

APPLICATION OF STRUCTURED INQUIRY LEARNING MODELS TO ENHANCE STUDENTS' CRITICAL THINKING SKILLS

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Abstract: This study aimed to describe the implementation of learning, the improvement of students' critical thinking skills, and the student responses after applying the structured inquiry learning model to the sub-material of fluid pressure. This type of research used a pre-experimental design with one group pretest-posttest design. The research subjects used were students of the public junior high schools in Surabaya, Indonesia. This study used several instruments in the form of learning implementation observation sheets, test sheets, and questionnaire sheets which were then analyzed by quantitative description. The results showed that the implementation of learning obtained very good criteria with mode 4. Normality tests, paired t-tests, and N-Gain were used to analyze research data. The result of the standard test is significant. The value is 0.122, which means the data is normally distributed. Paired t-test produces a Sig value of 0.000 < 0.05, which means a significant difference after being given treatment in a structured inquiry learning model. The improvement of students' critical thinking skills can also be seen from the N-Gain results on each critical thinking skill indicator with a score of 0.81 (high), 0.77 (high), 0.91 (high), 0.76 (high), and 0.84 (high). Students gave positive responses to the application of this learning model with an average score of 93.81%, and the criteria were very high. These results indicate that students' critical thinking skills can improve after the applied structured inquiry learning model.

Keywords: *Structured Inquiry, Critical Thinking Skills, Fluid Pressure*

INTRODUCTION

The learning process is all activities planned with an effort to teach students to achieve expected goals [1]. The crucial thing in education is balancing learning processes and outcomes. A balance can be achieved if a teacher can perform his duties to the maximum. The component in education has a very important role in the curriculum [2] because the curriculum is a guide to the implementation of learning and one of the media to get the purpose of education. Now applies the 2013 curriculum, which requires students to be active while learning. In addition, with the 2013 curriculum, students are expected to have the best competence in terms of attitude, skills, or knowledge to face the ever-evolving era [3].

The process of learning natural sciences requires students to cultivate and discover for themselves the knowledge obtained, to be able to master various facts and concepts of natural science and apply a scientific attitude. Based on this, students must be directly involved by making observations or practicums. For the expected goals to be achieved, teachers need to carry out learning in a scientific inquiry [4]. In addition, learning must apply innovative learning models so that students are active in building student competencies and need to apply meaningful learning so that they are expected to practice students' critical thinking skills [5].

An important goal in education is one of them is critical thinking skills. In the 21st century, students need many skills to be mastered, one of which is critical thinking skills, so these skills must be trained [6]. If students master these skills, then students will

potentially have the ability intellectually and capably to solve problems in demand, be creative, think sensibly, and face the demands of the times [7].

The 2021 observation at the State Junior High Schools in Surabaya showed obstacles when learning took place, including natural sciences materials that were considered difficult. During the pandemic, there were no practicums, active teachers, low high order thinking skills, and students were less active. In addition, PISA (Programme for International Student Assessment) assesses students' reasoning levels, including critical thinking skills. Based on the survey results, the achievements achieved by students in PISA in recent years are very concerning; namely, from 2000 to 2018, Indonesia has been consistently ranked in the bottom 10 [8]. Liquid substance pressure sub-chapter material is a matter of physics, where this material is material is considered difficult for most students and must be understood. Data from the previous year showed a low value of student completion. The cause of students' low critical thinking skills is off them because the model given when learning is less varied and tends to be teacher-centered [9].

Structured inquiry is one model that corresponds to students' current curriculum and critical thinking skills. One of the advantages of inquiry learning is that it helps students improve critical thinking skills [10]. A previous study suggested that the inquiry model could improve the critical thinking skills of students [11][12]. Improving students' critical thinking skills at State Junior High Schools in Surabaya can use structured inquiry learning models. Llewellyn classifies the

inquiry into 4, namely Demonstration Inquiry, Structured Inquiry, Guided Inquiry, and Free Inquiry [13]. When sorted from the lowest, structured inquiries are on the second level. At this stage, the teacher still provides problem formulations and experimental procedures. At the same time, students are responsible for explaining the experiment's results based on the data that has been obtained [14]. Students in class VII have never practiced because of the impact of covid-19, so teachers need to guide when practicum. Through Structured Inquiry, students can conduct an experiment that makes students understand liquid pressure materials.

