hake, 2002; Sukarelawan et al., 2024). The N-gain score is calculated using the following formula:

$$N_{Gain} = \frac{\text{Posttest Score} - \text{Prestest Score}}{\text{Ideal Score} - \text{Prestest Score}} \quad (1)$$

Table 2 presents the criteria for interpreting N-gain scores.

Table 2. N-gain criteria

Criteria	Gain point
High	$g > 0.7$
Medium	$0.3 < g \leq 0.7$
Less	$g \leq 0.3$

4. One-Way Anova (ANOVA)

ANOVA is a statistical method used to analyze the average comparison of three or more independent data groups (Mishra et al., 2019). The purpose of the ANOVA test is to identify significant differences between the mean values of the groups.

5. Student Response Questionnaire Analysis

The student response questionnaires were analyzed both descriptively and qualitatively to evaluate student reactions to the learning media provided during the teaching process in both experimental and control classes (Afrianti et al., 2022; Sudjana, 2009). The analysis of student response questionnaires was performed using the following formula:

$$P = \frac{f}{n} \times 100\% \qquad (2)$$

Note:
P : Percentage of students
f : Frequency of student responses
n : Total number of students

After calculating the student response questionnaire score, the results were interpreted according to the criteria shown in Table 3.

Table 3. Criteria for percentage of student response questionnaire

Percentage score (%)	Category
0-20%	Very poor
21-40%	Poor
41-60%	Fair
61-80%	Good
81-100%	Excellent

III. RESULTS AND DISCUSSION

A balance test was conducted in the form of a pre-test before the teacher provided explanations of the material and applied the learning models in both the experimental and control classes. A description of the pre-test results is provided in Table 4.

Table 4. Pre-test data description

No.	Class	N	Min	Max	Mean	Std. Deviation
1.	E-1	30	20	50	29.90	9.06
2.	E-2	30	10	50	26.38	8.25
3.	Control	30	10	40	25.52	8.27

Table 4 presents the descriptive statistics for three learning groups: Class E-1, Class E-2, and the control class, each consisting of 30 students (N = 30). In Class E-1, the minimum score was 20, the maximum score was 50, the mean was 29.90, and the standard deviation was 9.06. In Class E-2, the minimum score was 10, the maximum score was 50, the mean was 26.38, and the standard deviation was 8.25. The control class had a minimum score of 10, a maximum score of 40, a mean of 25.52, and a standard deviation of 8.27. This data indicates that Class E-1 had the highest average score, followed by Class E-2 and the control class, with the greatest variability observed in Class E-2 (standard deviation 9.25). Following this initial analysis of the pre-test data, a prerequisite test was conducted, with normality results presented in Table 5.

Table 5. Pre-test normality test

No.	Class	Significant	Decision
1.	E-1	0.171	Normal
2.	E-2	0.252	Normal
3.	Control	0.343	Normal

Table 5 shows the normality test results for the pre-test data of three class groups: E-1, E-2, and the control class. The significance values for the three groups were 0.171 (E-1), 0.252 (E-2), and 0.343 (Control), all of which are greater than 0.05. This indicates that the pre-test data from all three groups follow a normal distribution. The next prerequisite test was the homogeneity test, and the results of this test are shown in Table 6.

Table 6. Pre-test homogeneity test

Data	Significant	Decision
Pretest	0.685	Homogeneous

Table 6 presents the homogeneity test results for the pre-test data, with a significance value of 0.685, which is greater than 0.05. This confirms that the pre-test data across the three groups are homogeneous, meaning the variances are similar. The combined results from Tables 4, 5, and 6 indicate that the pre-test data for the three groups were both normally distributed and homogeneous. With this confirmation, the researcher proceeded to apply the learning models to each class.

The descriptive analysis of students' concept understanding, before and after the application of the learning models, is presented in Table 7. This table compares the results of the 10-item test administered to Class E-1 (CoCoAER model), Class E-2 (Jigsaw model), and the control class.

