



THE EFFECTIVENESS OF GUIDED INQUIRY AND INSTAD TOWARDS STUDENTS' CRITICAL THINKING SKILLS ON CIRCULATORY SYSTEM MATERIALS

B. K. B. Putra*¹, B. A. Prayitno², Maridi³

^{1,2}Post-Graduate Science Education Program Departement, Sebelas Maret University of Surakarta, Indonesia

³Department of Biology Education, Sebelas Maret University of Surakarta, Indonesia

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ABSTRACT

Critical Thinking Skills (CTSs) are fundamental skills possessed by students to adapt to the external challenges of 21st-century. To empower students' CTSs, Guided Inquiry and INSTAD may work effectively. This research aimed to see the effectiveness of guided inquiry and INSTAD toward students' critical thinking skills. This research was a quasi-experimental. The instrument to get the CTSs data was a valid essay test according to Facione. The sampling technique employed was the intact group sampling method. The number of participants involved was 188 XI grade science program students of SMAN 7 Surakarta; a middle-quality school. The total number of research sample was 64; 32 students in the Guided Inquiry class and the other 32 students in the INSTAD class. Hypothetical test using ANCOVA resulted in a 5% of significance level. The results indicated that there were significant differences of CTSs on circulatory system topic between the INSTAD and Guided Inquiry class. The students who experience the INSTAD class has higher CTSs than those joined the Guided-Inquiry class.

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INTRODUCTION

The 21st-century is an era of science where technology has developed rapidly. The required skills to face the 21st-century challenges were not only about teaching reading, writing, and arithmetic but also about how to use and develop thinking skills became the high-order thinking skills (HOTS) (Borstner & Gartner, 2014; Collins, 2014). Brookhart (2010) defined higher-order thinking includes a list of skills or procedures performed by critical thinkers. Critical thinking skills are one of the HOTS needed for making purposeful, reflective and fair-minded judgments about what to believe or practical issues in the future.

Therefore, critical thinking becomes very important as the real problems in today's life have been more and more complicated (Mutakinati & Anwari, 2018). Students' CTSs and HOTS should also be optimally empowered in school learnings.

Critical thinking skills have a long-term benefit in the field of education as it can assist students in solving problems encountered in the learning process and its application in everyday life (Kaddoura, 2011). Meanwhile, the short-term goal of the CTSs in the learning process is to strengthen students' conceptual understanding (Khasanah, et al, 2017), especially in the natural sciences (IPA) subject. In other words, the students' CTSs are needed to overcome problems in everyday life.

*Correspondence Address

E-mail: bartolomeusbiologi@student.uns.ac.id

Facione (2011) classified critical thinking skills into several aspects: (1) Interpretation; (2) inference; (3) evaluation; (4) explanation; (5) analysis; and (6) self-regulation. The interpretation aspect requires students to be able to categorize and explain the meaning of terms. The analysis aspect is related to researching ideas, identifying and analyzing arguments. The evaluation aspect refers to the skills to assess opinions. The inference aspect consists of the skills to look for evidence and alternatives. The explanation aspect is the skills to express results, justify procedures, and present data. Finally, the self-regulation aspect deals with the skills to monitor students' self-learning. These aspects must be possessed by each student to face nowadays challenges as competition has become a very normal thing. This is parallel to Fong et al. (2017) who stated that students who have critical thinking skills tend to be more competent than students who are less critical.

According to the observation results at XI MIPA of SMAN 7 Surakarta of critical thinking skills test compiled based on the Facione indicators revealed that the aspect of interpretation was 45,81%; the analysis was 33,59%; the evaluation was 30.01%, the explanation was 24.84%, the inference was 27.01%, and the self-regulation was 62.50%. The critical thinking skills scores between 25-43,75% were included in a low category, 43,76-63,15% in a medium category and 63,16-80,00% in high category (Saputri et al., 2017). Based on the observation results, the critical thinking skills of XI MIPA students in SMAN 7 Surakarta remained low.

Students' critical thinking skills could be optimized by applying an inquiry-based learning model (Asyari et al., 2016; Boleng et al., 2017; Zubaidah et al., 2017). The inquiry-based learning demands students to actively build their own knowledge, make reasoning, and compare new concepts with the early concepts (Putra et al., 2016). The inquiry-based learning also concerned about the process of learning instead of the product, which is compatible with the essence of integrated sciences (IPA) learning. An IPA Learning orients to the comprehension process; therefore, it could train students' thinking skills, solve problems, and lead students into self-regulated learners i.e. independent learners through a series of activities (Lederman et al., 2013).

