Improving Critical Thinking Skills through a STEAM-Integrated SSCS Learning Model on Static Fluid Concepts

Luk Luk Iljannah[1], Parno[1]*, Sujito[1], & Nina Diana Nawi[2]
[1]Physics Education Study Program, State University of Malang, Indonesia
[2]Physics Education Study Program, University Teknologi Malaysia, Malaysia
*Corresponding Author: parno.fmipa@um.ac.id

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Abstract – *Critical thinking skills in static fluid materials remains suboptimal, necessitating the implementation of an instructional model that effectively enhances this skill. The STEAM-integrated SSCS learning model presents a novel solution that is still rarely applied in educational settings. This study aims to examine the effect of this model on improving students' critical thinking skills in static fluid materials. A quasi-experimental design with a Pretest-Posttest Control Group was employed, involving Class XI students from SMA Negeri 1 Boyolangu Tulungagung. Participants were selected using a cluster random sampling technique, comprising 37 students in the experimental class (STEAM-integrated SSCS model) and 34 students in the control class (conventional model). The instrument used was a Critical Thinking Skills Test on static fluid material, consisting of nine essay questions validated with a reliability coefficient of 0.625 (medium category). The analysis revealed that the STEAM-integrated SSCS model significantly improved students' critical thinking skills, as indicated by a significance value of 0.000. The experimental class obtained an N-Gain score of 0.678 (medium category), higher than the control class's score of 0.426 (medium category). N-Gain values for each static fluid submatter and critical thinking indicator were also consistently higher in the experimental class. Although improvements were observed, experimental class students still faced difficulties in problem-solving and decision-making, while control class students struggled with hypothesis testing. The model's effectiveness is further supported by a Cohen's d effect size of 1.997, categorized as "large". Future research should consider optimizing the learning time to complete the miniature products and increasing the number of pre-test and post-test items to allow for more comprehensive analysis of each submatter and could explore the application of STEAM-integrated SSCS across various physics topics to verify generalizability.*

Keywords *: SSCS; STEAM; Critical Thinking*

INTRODUCTION

21st century skills require critical thinking skills (Yennita & Zukmadini, 2021) which are considered among the most important because they enchance students' learning skills to engage in debates and discussions (Alsaleh, 2020; Toheri, Winarso & Haqq, 2020). This skills helps students be more analytical and think deeply (Safitri, Suyanto & Prasetya, 2024). This skills also helps students become independent and skilled in solving a problem (Saphira et al, 2022). In physics learning, students are encouraged to be able to identify, solve problems, analyse, conclude, and evaluate (Astutik et al, 2020). Moreover, critical thinking skills are essential for identifying the root cause of a problem and determining the most effective solution (Supena, Darmuki & Hariyadi, 2021).

The form of critical thinking skills proposed by Tiruneh is categorized into students' skills in reasoning, hypothesis testing, argument analysis, likehood and uncertainty analysis, and problem-solving and decision-making (Tiruneh et al, 2016). However, students' critical thinking skills are still not optimal, as indicated by difficulties in analyzing, determining formulas, and providing appropriate arguments (Suriati, Sundaygara & Kurniawati, 2021). In physics material, this skills also remain low (Eris, Sitompul & Oktavianty 2024), including static fluid material (Rahmatin et al, 2024).

Static fluid material is considered one of the most important materials in physics (Kurniawan et al, 2021; Nada et al, 2024). If students do not master this material, they may encounter significant difficulties in understanding related concepts (Kurniawan, 2021). This material has the nature of applying formulas, providing factual information, and many contextual applications in everyday life (Aneilla et al, 2023; Ate et al, 2022; Husniah et al, 2020; Widayoko, 2021). This material is classified as the most difficult among other materials (Berasa & Desnita, 2023). This is because there is not much direct and contextual material delivery such as project creation (Novianto et al, 2018). A common difficulty encountered in this topic is the persistent misconception among some students that an object's mass determines its position within a fluid (Halim et al, 2020; Mellu and Langtang, 2023), both the mass of the object and the volume of the displaced liquid influence the magnitude of the buoyant force. (Halim, 2020). The suboptimal understanding of this material affects students' critical thinking skills (Nolowala et al, 2024).