Table 7. Analysis of learners' concept understanding

Item	Concept understanding											
	CoCoAER				Jigsaw				Conventional			
	Pre-test		Post-test		Pre-test		Post-test		Pre-test		Post-test	
	∑S	%	∑S	%	∑S	%	∑S	%	∑S	%	∑S	%
1	0	0.00	25	83.33	2	6.67	20	66.67	1	3.33	12	40.00
2	13	43.33	24	70.00	10	33.33	15	50.00	9	30.00	11	36.67
3	2	6.67	25	83.33	3	10.00	12	40.00	2	6.67	13	43.33
4	0	0.00	22	63.33	2	6.67	24	80.00	5	16.67	15	50.00
5	6	20.00	25	83.33	5	16.67	8	26.67	4	13.33	16	53.33
6	13	43.33	28	93.33	8	26.67	14	46.67	10	33.33	13	43.33
7	15	50.00	28	93.33	20	66.67	17	56.67	11	36.67	20	66.67
8	16	53.33	27	90.00	5	16.67	13	43.33	4	13.33	10	33.33
9	10	33.33	26	86.67	15	50.00	21	70.00	15	50.00	18	60.00
10	14	46.67	28	93.33	9	30.00	23	76.67	8	26.67	14	46.67

Table 7 shows the descriptive analysis results related to students' understanding of concepts in three learning models: CoCoAER, Jigsaw, and Conventional. This table includes both pre-test and post-test data for each item, reflecting the level of improvement in students' understanding of static fluid concepts for each model. In the CoCoAER model, significant improvements were observed across all items. For example, in Item 1, the number of students who demonstrated understanding increased from 0% (pre-test) to 83.33% (post-test). Similar improvements were seen in Item 10, where the number of students increased from 46.67% to 93.33%. These results indicate that the CoCoAER model was highly effective in improving students' understanding of concepts. The Jigsaw model also showed improvements, though not as dramatic as the CoCoAER model. For instance, in Item 1, the number of students who understood the concept increased from 6.67% (pre-test) to 66.67% (post-test). Similarly, in Item 10, the number of students who understood the concept increased from 30.00% to 76.67%. This indicates that the Jigsaw model was effective, though its impact was slightly less than that of CoCoAER. The conventional model also demonstrated improvements, but these were comparatively smaller. For example, in Item 1, the percentage of students who understood the concept increased from 3.33% (pre-test) to 40.00% (post-test), and in Item 10, the percentage increased from 26.67% to 46.67%. These results suggest that the conventional model was less effective than the CoCoAER and Jigsaw models in improving students' concept understanding. Overall, the CoCoAER model yielded the highest improvement in students' understanding of static fluid concepts, followed by the Jigsaw model. The conventional model showed the lowest level of improvement. Misunderstandings of concepts in physics, particularly in the material on static fluids, can arise due to associative thinking, incomplete initial concepts, and insufficient reasoning (Amalissholeh et al., 2023; Wicaksono et al., 2019). It is essential to address these challenges to improve students' conceptual understanding

An N-gain analysis of the concept understanding test was performed to assess improvements in concept understanding with the CoCoAER model in the experimental class (E-1) compared to the Jigsaw model (E-2) and the conventional lecture model. The N-gain score analysis, which compares the pre-test and post-test scores, can be used to determine the effectiveness of the learning models. The results of the N-gain analysis are presented in Table 8.

Table 8. The results post-test and N-Gain

Criteria	E-1	E-2	Control
High	22	14	1
Medium	8	16	11
Less	0	0	18
Total	30	30	30

Table 8 presents the N-Gain results for the post-test across three groups: the Experimental Group (E-1), the Experimental Group (E-2), and the Control group. In Group E-1, the most effective results were seen, with 22 students in the "High" category ($g \geq 0.70$) and none in the "Low" category ($g \leq 0.30$). Group E-2 ranked second, with 14 students in the "High" category, 16 in the "Medium" category ($0.30 < g < 0.70$), and no students in the "Low" category. Meanwhile, the Control group showed the least effective results, with only 1 student in the "High" category, 11 in the "Medium" category, and the majority, 18 students, in the "Low" category. These results suggest that the CoCoAER learning model applied to E-1 was more effective than the Jigsaw model used in E-2 and the conventional method used in the Control group. This finding aligns with previous research by Fajri et al. (2022), which showed that the CoCoAER model led to significant increases in concept understanding, with an average N-Gain score greater than 0.75. Additionally, similar studies by Rizki (2021) and Safrizal (2021), reported average N-Gain values of 0.63 and 0.70, respectively, indicating positive results with the CoCoAER model. According to Nazariani & Zainuddin (2024), the CoCoAER model is classified as highly practical, further supporting its effectiveness in enhancing students' conceptual understanding compared to traditional methods.