Inquiry-based learning is a very suitable learning model for IPA learning, also on Circulatory System Study Materials (Retnawati et al., 2017). the circulatory system study material has many abstract concepts, so it cannot be understood simply by memorizing it. Scientific work

contained in both models allows students to observe directly, conceptualize, and deduce new knowledge that has been obtained from the experimental activities. For example, the question of the principles of blood classification. Through the scientific approach, students can immediately observe how the clump process occurs or not, what is agglutinin and antigen, so that students can then conclude the principles of blood classification. In addition, through these activities students are able to train aspects of critical thinking skills i.e., interpreting, analyzing, concluding, evaluating, self-regulation, and explaining (Weaver et al., 2016).

Scott et al. (2010) stated that guided-inquiry teaching has six stages; observation, formulating problems, hypothesizing, designing and executing experiments, analyzing data, and communicating. The observation stage intends to reveal students' early conception which assists teachers to recognize their initial understanding and ideas. The next stage is to formulate problems, make hypotheses, design and carry out experiments. These three phases give students the opportunity to do independent scientific work. The next stage of analyzing the data requires students to develop their thinking skills to get the final conclusions from the performed experiments; thus, they are expected to use higher-order thinking skills. The last stage is communicating aiming at providing students with the opportunity to present the experimental results so as to be able to train their explaining skills.

The weakness of the Guided-Inquiry model was the time limitation to perform scientific work in IPA learning. The low-level academic students even should try harder to keep up with the pace of other higher-level academic students when the time is very limited (Duffy & Azevedo, 2015). The guided-inquiry learning which focused only on the application of the learning model would be difficult to accommodate the training of low-level academic students' CTSs. To solve this problem, it is important to conduct scaffolding of Higher Academic (HA) and Lower Academic (LA) students. The scaffolding of HA and LA students in IPA learning could be effective if the scientific work is performed in a cooperative group (Nussbaum et al., 2009).

In addition, the empowerment CTSs of the students with different academic levels is obviously essential. A potential learning model to improve the HA and LA students' critical thinking skills is the Inquiry-Student Team Achievement Development (INSTAD). INSTAD is a new learning model which integrates the investi-

gative aspect from the guided-inquiry model and collaborative aspect from STAD model (Prayitno & Suciati, 2017). Previous research result on the INSTAD has shown great improvement Students' Science Proses Skills and Scientific Outcomes. Thus, the INSTAD is assumed to be able to improve students' CTSs more effectively than the Guided-Inquiry.

According to Prayitno (2017), the INSTAD has five phases. The First phase is problem orientation which not only requires students to find problems from the presented phenomena but also organizes learning where students are split into teams of 5 people with heterogeneous academic skill levels. The next phase is collaborative inquiry work. This stage demands students to conduct IPA concepts by scientific work in a different way. The unification of various academic skill levels is intended to foster the scaffolding process through peer tutorials. As a result, the aspect of self-regulation and explanation could be optimized further than in the Guided-Inquiry model. The third phase is the presentation, performed after the collaborative concept-forming activity. The next phase is the individual test and team recognition, which is not included in the Guided-Inquiry. The individual test trained students to evaluate the received IPA concepts during the learning process through practice questions. Then, each student should calculate the individual progress scores, team scores, and team rewards. The last stage is the monitoring, which trains students to evaluate their learning improvement after the series of activities they performed (Sulistijo et al., 2017).

Based on the explanation above, it was necessary to do a research aimed to test the effectiveness of Guided-Inquiry and INSTAD towards the students' critical thinking skills.

METHODS

This research was quasi-experiment with 2x1 factorial design (Creswell, 2012). The research sample was treated for five meeting, and the CTSs were measured at the end of the treatment. The independent variable of this research was the Guided-Inquiry and INSTAD teaching models, while the dependent variable was the students' critical thinking skills. The analysis of this research employed descriptive statistical analysis and inferential statistics. The data of critical thinking skills were collected with a sort of essay test. The test instrument for retrieving the critical thinking skill data referred to the Facione indicators.

The participants of this research involved 188 students of XI grade science class at SMAN

7 Surakarta as middle-quality school. The researchers decided to choose middle-quality school assuming that it has more various academic skill level than low or high-quality schools. The intact group sampling has previously been done for the equality test (Creswell, 2012). The equality test in this study was done to the students' examination scores using the test of Komolgorov-Smirnov Normality and Levene's homogeneity. The normality and homogeneity test results indicated that the population had equality. After the equality test obtained, we did match the class test using the ANOVA. The ANOVA results suggested that there were no significant differences of each class' thus, the researchers directly chose two sample groups; XI-Science 2 as the experimental group 1 which would be treated using the INSTAD model and XI-Science 3 as experimental group 2 which would adopt the Guided Inquiry model.