Phases in structured inquiries can support indicators of critical thinking skills. This research update lies in the sub-indicators of critical thinking skills, sub-materials, and the subject of the study. In previous studies, the skill indicators used include presenting hypotheses, writing down experimental results, acting by providing follow-up explanations, and drawing conclusions [15]. The sub-indicators of critical thinking skills are identifying or formulating questions, considering observation results, considering the use of appropriate procedures, writing observation results, drawing conclusions from the results of investigations, posing hypotheses, acting by providing advanced explanations using logic strategies, determining an action, and formulating alternative solutions. Liquid pressure is a sub-material used, while the research subject is a student at one of the State Junior High Schools in Surabaya. This study has the objectives: (1) Describe the implementation of the structured inquiry learning model towards improving students' critical thinking skills; (2) Describe the improvement of students' critical thinking skills after the implementation of the structured inquiry learning model (3) Describes the student's response to the structured inquiry learning model.

RESEARCH METHODS

This study used a pre-experimental type. The research design uses a "One group pretest-posttest design" where the subject is only 1 class without the following control classes [16]:

$$O_1 \text{ X } O_2$$

Information: O_1 = Pretest students before learning; X = use of structured inquiry model; O_2 = Student posttest after learning

The research subject was directed at one of the State Junior High Schools in Surabaya with 36 students of class VIII-A, which was divided into two sessions where one session consisted of 18 students.

The study used several instruments:

1. Observation Sheet of Learning Implementation
 This sheet is a table containing several components in the form of preliminary, core, and closing activities, phases of structured inquiries, teacher and student activities, and assessment of

learning implementation using the Likert scale. In addition, the evaluation and the name and signature of the observer at the end. This sheet helps evaluate the quality of the implementation of the learning process and whether or not it matches the full syntax of the structured inquiry learning model according to the learning implementation plan that has been created—three observers judge. Observers judge by giving a checklist mark.

2. Critical Thinking Skills Assessment Test Sheet

This instrument contains an assessment sheet on students' critical thinking skills in the form of pretests and posttests. The test includes ten multiple-choice questions and five descriptions. It contains indicators of critical thinking skills, namely providing simple explanations, building basic skills, concluding, providing advanced explanations, and organizing strategies and tactics.

3. Questionnaire Sheet

This sheet contains several components in the form of titles, filling instructions, and tables. There are numbers, 15 statements and very disapproving, disapproving, agreeing, and strongly agreeing statements filled out by students. Students fill in by providing a checklist mark. This sheet is useful for knowing student responses after applying the Structured Inquiry model.

The data collection methods used include:

1. Observations are needed to find out the teacher's activities.
2. Test to find out the improvement of critical thinking skills.
3. Questionnaire or questionnaire method to get student reactions after applying this model.

The data analysis techniques used are as follows:

1. Analysis of Learning Implementation

In the learning implementation plan, the Structured Inquiry learning model obtained data about the teacher's activities during learning. Data is obtained from the observation sheet in the form of observer assessment results in the form of assessment scores which are then analyzed by determining the mode of each aspect based on the criteria for learning implementation. Mode is data that is often seen or has the highest frequency based on observations obtained [17]. Table 1 shows the learning implementation criteria.

Table 1. Learning Implementation Criteria

Score	Criteria
4	Very Good
3	Good
2	Enough
1	Not Good

2. Critical Thinking Skills Assessment Test Data

1) Normality Test

This test is useful for knowing whether or not the data is distributed normally, and one of them can use the Kolmogorov Smirnov Test [18]. Research data is normal if the signification value > 0.05 and the research data is not normal if the signification value < 0.05 [19]. This data analysis technique uses SPSS 25.