The balance test for the post-test results was performed to check for normality and homogeneity before proceeding with the One-Way ANOVA statistical test. The results of this test are shown in Table 9.

Table 9. Description of post-test data

No.	Class	N	Min	Max	Mean	Std. Deviation
1.	E-1	30	60	100	86.00	12.20
2.	E-2	30	60	95	79.17	8.15
3.	Control	30	25	80	46.50	14.57

Table 9 provides a statistical description of the post-test results across the three groups: E-1, E-2, and the Control group. Group E-1 achieved the highest average score of 86.00 with a standard deviation of 12.20, a minimum score of 60, and a maximum score of 100. Group E-2 had an average score of 79.17 with a standard deviation of 8.15, a minimum value of 60, and a maximum value of 95. The Control group had an average of 46.50, a standard deviation of 14.57, a minimum value of 25, and a maximum value of 80. This data indicates that Group E-1 outperformed both Group E-2 and the Control group in terms of average post-test scores. Following the descriptive analysis, a normality test was conducted on the post-test data, and the results are presented in Table 10.

Table 10. Post-test normality test

No.	Class	Significant	Decision
1.	E-1	0.873	Normal
2.	E-2	0.221	Normal
3.	Control	0.755	Normal

Table 10 shows the results of the normality test for the post-test data. All groups E-1 (0.873), E-2 (0.221), and Control (0.755) have significance values greater than 0.05, indicating that the data in all groups meet the assumption of normality. Next, a homogeneity test was conducted on the post-test data. The results of this test are shown in Table 11.

Table 11. Post-test homogeneity test

Data	Significant	Decision
Pre-test	0.450	Homogeneous

The homogeneity test for the post-test data yielded a significance value of 0.450 ($p > 0.05$), which indicates that the variances between the groups are homogeneous. This confirms that the data is suitable for parametric analysis using the One-Way ANOVA test. The One-Way ANOVA test was then applied to assess whether there were significant differences between the groups in both pre-test and post-test results. The results of the ANOVA test for the pre-test data are shown in Table 12, and the post-test results are presented in Table 13.

Table 12. Anova pre-test of experimental class and control class

Description	Sum of squares	df	Mean Square	F	Significant
Between groups	280.493	2	140.246	1.561	.216
Within groups	7547.093	84	89.846		
Total	7827.586	86			

Table 12 presents the ANOVA results for the pre-test data, showing a significance value of 0.216 ($p > 0.05$). This indicates that there are no significant differences between the groups in the pre-test data, suggesting that the groups had similar starting conditions before the treatment. The ANOVA test results for post-test data are presented in Table 13.

Table 13. Anova post-test of experimental and control classes

Description	Sum of squares	df	Mean square	F	Significant
Between groups	26013.163	2	13006.581	88.609	.000
Within groups	12330.102	84	146.787		
Total	38343.264	86			

Table 13 presents the ANOVA test results for the post-test data from classes E-1, E-2, and Control. The sum of squares value for Between Groups is 26013.163, while for Within Groups it is 12330.102, giving a total of 38343.264. The degree of freedom (df) for Between Groups is 2, and for Within Groups is 84. The mean square value for Between Groups is 13006.581, while for Within Groups it is 146.787. The analysis results show an F value of 88.609 with a significance of 0.000 ($p < 0.05$), indicating a significant difference between the groups in the post-test data.