The instrument was a written test compiled using the rubric of critical thinking skills developed by Facione (Facione, 2011). Before starting the assessment, the validity and reliability index of the essay test were tested. The validity test was conducted through an expert analysis and empirical test. Three expert lecturers from Post-Graduate Programme of Teaching and Education Knowledge Faculty of the Sebelas Maret University of Surakarta were selected in analyzing whether the test was appropriate for measuring the critical thinking skills indicators and whether it was consistent with the learning materials. The expert judgments declared that the test was valid with a validity index of 3.80.

The implementation of learning models during the research was controlled by six observers based on observational instruments to check the consistency of the model's implementation. The INSTAD teaching model was applied by considering the criteria of the grouping method. Groups in each treatment class were divided into six of five members each. Two or three students with high academic skills were put together with lower academic skills students in order to guarantee the peer scaffolding in this model. Whilst, in the Guided-Inquiry learning model, a random grouping system was applied.

This study lasted four times in class with consistent group member. Each meeting was run for 90 minutes. The first meeting discussed the blood components, and the second meeting was about the blood type. The third meeting talked about the organs and mechanisms of the circulation system. The fourth meeting was about the disorders and abnormalities in the circulation system. The last meeting was an examination to

carry out the critical thinking skill data retrieval using the validated questions.

The data analysis employed the ANCOVA test. Prior to that, the normality and homogeneity tests were performed. In order to eliminate the variation of critical thinking skills among the research samples, the pre-test scores or the baseline of the students' CTSs were used as covariates. The Kolmogorov-Smirnov parametric statistical analysis was adopted for testing the data normality. The pre-test score was 0.070 and the posttest score was 0.052 i.e. in the normal category, whereas the Levene homogeneity test concluded that homogeneous variants were at 0.54.

RESULTS AND DISCUSSION

The results of the critical thinking skill tests on the learning model data source are presented in Table 1.

Table 1. ANACOVA Test Results Students' Critical Thinking Skills

Source	Type III Sum of Squares	df	Mean Square	p.
Corrected Model	1157.156 ^a	2	385.719	.000
Intercept	9354.534	1	9354.534	.000
Model	165.554	1	165.554	.039
Pretest	285.968	1	285.968	.008
Error	2219.898	60	36.998	
Total	376939.438	64		
Corrected Total	3377.054	63		

The ANCOVA assumed that there were no group differences at the pretest; therefore, the first step was looking at the p.values of pretest as the covariate. Table 1 showed that the p.value of pretest data source was 0.008 (<0.050), which indicated that the sample had a significant difference for the baseline. It means, most of the research participants experienced a critical thinking skill improvement. Then, the Model data source obtained the p.values of 0,039 ($<0,050$), showing a significant difference in the learning model's impact on critical thinking skills. The results of the students critical thinking skills taught with the Guided-Inquiry and INSTAD were visualized in Table 2.

Table 2. Critical Thinking Skills in Different Learning Models

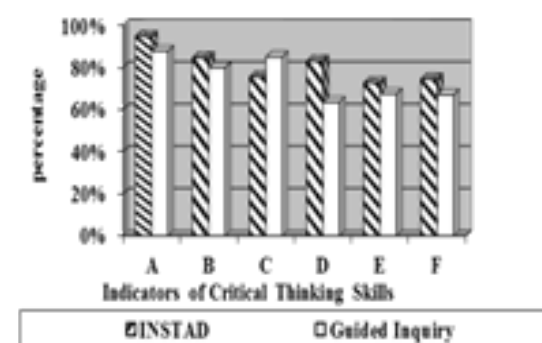
Model	XCTS	YCTS	Gain	CTScor
Guided Inquiry	30.636	71.721	43.68	73.205
INSTAD	31.719	79.752	50.45	79.924

Description:

XCTS (The average result of critical thinking skills pre-test); YCTS (the average result of critical thinking skills post-test); CTScor: (The average corrected critical thinking skills)

Based on the Ancova test results shown in Table 1, there was a significant difference in students' critical thinking skills improvement between the guided inquiry and INSTAD learning model. Table 2 indicates the students' critical thinking skills in INSTAD class had a corrected average value of 81.093, higher than the Guided Inquiry which was only 75.205. Table 2 also shows an increase in critical thinking skills of the Guided-Inquiry class by 143%, while the INSTAD class had a higher increase of 159%. This results revealed that the INSTAD model had a higher potential to improve critical thinking skills than the Guided Inquiry model.