2) A paired t-test (paired t-test)

The paired t-t test is one of the hypothesis testing methods in which the data used is paired. This test is useful for finding out the average difference between two variables. The t-pair test is tested through SPSS 25 based on decision making if the signification value > 0.05, and H0 is not accepted if the signification value < 0.05 [20].

3) N- Gain

N-Gain (normalized gain) is used to measure the improvement of students' critical thinking skills before and after the structured inquiry model is applied. Here is the formula of N-Gain:

$$N\text{- Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \times 100\%$$

Table 2 shows the normalized Gain criteria [21] .

Table 2. Normalized Gain Criteria

Normalized Gain Value	Interpretation
$0.70 \leq N\text{-Gain} \leq 1.00$	High
$0.30 \leq N\text{-Gain} < 0.70$	Moderate
$0.00 < N\text{-Gain} < 0.30$	Low
$N\text{-Gain} = 0.00$	No increase
$-1.00 \leq N\text{-Gain} < 0.00$	There was a decrease

3. Questionnaire Data

A score is given for each number of questionnaires following the Likert scale (Table 3).

Table 3. Likert scale rating

Answers	Score Scoring
Strongly agree (SS)	4
Agree (S)	3
Disagree (TS)	2
Strongly disagree (STS)	1

The results of student response data are then analyzed by calculating the percentage of student responses in each statement submitted with the formula:

$$\text{Percentage} = \frac{\text{Number of values obtained}}{\text{Maximum value}} \times 100\%$$

Table 4 shows the criteria for each student's response [18].

Table 4. Response Criteria on Questionnaire

Response	Criteria
$85\% \leq \text{response}$	Very High
$70\% \leq \text{Response} < 85\%$	High
$50\% \leq \text{Response} < 70\%$	Less High
$\text{Response} < 50\%$	Less High

RESULT AND DISCUSSION

This study resulted in: (1) The implementation of the Structured Inquiry model; (2) Improvement of critical thinking skills; (3) Student response after the implementation of the Structured Inquiry model.

The implementation of the learning model used was observed by three observers consisting of 1 teacher of junior high school (SMP Negeri 49 Surabaya) and two students of Science Education, State University of Surabaya. The Structured Inquiry learning model has a learning syntax of 4 as follows: (1) Identify questions; (2) Conduct experiments; (3) Data analysis; (4) Conclusion (Eldiawati, 2018). The syntax execution of structured inquiry learning models is assessed using values from 1 to 4. The results showed that implementing the structured Inquiry model on the liquid pressure sub-material from meeting I to meeting III has a mode four categorized very well. It can be stated that the implementation of the structured inquiry in the liquid pressure sub-material is very good.

Critical thinking skills can be improved by carrying out data analysis using normality tests, t-pairing tests, and calculating N-Gain scores analyzed based on student test results. Here are the results of the normality test:

Table 5. Normality Test Results One- Sample Kolmogorov-Smirnov Test

N (Number of students)	Asymp. Sig (2-tailed)
36	0.122

Table 5 can be stated that the normality test using SPSS 25 gets the Asymp value. Sig is 0.122 > 0.05. The results showed normal distribution data. After that, a t-test is carried out in pairs (Table 6).

Table 6 above shows that the paired t-test returns a Sig value of 0.000 < 0.05. It can be known that there is a significant difference between the critical thinking skills values of students before and after the implementation of this model. Improvements in critical thinking skills can also be known based on the results of the N-Gain score in each indicator. Here is a table of N-Gain scores for each indicator of critical thinking skills:

Table 6. Test Results t- Paired (Paired Sample Test)

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest-Posttest	-58.58333	10.22706	1.70451	-62.04367	-55.12299	-34.370	35	0.000

Table 7. N- Gain Each Critical Thinking Skills Indicator

No.	Critical Thinking Skills Indicator	Average Pretest Score	Average Posttest Value	N- Gain	Gain Categories
1	Giving a Simple Explanation	7.08	17.63	0.81	High
2	Building Basic Skills	5.69	16.8	0.77	High
3	Conclude	5.43	18.75	0.91	High
4	Provide Advanced Explanations	3.34	16.12	0.76	High
5	Setting Strategies and Tactics	6.53	17.91	0.84	High

Based on the N-gain's interpretation criteria, the gain obtained falls into the high category. It can be interpreted that there is an increase in critical thinking skills after implementing the Structured Inquiry learning model on the liquid pressure sub-material.