In the past five years, numerous pedagogical approaches have been utilized with the aim of fostering the increase of critical thinking skills among students, such as Curious Note Program (CNP) on Newton's law material (Azmi & Suliyanah, 2021), OIDDE on temperature and heat material (Lasmana et al, 2020), inquiry-flipped classroom on impulse momentum material (Koes-H et al, 2020), PBL-STEM on optical instrument material using virtual simulation medium (Parno et al, 2021), and ECIRR on travelling waves and stationary waves (Rohmah et al, 2023). However, these studies still have weaknesses, namely low critical thinking skills on evaluation indicators (Koes-H, 2020), low influence on certain submatters (Parno, 2021), passive students (Rohmah, 2023), and lack of student interest (Lasmana, 2020). Furthermore, studies on static fluid material are relatively infrequent.

Choosing an appropriate learning model is crucial, given the various limitations outlined above. An alternative model to foster this skills is SSCS (Nurizkia et al, 2025). The SSCS learning model expands conceptual knowledge in solving problems, fosters critical thinking skills (Putri, Q S et al, 2022) and increases student interest (Khodijah et al, 2024). The SSCS learning model enables students to engage actively in thinking, exchanging ideas, analyzing, and cultivating both problem-solving skills and self-efficacy (Zulkarnain et al, 2020). The SSCS learning paradigm states that in order for students to answer issues successfully, they must expand their conceptual knowledge, apply concepts in real-life contexts, and cultivate critical thinking skills (Putri, Q S, 2022; Zulkarnain, 2020).

The SSCS problem-based learning model developed by Pizzini consists of four learning steps (Pizzini et al, 1989). The steps of this SSCS learning model include search, solve, create, and share (Pizzini, 1989). The steps of this SSCS learning model include search by exploring a problem, solve by implementing a problem solving plan, create by producing solutions and evaluating what has been obtained from a product, share by communicating problem solving products (Maskur et al, 2022; Pizzini, 1989; Yasin et al, 2020). However, this model is still rarely used in static fluid material (Ambaryani et al, 2022). In addition, in SSCS the scientific method and product manufacturing do not have clear procedures. This can be overcome by integrating STEAM in learning (Febriansari et al, 2022).

STEAM aims to enhance students' critical thinking and creative skills through interdisciplinary learning that combines art and design (Chung et al, 2022). In the implementation of STEAM education, several activities are planned to prepare students for the design process and gain early experience before entering the design stage. These activities include experimentation, observation, and research (Erol et al, 2023). The integration of STEAM enables students to create science- and technology-based innovations, thereby enhancing their potential to compete globally (Ishartono et al, 2021).

The advancement of STEM education by including elements of art or "arts" into the curriculum is known as STEAM (Mu'minah & Suryaningsih, 2020). The five fields of science are integrated in STEAM which is an important discipline to be taught as a demand for the development of the 21st century (Mu'minah, 2020). STEAM learning produces outputs where students must process the data that has been received and then used to solve problems (Amirinejad & Rahimi, 2023). Students' critical thinking skills will grow as they solve challenges and come up with solutions when STEAM is incorporated into SSCS. In the classroom and in daily life, STEAM-based learning can improve critical thinking skills, especially in problem-solving and solution-finding (Hafizhah et al, 2024). Additionally, the STEAM method is beneficial since it helps enhance students' critical and creative thinking skills and facilitate their conceptual understanding. (Amiruddin et al, 2022).

Research combining SSCS and STEAM in static fluid learning remains very limited, thus offering a new direction in science education innovation. This study aims to examine the effect of the STEAM-integrated SSCS learning model on improving students' critical thinking skills regarding the concept of static fluids.

RESEARCH METHODS

This study was conducted using a quasi-experimental design with a Pretest-Posttest Control Group Design (Creswell & Creswell, 2018). A more detailed overview can be found in Table 1.

Tabel 1. Quasi Experiment Research Design

Pretest	Treatment	*Posttest*
O_1	X_1	O_2
O_1	X_2	O_2

Keterangan:

O_1 : Critical thinking skills pretest for experimental and control groups

X_1 : Implementation of the STEAM-integrated SSCS learning model in the experimental group

X_2 : Implementation of conventional learning model in the control group.

O_2 : Critical thinking skills posttest for experimental and control groups

Participants in this study were class XI MIPA students of SMA Negeri 1 Boyolangu, Tulungagung, in the odd semester of the 2024/2025 academic year. A cluster random sampling technique (Acharya et al, 2013) was utilized to select the sample, resulting in an experimental group (Class XI-2) consisting of 37 students and a control group (Class XI-3) consisting of 34 students.