The ANOVA test results for the pre-test data showed a significance value of 0.216 ($p > 0.05$), suggesting no significant difference between groups E-1, E-2, and Control. This indicates that before the treatment, the three groups had relatively similar initial conditions. However, after the treatment, the post-test data in Table 13 shows a significance value of 0.000 ($p < 0.05$), indicating a significant difference between groups E-1, E-2, and Control. This suggests that the treatment applied to groups E-1 and E-2 had a notable impact on the post-test results, unlike the Control group.

Due to the significant differences revealed by the ANOVA test, further analysis was conducted using the Tukey HSD Post Hoc Test to determine which specific groups showed significant differences in their mean post-test scores. The results of the Tukey HSD Post Hoc Test are presented in Table 14.

Table 14. Post Hoc Tukey HSD test of experiment and control post-test

(I) Group	(J) Group	Mean difference (I-J)	Std. Error	Significant	95% Confidence interval	
					Lower bound	Upper bound
E-1	E-2	5.679	3.130	.002	-1.79	13.15
	Control	39.962*	3.240	.000	32.23	47.69
E-2	E-1	-5.679	3.130	.002	-13.15	1.79
	Control	34.283*	3.189	.412	26.67	41.89
Control	E-1	-39.962*	3.240	.000	-47.69	-32.23
	E-2	-34.283*	3.189	.412	-41.89	-26.67

*. The mean difference is significant at the 0.05 level.

Table 14 presents the results of the Tukey HSD Post Hoc test, comparing the mean post-test scores of the three groups. The mean difference between E-1 and E-2 was 5.679 with a significance of 0.002 ($p < 0.05$), indicating a significant difference. The difference between E-1 and Control was 39.962 with a significance of 0.000 ($p < 0.05$), which also indicates a significant difference. However, the difference between E-2 and Control, with a mean difference of 34.283, has a significance of 0.412 ($p > 0.05$), indicating no significant difference. These results suggest that the treatment applied to E-1 resulted in a significant improvement compared to both E-2 and Control, while no significant difference was observed between E-2 and Control.

An analysis of student responses to the influence of CoCoAER, Jigsaw, and conventional learning models was conducted to evaluate their effectiveness in enhancing student engagement and participation during the learning process. This analysis is presented in Table 15.

Table 15. Results of student response questionnaire analysis

Indicator	Number of questions	Total	Percentage	Category
Learners' satisfaction with the CoCoAER learning process	10	48	96.00	Very satisfied
Learners' satisfaction with the Jigsaw learning process	10	25	50.00	Fair
Learners' satisfaction with the Conventional learning process	10	20	40.00	Fair

Table 15 summarizes the results of student response questionnaires for the CoCoAER, Jigsaw, and Conventional learning models. Students' satisfaction with the CoCoAER learning process scored a total of 48 with a percentage of 96.0%, placing it in the "Very Satisfied" category. The CoCoAER model was highly favored by students for several reasons: (1) It actively involves students in the learning process through activities such as exploration, group discussion, and project-based learning, which tend to increase student interest and motivation, (2) Its contextual approach, which connects learning to students' everyday lives, makes the content more meaningful, (3) The interactive nature of CoCoAER makes it easier for students to grasp complex concepts, and (4) The model's personalized approach allows students to learn at their own pace, which enhances satisfaction by making students feel valued and understood.

The Jigsaw model received a total score of 25, with a percentage of 50.0%, placing it in the "Fair" category. Several factors contribute to this lower satisfaction compared to CoCoAER: (1) Jigsaw requires effective teamwork, and if not all students are active or understand their roles, the learning process can be hindered, (2) Imbalanced contributions from group members can create an uneven learning experience, and (3) The time required for group members to share and combine information may be insufficient, causing the learning process to feel rushed.

Meanwhile, the conventional learning model scored a total of 20, with a percentage of 40.0%, placing it in the "Fair" category. The low satisfaction with this method can be explained by several factors: (1) Conventional learning is often one-way, with the teacher dominating the delivery of the material. This passive structure tends to limit student engagement and leaves little room for exploration or discussion, which diminishes students' active involvement in the learning process. (2) Conventional methods typically rely solely on lectures without the support of engaging learning media, which can lead to decreased student attention and interest. (3) These methods are often less responsive to the current generation's learning needs, as students tend to favor more interactive and engaging approaches.