Student responses during learning using this model can be seen in the questionnaire filled by students. The student response results of the 15 statements that have been made produce the following percentages (table 8).

The lowest response is 87.60%, having a very high criterion in statement number 5. The highest response is 99.30%, with a very high criterion, namely in statement number 15. The average overall response result was 93.81%, having very high criteria. Students' response to the applied learning model is very high based on these results.

The learning was held in as many as three meetings. At meeting 1, the student was given a pretest and practicum hydrostatic pressure question. At meeting 2, the practicum of Archimedes law, and the meeting of 3-pascal legal practicums, giving posttest questions filling out student response questionnaires. Activities in learning include an introduction, core, and cover. In this activity, four structured inquiry phases include the question identification phase, conducting experiments, data analysis, and conclusions [22]. The results of the implementation analysis show the mode value for meetings 1, 2, and 3, namely 4, with excellent criteria. During the learning process, the teacher serves to facilitate students. A study mentions that the implementation of this model of teachers has a role in facilitating students, while students must be active [23]. According to a study, teachers agree that active interaction is very important, and online learning cannot replace it [24].

Table 8. Student Response Results Recapitulation

Statement Number	Percentage (%)
1	92.30
2	93.75
3	91.60
4	93.75
5	87.60
6	93.05
7	88.88
8	95.83
9	97.91
10	96.52
11	95.13
12	90.97
13	95.83
14	95.13
15	99.30
Average	93.81

Critical thinking skills are competencies demanded from students in the face of the times, so every student must improve these skills [25]. The improvement of critical thinking skills can be seen from the results of pretests and posttests. The test question contains critical thinking indicators and critical thinking sub-indicators from R. Ennis. Essential indicators of thinking provide a simple explanation. The sub-indicator used is to identify or formulate questions. In indicators building basic skills, the sub-indicators used are considering the results of observations, using appropriate procedures, and writing the results of observations. In the indicator concluded, the sub-indicator used is to draw conclusions from the investigation results and put

forward a hypothesis. In the indicator provides an advanced explanation, the sub-indicator used is to act by providing further explanations. In critical thinking indicators, set strategies, and tactics, the sub-indicators use logic strategies, determine action, and formulate alternative solutions [26].

The results of the normality test, t-pairing test, and N-Gain stated that the structured Inquiry model influenced the improvement of students' critical thinking skills. Learning using structured inquiries affects the improvement of student science literacy and has a positive impact on students, including critical thinking skills. In addition, it also has a positive impact on student development [27]. N-Gain is made on each indicator of critical thinking skills. The highest N-Gain result of 0.91 is on the critical thinking indicator concluding with high criteria. This result is from a study that states that the application of Inquiry learning directs students to analyze and find information themselves to make it easier for them to make conclusions based on facts or research results that have been done [28]. In the application of the inquiry model, teachers as facilitators play a role in encouraging students to think critically and discipline students. In addition, create a comfortable and pleasant atmosphere for students to express themselves to allow them to make decisions, including formulating appropriate conclusions based on the results of experiments [29]. The lowest critical thinking skills indicator, among others, is the indicator that provides a follow-up explanation with a score of N-Gain of 0.76 with high criteria. The factor that makes the indicator provide an advanced explanation has the lowest N-Gain is caused by the habits of students who tend to refer to formulas. When analyzing the results of experiments by providing advanced explanations, students are less able to connect with theory. A study also stated that the indicator provides an advanced explanation to get the lowest percentage of success compared to other indicators with a percentage of 60% (medium) [30].