This study utilized the Static Fluid Critical Thinking Skills Test as the primary research instrument. This study adopts a previous research test instrument consisting of 9 essay questions that have been tested for validity with a reliability of 0.625 in the medium category (Parno et al, 2022). In its implementation, the question numbers in the instrument were randomised. This is because to sort the question numbers according to the static fluid submatter.

The outcomes of the pretest and posttest were analyzed quantitatively. The data analysis technique employed includes descriptive statistical tests, including normality and homogeneity assessments (Usmadi, 2020), pretest initial similarity tests, and different tests using SPSS 25.0 for Windows software. The Independent Sample T-Test was conducted based on the pretest results, which met the assumptions of normality and homogeneity (Putri et al, 2023). The Mann Whitney Non-parametric Test was employed since the posttest results were normal and inhomogeneous.

Furthermore, the effectiveness of the intervention was assessed by calculating the N-Gain score, which measure the degree of improvement in students' critical thinking skills (Oktavia et al, 2019). N-Gain calculations were also carried out on each submatter and each critical thinking indicator. Finally, the effect size was calculated to evaluate the effectiveness of the STEAM-integrated SSCS learning model in improving students' critical thinking skills on the topic of static fluids (Khairunnisa et al, 2022).

RESULTS AND DISCUSSION

Results

The descriptive statistical test result are presented in Table 2.

Table 2. Descriptive Statistical Test Results

Descriptive Statistic				
	Experiment		Control	
	Pretest	*Posttest*	*Pretest*	*Posttest*
N	37	37	34	34
Lowest score	14.810	62.960	7.410	29.630
Highest score	62.960	92.590	62.960	77.780
Average	35.035	79.79	32.789	61.438
Standard Deviation	12.177	6.545	15.849	10.638

As presented in Table 2, the pretest scores of both groups were relatively comparable; however, the experimental group demonstrated significantly higher posttest performance compared to the control group. Thus, it can be inferred that the implementation of the STEAM-integrated SSCS learning model led to a more effective improvement in students' critical thinking skills compared to conventional learning methods.

To perform the t-test on both pretest and posttest data, the assumptions of normality and homogeneity must first be fullfiled. The normality test results are presented in Table 3 below.

Table 3. Normality Test Results

Normality Test					
Class	Value	*Shapiro-Wilk*			Description
		Statistic	*df*	*Sig.*	
Experiment	*Pretest*	0.950	37	0.095	Normal
	Posttest	0.947	37	0.075	Normal
Control	*Pretest*	0.952	34	0.139	Normal
	Posttest	0.945	34	0.090	Normal

All of the data were found to be normally distributed based on Table 3. The homogeneity test results are presented in Table 4.

Table 4. Homogeneity Test Results

Homogeneity Test					
Value	*Levene Statistic*	*df 1*	*df 2*	*Sig.*	Description
Pretest	3.653	1	69	0.060	Homogeneous

Posttest	5.059	1	69	0.028	Inhomogeneous

Table 4 indicates that the pretest data originates from a population that is homogeneous, while the posttest data comes from an inhomogeneous population.

Since the pretest data met the assumptions of normality and homogeneity, an independent t-test was utilized as a parametric test to assess the differences. The initial state similarity test results are presented in Table 5.

Table 5. Initial State Similarity Test Results

Independent Sample-T test					
	F	Sig.	t	df	Sig.(2-tailed)
Pretest	3.653	0.060	0.673	69	0.503

The significance value, as determined by Table 5 is 0.503. It can be concluded that there is no statistically significant difference in critical thinking skills between the experimental and control groups in the pretest, as the significance value is ≥ 0.05. This implies that if a change in skills occurs at the conclusion of the research action, it is entirely the result of the action.

A non-parametric, the Mann Whitney test, was employed because the posttest data satisfied the normality assumption but did not meet the homogeneity requirement. The results of differential test of critical thinking skills are presented in Table 6 below.

Table 6. Results of Differential Test of Critical Thinking Skills

Value	Sig. Mann Whitney
Posttest	0.000

The significance value as determined by Table 6 is 0.000. Given that the significance value is < 0.05, it can be concluded that there is a statistically significant difference in critical thinking skills between the experimental and control groups on the posttest. This indicates that the STEAM integrated SSCS model which was used in the experimental class was more effective than the traditional model in the control group at increase critical thinking skills.

Table 7 below displays the outcomes of the N-Gain Score calculation.