This difference in satisfaction suggests that more innovative and interactive learning models, such as CoCoAER, align better with the needs of today's students. CoCoAER creates opportunities for students to actively engage, adapt to their individual learning styles, and enjoy a more meaningful and enjoyable learning experience. In contrast, traditional methods like Jigsaw and Conventional, despite having their own advantages, may not be as effective in maintaining student interest or providing an optimal learning environment. These results offer important insights for educators and institutions to consider adopting more innovative learning methods, such as CoCoAER, which not only increase student satisfaction but also have the potential to improve overall learning outcomes. However, it is crucial to continually assess the effectiveness of each method to ensure its suitability for the specific context and needs of the students.

The CoCoAER learning model proved to be the most effective in enhancing students' understanding of the concept of hydrostatic pressure, achieving a very high satisfaction score of 96%. This success is attributed to CoCoAER's interactive, contextual, and personalized approach. Additionally, the CoCoAER model effectively helps prevent student misconceptions in topics such as static electricity, falling into the "satisfied" category (Nazariani & Zainuddin, 2024; Safrizal, 2021). When compared to the Jigsaw learning model, which falls into the "good" category (50%), and the Conventional model, which also falls into the "good" category (40%), CoCoAER demonstrates superior effectiveness.

Several related studies support the efficacy of the Jigsaw model in improving student interest, motivation, participation, and learning outcomes (Damayanti & Rudyatmi, 2020). Furthermore, the implementation of the CoCoAER model according to its prescribed syntax has shown that student engagement is classified as "excellent" (Zainuddin et al., 2020). Other research also indicates that cooperative learning models like Jigsaw tend to yield better results than conventional methods (Nadrah, 2023) and the Jigsaw model has been found to enhance both student interest and learning outcomes (Darsan, 2022). The CoCoAER learning model has great potential as a primary strategy for teaching static fluids, as it emphasizes interactivity, real-world contextualization, and alignment with student characteristics factors that have been shown to significantly improve the quality of the learning experience. This approach fosters active student engagement, which helps reduce misconceptions, especially in abstract topics such as static electricity. Additionally, CoCoAER offers flexibility for educators to design activities that cater to the diverse needs and capabilities of students, thereby creating a responsive and supportive learning environment. Compared to the Jigsaw and conventional approaches, CoCoAER excels in terms of both effectiveness and student satisfaction. However, Jigsaw remains a valuable tool for enhancing group dynamics and motivating students. Therefore, widespread implementation of CoCoAER is highly recommended, with potential integration with collaborative methods like Jigsaw to create more engaging, adaptive, and effective learning experiences.

IV. CONCLUSION AND SUGGESTION

This study found that the CoCoAER learning model was significantly more effective than both the Jigsaw and conventional lecture methods in improving students' conceptual understanding of static fluid, particularly on the topic of hydrostatic pressure. The CoCoAER group achieved the highest average post-test score (86.00) and demonstrated the highest proportion of students in the high N-Gain category (73.3%). Statistical analysis confirmed a significant difference between the groups ($p < 0.05$), with CoCoAER outperforming Jigsaw and control methods. Additionally, student satisfaction was highest in the CoCoAER group, with 96% of students expressing a "very satisfied" response, indicating the model's effectiveness in promoting engagement, contextual learning, and cognitive development.

However, the study had several limitations. It was conducted at a single school with a limited number of participants and focused solely on the static fluid topic. Variability in teacher experience and students' prior knowledge may have also influenced the outcomes. Future studies should expand to other physics topics, involve diverse educational settings, and examine long-term effects of the CoCoAER model. Combining CoCoAER with digital learning tools or collaborative strategies such as the Jigsaw model may also yield richer insights. This research contributes to physics education by demonstrating how the CoCoAER model can address persistent misconceptions and improve student comprehension through interactive, contextual, and cooperative strategies. Its implementation offers a practical solution for enhancing physics instruction, particularly in challenging and abstract topics, and aligns with the demands of 21st-century science education.

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