There are three activities in each meeting: introduction, core, and closing. At the beginning of learning, perception is given to students, conveying the subject matter to be discussed, providing motivation, and conveying learning goals. Perception encourages learners to recall the information they have and their preparation for learning [31]. Students are delighted when given motivation by teachers presenting real problems. At the time of learning, active interaction between teachers and students is very important, including when teachers provide motivation [24]. They watched the explanation from the teacher closely. Many students ask about the explanations presented so that students get preliminary knowledge of the material to be discussed. There is a relationship between structured inquiry and critical thinking skills. The syntax contained in the structured inquiry model can support the indicator contained in critical thinking skills [15].

Students will think about the provisional conjecture of the experiment being conducted in the question identification phase. In this phase, students are trained one of the indicators of critical thinking, namely writing hypotheses. When the teacher gives an illustration in the learner worksheet and shows the formulation of the problem used in the experiment, students will try to develop a hypothesis. The illustrations given to students are real examples that have something to do with the material at the meeting. Previous research suggests that real phenomena in everyday life are needed when studying natural sciences [32].

In the experimental phase, students carry out experiments following the steps of the experiment in the learner's worksheet. In this phase, students are trained one of the indicators of critical thinking, namely writing the experiment results. Experiments need to be conducted aimed at obtaining evidence from the formulation of problems that previously existed, and they can play a direct role [33]. Students write the trial results data into tables contained in the learner's worksheet based on the experiments they conducted. In addition, they discussed with each other to conduct experiments properly according to the steps.

In the data analysis phase, students will analyze data and answer all questions in the student worksheet by discussing in groups and independently looking for answers in the book and on the internet. When discussing, they exchanged ideas to solve all the questions. After that, they will discuss the best answer to each question again; 70% of students agree that in the discussion, they are more able to express their opinions [34]. In this phase, students are trained one of the indicators of critical thinking, namely giving further explanations. They will relate the results of the practicum and existing theories.

In the last phase of the conclusion, students and their groups will provide conclusions by formulating problems that have previously been known to students. This stage can train critical thinking skills in the form of concluding. Students are required to be able to conclude the results of the experiment. Problems can be solved if they are analytically critical [35]. After this stage, they will convey the experiment results with a presentation.

Responses from students are given after the implementation of treatment. The highest response was 99.30% who started learning natural sciences in liquid pressure sub materials using the structured Inquiry learning model made it easy for students to formulate conclusions. The constructivist theory says that teachers provide facilities for students to get their information to make the learning process meaningful for students [36]. A study also states that in the application of the Inquiry model, teachers play a role in encouraging students, disciplining students, and creating a comfortable atmosphere for students to express themselves to allow students to make decisions, including in terms of formulating

appropriate conclusions based on the results of experiments [29]. The second highest response was 97.91%, who stated that the structured Inquiry learning model could eliminate students' boredom while studying in the classroom. Recent research says that the Inquiry model can overcome student saturation while studying in the classroom [37]. The third highest response was 96.52% which stated that students were more excited to learn in the classroom using a structured Inquiry learning model. This model can make all students more excited so that it will positively affect their learning outcomes [38]. The average student response, 93.81%, has very high criteria. Based on these results, students' response to implementing a structured inquiry model of crystal is very high.

The Structured Inquiry learning model can improve students' critical thinking skills due to influencing factors. The structured inquiry itself is a means that has the potential to improve indicators of critical thinking skills. In this model, the teacher still provides problem formulations, and experimental procedures are very helpful for students in solving existing problems. However, students are still responsible for explaining the results of the experiment based on the data that has been obtained so that students will think critically about the results of the experiments that have been conducted and will analyze every information obtained. Another influencing factor is the active involvement of students during the learning process. Students are very enthusiastic and pay attention to the teacher's explanation. The role of the teacher as a facilitator also helps improve students' critical thinking skills.

CONCLUSION

Based on the results of research and discussion, the implementation of the structured inquiry learning model can be carried out very well. It is based on the assessment results of the learning model's performance with excellent criteria. Students also experience improvements in critical thinking skills. It is evidenced by the results of the t-pairing and N-Gain tests. Student response to implementing the structured Inquiry learning model received an average score of 93.81%, with very high criteria.

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