Table 7. N-Gain Score Calculation Results

Class	N-Gain	Category
Experiment	0.678	Medium
Control	0.426	Medium

Table 7 shows that although both classes are in groups with different treatments, the N-Gain score of the experimental class for critical thinking skills is higher than the control class. This N-Gain result confirms previous findings, which indicate that the use of the STEAM-integrated SSCS model by the experimental class improves critical thinking skills more than the use of the traditional model by the control group.

Table 8 below shows the N-Gain value for each submatter.

Table 8. N-Gain Calculation Results Submatter

Submatter	Class			
	Experiment		Control	
	N-Gain	Category	*N-Gain*	Category
Hydrostatic Pressure	0.542	Medium	0.350	Medium
Archimedes' Law	0.798	High	0.468	Medium
Surface Tension	0.468	Medium	0.320	Medium
Capillarity	0.824	High	0.433	Medium
Viscosity	0.966	High	0.741	High

Table 8 shows that for every submatter, the experimental class's N-Gain values are consistently higher than the control class's. In fact, the N-Gain value of the experimental group was slightly higher than that of the control group for the submatters of Archimedes' Law and capillarity. Furthermore, both groups appeared to obtain the highest N-Gain value on the same submatter, namely viscosity and the lowest on the submatter of surface tension.

The N-Gain values per critical thinking' indicator are presented in Table 9.

Table 9. Indicator N-Gain Calculation Results

Indicators	Class			
	Experiment		Control	
	N-Gain	Category	*N-Gain*	Category
Reasoning	0.810	High	0.409	Medium
Hypothesis Testing	0.391	Medium	0.250	Low
Argument Analysis	0.753	High	0.457	Medium
Likehood and Uncertainty Analysis	0.966	High	0.741	High
Problem-solving and Decision-making	0.376	Medium	0.311	Medium

Table 9 shows that for every indicator, the experimental class's N-Gain values are greater than the control class's. Notably, for the first three indicators, the experimental class achieved an N-Gain level one category higher than that of the control class. It is also evident that both classes attained their highest N-Gain on the same indicator, namely Likehood and Uncertainty Analysis. However, the Problem-solving and Decision-making indicators in the experimental class exhibited the lowest N-Gain, while the Hypothesis Testing indicator showed the lowest N-Gain in the control class.

To assess the impact of the STEAM-integrated SSCS learning model on enhancing students' critical thinking skills in the subject of static fluids, Cohen's d effect size was calculated, yielding a value of 1.997, which falls into the 'large' category. This indicates that the large-scale implementation of this learning model has a substantial impact.

Discussion

According to the results of the data analysis, the enhancement of students' critical thinking skills is more effective through the application of the STEAM-integrated SSCS learning model than through the traditional learning model. Previous research supports this idea, showing that the SSCS learning model improves critical thinking skills related to heat and temperature matter better than conventional learning models (Handayani et al, 2021). According to additional supporting research, the SSCS learning model improves students' critical thinking skills better than conventional learning models (Arisa et al, 2021). Other research indicates that the SSCS learning model not only teaches students how to solve problems, but also helps them develop critical thinking skills (Putri, Q S, 2022). This study showed that in students' posttest answers, students with the STEAM-integrated SSCS learning model were more detailed and critical than students with conventional learning models.

The following teaching practices are associated with the success of the STEAM-integrated SSCS model in enhancing critical thinking skills. During the two cycles of implementing the STEAM-integrated SSCS learning model, students actively asked questions, discussed, and were able to solve problems. The implementation of the SSCS learning model enables students to apply their critical thinking skills in problem-solving situations (Zulkarnain, 2020). Outside of learning, students are active in consulting about the miniature products that are being worked on. In this case, the teacher frees students to be creative and innovative. Students felt responsible for the tasks given starting from making miniature products, making posters, and completing LKPD. This finding is supported by other studies indicating that the implementation of the SSCS learning model helps guide students more effectively in discussions and problem-solving activities (Yasin, 2020). Moreover, existing studies indicate that the SSCS learning model enhances students' critical thinking skills. (Fitriyah et al, 2024). Incorporating STEAM into the SSCS learning model improves students' critical thinking skills. This is due to the fact that STEAM integration can generate critical ideas that can help solve problems (Fitriyah & Ramadani, 2021). Similar research shows that integrating STEAM can increase students' capacity to use critical thinking to solve problems (Sulastri & Cahyani, 2021). This indicates that incorporating STEAM into the SSCS learning model not only enhances students' critical thinking skills but also motivates them to engage more actively in developing creative solutions to the challenges they encounter.