Differences in the students' critical thinking skills between the Guided Inquiry and INSTAD class were also analyzed based on every aspect of critical thinking skills. Figure 2 visualizes the score differences of each critical thinking skill aspect in the Guided Inquiry and INSTAD class.



Description:

A: Interpretation, B: Analyzing, C: Explanatory, D: Evaluation, E: Concluding, F: Self-regulation

Figure 1. The Differences between the Two Learning Models on Each Aspect of Critical Thinking Skills

Figure 1 informs that the students' interpretation skill in the INSTAD teaching model obtained the highest score than others, whereas the evaluation skill in the Guided-inquiry teaching model had the lowest percentage. Although the students' ability to interpret, analyze, evaluation, concluding, and self-regulation in the INSTAD class was higher than in the Guided-Inquiry class, the explanatory skill of the Guided-Inquiry class was better.

The Collaborative group formation phase for inquiry work which places the heterogeneous academic level of students made an obvious difference for the INSTAD model compared to others (Prayitno & Suciati, 2017). In addition, the teachers also provided the materials of circulatory system phenomena which became the investigating issue such as anemia, accidents, and blood transfusions. The cases were able to stimulate the students' curiosity before the learning began. The scaffolding process worked so well that each group member with a higher academic level was able to guide the lower academic members to achieve ZPD (Zone of Proximal Development) (Azizah et al., 2018). Scaffolding supported the students at the beginning of a lesson and then gradually turned over the responsibility of them to operate on their own (Gillies & Haynes, 2011). Peer tutors among group members in the INSTAD model were more active than the Guided-Inquiry class. The scaffolding process between peers has fostered each students' critical thinking skills, especially the self-regulation which score higher in the INSTAD class (Garrison & Akyol, 2015).

LA1: No determining part of heart (the experiment using Cow Heart), then ask to HA1

HA1: Prompting and probing (ask to LA1), then Observe and verbalizing the cow heart, the right and left heart can be distinguished by observing the valve

LA1: No determining the location of Aorta, ask to HA2

HA2 : Prompting and probing (ask to LA1), then LA2 explaining the location of Aorta (on his answer), then Making concept map (between the part of Heart)

Figure 2. The Examples of Peer Tutoring between HA and LA Students in the Collaborative Group of INSTAD

The increasing aspect of explanation indicated that the students started to be trained to describe the information illustrating the content of the information clearly (Facione, 2011). After treatment using both models, the students were able to explain the procedures for measuring a person's blood pressure, identify between normal and abnormal blood pressure, and provide the experimental results, such as explaining the structure and function of circulatory organs. A good explanation cap skills will be seen when a student expresses her opinion with confidence (Zhou et al., 2013). Their activities of constructing the concepts, drawing a conclusion, presenting to others have been proven to improve students' critical thinking skills, especially the explanation aspect (Sampson & Clark, 2008; Forawi, 2016).

The class presentation stage required the students to act as the presenter in charge of explaining the experimental results. The students presented the various components of blood, the principle of blood type, and other concepts obtained during the scientific work. Both learning models have stages that enable students to communicate the experimental results. However, the collaborative group of INSTAD learning tended to make the lower academic group members became less confident when explaining something so that students were more likely to have a higher academic member to explain it. The lack of confidence resulted in the less optimal explanation skill. (Damavandi & Shekari, 2010; Ramli et al., 2017).

The results of this research showed that there was a difference in critical thinking skills between the INSTAD and Guided-Inquiry models. Thus, it is parallel with the previous research stating that the INSTAD has a higher potential to enhance learning process than the Guided-inquiry (Prayitno et al., 2017; Prayitno & Suciati, 2017; Sulistijo et al., 2017). However, it should be kept in mind that these results are specific to study the effect of different teaching models in students critical thinking skills.

The differences between INSTAD and Guided-inquiry were seen from the differences in their activities of inquiry work. The collaborative team fostered the low academic students to determine their own scaffolding process since peer tutoring provides longer study time for low academic students (Wass et al., 2011). Adequate study time is obviously able to improve the critical thinking skills of low academic students.

Based on these research results, the researcher recommended implementing the INSTAD

model especially for the scaffolding process by peer tutoring to nurture students' critical thinking skills. Each of critical thinking skill indicator needs to be trained as it is one of the fundamental skills to master IPA and implement it in everyday life.

CONCLUSION

The research finding supported the theory and the previous research stating that there was a difference in critical thinking skills between the two models. The students who joined the INSTAD class had the highest critical thinking skill indicators except for the explanation. This research was limited to the subject of science in SMAN 7 Surakarta. The research may be continued on the subject of science or other subjects at primary or middle schools. Future research can also focus on other thinking skills such as creativity, problem-solving, scientific literacy, and among others.

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