The study results revealed that while both the STEAM-integrated SSCS and conventional learning models fell within the moderate category, the N-Gain score of the class using the STEAM-integrated SSCS model was higher than that of the class using the conventional model. This happens because the activity of making miniature products of hydraulic bridges and ships as a solution to real daily problems in STEAM-integrated SSCS learning, and this does not happen at all in conventional learning. This enables students in the experimental class to become accustomed to engaging with phenomena encountered in contextualized, real-life situations, conducting experiments, determining the best materials, designing and testing miniature products. By creating miniature products, the STEAM approach encourages students to actively talk about their conceptual understanding of static fluid materials. According to relevant research, the SSCS learning model has a positive impact, as evidenced by the improvement in critical thinking skills following its implementation (Handayani, 2021). Previous research applying the SSCS model showed an N-Gain value of 0.59 (Arisa, 2021). This indicates that the STEAM integrated SSCS learning is more comprehensive, resulting in greater improvement in critical thinking skills as shown by an N-Gain score of 0.678.

This study also calculated the N-Gain values for each submatter. The highest N-Gain was observed in the viscosity submatter for both the experimental and control classes. It appears that students have understood the viscosity submatter and have not understood the surface tension submatter. Supporting research indicates that the N-Gain value for the viscosity submatter is higher than that of other submatter in both the experimental and control classes (Parno et al, 2020). Question number 9 discusses the viscosity submatter by presenting an oil drop experiment that requires students to calculate the speed of oil in the air. While a number of students in the control class did not respond, the majority of students in both the experimental and control classes were able to accurately calculate the terminal velocity value.

The STEAM integrated SSCS instructional model enhances students’ skills to comprehend the viscosity submatter effectively. Through structured experimental activities, students are systematically guided to identify problems and develop solutions throughout the learning process. This is in accordance with the character of SSCS learning which helps students understand and construct concepts in an organised manner (Luthfiyah et al, 2021). A different study that implemented the STEM approach alongside formative assessment within a Problem-Based Learning (PBL) framework on static fluid material reported an N-Gain score of 0.364 for the viscosity submatter, which is categorized as medium (Parno et al, 2021). This indicates that the viscosity submatter taught using the STEAM-integrated SSCS learning model, which achieved an N-Gain of 0.966 in the high category, is more effective than the STEM approach alongside formative assessment within a Problem-Based Learning (PBL).

The lowest N-Gain was observed in the surface tension submatter. In question number 4, a paper clip experiment was presented, and students were required to identify the source of the problem and propose a potential solution plan. Most students in the experimental class could mention two solutions but had not linked them to the concept of surface tension. Meanwhile, in the control class most students could only mention one solution. In question number 5, a picture and statements related to surface tension events experienced by mosquitoes were presented, students were asked to determine the truth of the statements presented. Most of the experimental class's students were able to assess the statement's veracity and connect the idea of surface tension to the phenomena they saw. Meanwhile, in the control class, most students could assess the truth of the statement and explain the concept of surface tension but could not relate the concept of surface tension to the events that occurred.

Based on the description above, students who take part in STEAM-integrated SSCS learning have a better understanding of the surface tension submatter. In the learning process on this submatter, students conduct surface tension experiments that allow students to actively ask questions. The SSCS learning model is effective in fostering active student engagement throughout the learning process (Anshori & Masriyah, 2023). Other research shows that the difficulty in surface tension submatter is higher than that of hydrostatic pressure submatter (Parno, 2021). Compared to other submatters, the surface tension submatter showed the lowest N-Gain value.

Meanwhile, the experimental class consistently demonstrated higher N-Gain improvements across all submatters compared to the control class. This is because in learning, the STEAM approach can increase motivation, encourage critical thinking, and make science learning more interesting (Conradty & Bogner, 2019). Making miniature ship products allows students to explore concepts through discussions in solving problems. Students learn new situations and solve problems realistically during SSCS learning (Agustin et al, 2018). Students are guided to conduct experiments so as to foster students' scientific attitudes (Khaillasiwi et al, 2020). In addition, through experiments using the STEAM approach allows students to easily understand learning (Shatunova et al, 2019). The STEAM approach to learning not only deepens conceptual understanding but also fosters students' critical, creative, and innovative thinking in problem-solving through exploration and experiential learning.

Not only that, the results of this study also calculated the N-Gain per indicator. Both classes obtained the highest N-gain on the indicator of Likehood and Uncertainty Analysis. Critical thinking indicators analyse possibilities and uncertainties contained in question number 9. In question number 9, requiring students to calculate the velocity of the oil in air. In the experimental class, students were able to answer questions and Likehood and Uncertainty Analysis of the questions given. In this indicator, the average student is able to answer the question well. Meanwhile, in the control class, some students responded to the questions without conducting a proper analysis of the calculations. This is because in learning in experimental classes students conduct experiments and test miniature products that have been made. In learning in experimental classes, students are required to determine the best solution from possible alternatives. In the meantime, throughout the control class's learning process, students have no experience in experiments and lack of practice in analysing factors that affect the results of experiments. The higher improvement in indicator Likehood and Uncertainty Analysis suggests that hands-on product creation activities foster deeper cognitive engagement compared to conventional methods.

STEAM integrated learning trains students to deal with everything through the miniature product project given (Mu'minah, 2020). Research focusing solely on SSCS or solely on STEAM in relation to the Likelihood and Uncertainty Analysis indicator is still difficult to find. This suggests that the integration of SSCS with STEAM is relatively new. Therefore, what can be done is to compare this integrated model with other learning models based on the same indicator. In comparison to other studies that utilized the STEM approach combined with formative assessment in Project-Based Learning (PjBL) on static fluid material, the Likelihood and Uncertainty Analysis indicator achieved an N-Gain score of 0.44, placing it in the medium category (Parno, 2022). This demonstrates that the STEAM integrated SSCS learning model is superior at enhancing critical thinking skills based on the indicator of Likehood and Uncertainty Analysis, with an N-Gain of 0.966 in the high category.

In the meantime, it is clear that the experimental class's gain in N-Gain across all indicators is higher than the control class's. This is because the STEAM approach helps students think critically in understanding concepts in depth and applying them in real conditions (Hasani et al, 2024). Students are encouraged to create hypotheses through practical experiments when learning using the STEAM approach (Ashirov and Imankulov, 2024). Students' critical thinking skills can improve through debate, opinion sharing, and problem solving (Putri et al, 2024). In the experimental class, the learning process requires students to deepen their conceptual understanding in order to solve problems, apply knowledge to real-life situations, and enhance their critical thinking skills (Putri, Q S, 2022; Zulkarnain, 2020). Teachers use this SSCS learning paradigm to give students experience to students to increase student knowledge by implementing learning through groups that aim to facilitate discussion activities so that there is active interaction between students (Zulkarnain, 2020). The active interaction between students in this learning allows for a more dynamic exchange of ideas, so students are more motivated to explore solutions critically and systematically.

Analysis of the Cohen's d effect size of 1.997 computation results. When used extensively in the field to teach static fluid material, the STEAM-integrated SSCS learning paradigm significantly affects students' critical thinking skills. Because SSCS is a student-focused learning model, which teaches students how to solve their own problems by breaking them down into several phases (Khaillasiwi, 2020). In addition, students are assisted in connecting the material learned and its application in various other fields of science through group discussions (Khaillasiwi, 2020). STEAM motivates students to seek solutions to every issue and gives them a sense of involvement in the learning process (Fadhilah, 2022), which in this STEAM approach focuses students on having critical thinking skills (Sartono et al, 2020). Compared to previous research that utilized only the SSCS model, the effect size was shown at 0.44, which shown within the medium category (Nurizkia, 2025). This demonstrates that the SSCS learning paradigm with STEAM integration is superior for enhancing critical thinking skills.

CONCLUSION

The following conclusions can be made in light of the findings that were previously presented. Students who were taught using the STEAM integrated SSCS model demonstrated a greater improvement in critical thinking skills compared to those taught through conventional model. This is evidenced by the N-Gain score of the experimental class, which was 0.678 (medium category), higher than that of the control class, which was 0.426 (also in the medium category). Furthermore, the N-Gain values for each submatter of static fluid and each critical thinking indicator in the experimental class exceeded those of the control class. The effectiveness of the STEAM-integrated SSCS model in enhancing students' critical thinking skills on static fluid material is further supported by a Cohen's d effect size value of 1.997, indicating a large effect. The limitation of this study is that the indicator of solving problems and making decisions is the lowest increase among other indicators. Therefore, it is recommended to be more optimal in obtaining the necessary data and considering the allocation of learning time so that it is more efficient in completing miniature products. In addition, future researchers are advised to add the number of questions on the pretest and posttest so that each submatter can be analysed and could explore the application of STEAM-integrated SSCS across various physics topics to verify generalizability.

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