ENHANCING CRITICAL THINKING SKILLS OF FIFTH GRADE STUDENTS THROUGH STEAM EDUCATION IN LESSON STUDY ACTIVITIES

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ABSTRACT

This study aims to determine the effect of STEAM learning on the critical thinking abilities of fifth-grade students of the subject of IPAS at SDN 11 Peguyangan in the 2017/2018 academic year. This research is a quasi-experiment with a posttest- only control group design. The population of this study was all fifth-grade students at SDN 11 Peguyangan for the academic year of 2023/2024. The number of the population was 55 people spread across 2 classes. The sample was selected by using the saturation sampling technique. Determination of sample groups was carried out randomly with class VB as the experimental class and class VA as the control class. The data collection instrument was a test of critical thinking skills in fifth-grade students of IPAS subject with material on the properties of light that is in the form of valid and reliable essay questions/descriptions. The data analysis techniques used are descriptive statistics and the Mann-Whitney test. The results of the study show that the average critical thinking ability score for the experimental class was 83.3, which was higher than the control class, about 75.9. The results of hypothesis testing obtained an Asymp value. Sig. (2-tailed) is 0.03 <0.05, so there is a significant difference in critical thinking abilities between students who study with STEAM learning and students who study conventionally. STEAM learning has a significant effect on the critical thinking abilities of fifth-grade students at SDN 11 Peguyangan.

Keywords: *STEAM Learning, Lesson Study, Critical Thinking Skill*

1. INTRODUCTION

Piaget mentioned that an individual learns through an active thinking process. Then, the thinking process experienced by humans must be in accordance with the stage of cognitive development (McLeod, 2018). Elementary school students are at the concrete operational stage of cognitive development. The theory explains that a child can think optimally when learning through real objects. Through this understanding, learning patterns for elementary school students should not be abstract. All concepts/lessons need to be pursued through contextual experiences. It also requires the support of learning sources and objects that can be captured by the five senses of students, or can be manipulated physically. This theory should be a standard for elementary school teachers in designing learning in their classrooms. As stated by Sa'pang & Purbojo (2020), the development of learning design must pay attention to the characteristics of students who learn. The application of inappropriate learning design will certainly have an impact on the less than optimal development of students' 21st century skills.

Of the 21st century skills mentioned, *critical thinking* skills are the most challenging issue for teachers at SDN 11 Peguyangan. Thinking ability is an ability to process mental operations that include knowledge, perception, and creation (Duron et al., 2006). According to Karim & Normaya (2015) critical thinking ability consists of several indications of ability, namely; 1) basic classification; 2) assess basic support; 3) conclude; 4) follow-up classification; 5) strategy and tactics. At the elementary school level, critical thinking skills can at least be observed/measured based on several indicators such as; (a) basic clarification, (b) giving reasons, (c)

inferring, (d) further clarification, and generating conjectures or alignment (Ennis, 1985; O'Reilly et al., 2022). Children's critical thinking skills can be measured through intensive observation and cognitive tests. The process of developing critical thinking skills requires a lot of time and energy. It becomes more difficult if critical thinking skills are related to mental readiness or weaknesses in teaching strategies/stimuli.

Teachers at SDN 11 Peguyangan often encounter difficulties in stimulating critical thinking behavior and skills. The results of initial observations in learning in class V showed that the percentage of students who behaved positively in several criteria for critical thinking skills such as asking questions/opinions, and providing criticism/suggestions during PBM was in the range of 8%-20% of the total students. These findings are supported by the results of measuring the critical thinking skills of grade V students through a critical thinking skills *pretest*. The results of the IPAS *pretest* showed that the average score of critical thinking skills of students in class V-A was 58.6, while class V-B was 64.6 on a 100 scale. These results are not encouraging. According to the teacher, students' critical thinking skills are quite difficult to develop due to several innate factors, such as the tendency of children who are more waiting for the teacher's answer, lack of confidence/shyness in the learning process, and passivity in exploration and discussion.

The study of the problem of students' critical thinking skills in IPAS learning at SDN 11 Peguyangan led to an idea of learning design. The learning design in question is STEAM learning. STEAM is a learning approach that emphasizes the relationship between *science, technology, engineering, arts, & mathematics* knowledge and skills in classroom learning (Munawar et al., 2019). STEAM as a learning approach is a means for students to create science-technology-based ideas through thinking and exploring activities in solving problems through five integrated disciplines (Nurhikmayati, 2019). (Mardlotillah et al., 2020) found that the STEAM learning approach had a significant effect on the higher-level thinking skills of fifth grade students. In line with Sari's research (2023) which found an increase in the critical thinking ability of third grade students from 59.13% to 79.9% after going through STEAM learning.

STEAM can be a learning solution for students in dealing with technological developments combined with science. Various previous research results support the assumption that STEAM learning is indeed appropriate for developing the critical thinking skills of elementary school students. As a learning approach, STEAM is not a model or method that has a standardized syntax. STEAM in its application can be synergized with relevant learning models and methods. STEAM can enable the involvement of learners to perform learning activities optimally. To implement STEAM learning, teachers still need to consider and determine the learning scenario (introduction, core, closing) in detail. This also includes how classroom management techniques, to the assessment patterns used. However, SD N 11 Peguyangan teachers do not know much about the implementation of STEAM learning.

Dwijendra University and SDN 11 Peguyangan attempted to respond to this through *Lesson Study* activities. Yoshida et al. (2021) mentioned that *Lesson Study*, which in Japanese is called *Jugyou Kenkyuu*, is a model of developing teacher professionalism through collaborative and sustainable studies. Researchers, practitioners, and government agencies have reported various positive impacts of Lesson Study. *Lesson Study* (LS) contributes to teachers' professional development, school management, and education research beyond national borders. LS is divided into 3 stages, namely Plan, Do and See, which are continuous (Sartika, 2022). In a series of LS stages, teachers collaboratively design learning, research, and improve teaching using the evidence or learning outcomes they have collected related to student learning and development (Ewe, 2020). *Lesson Study* is an effective tool to develop innovative learning designs that fit the context of the problems at SDN 11 Peguyangan.

Departing from theoretical studies and previous studies, the development of STEAM learning design is thought to have an influence on the critical thinking skills of students in elementary schools. In addition to contributing to the critical thinking skills of students, the application of STEAM learning through *lesson study* is also believed to have an accompanying impact on the students, teachers, and principals involved. Abizar (2017) states that collaborative learning development through *Lesson Study* has the principle of *mutual learning*. Thus, the intended result is not only students who feel happy and comfortable learning, but also teachers who are increasingly professional. Therefore, it is important to conduct research related to the effect of STEAM learning on critical thinking skills of grade V students in *lesson study* activities at SDN 11 Peguyangan.

2. RESEARCH METODOLOGY

The research was conducted at SDN 11 Peguyangan in the odd semester of the 2023/2024 school year. This research is a type of *quasi-experimental* research using a *posttest only control group* design*.* There are two variables examined in this study, namely the STEAM learning approach as the independent variable, and critical thinking skills as the dependent variable. The study population was all fifth grade students as many as 55 people divided into 2 classes, namely 27 people from class VA and 28 people from class VB. The withdrawal of samples was carried out using saturated sampling technique, namely all members of the population became research samples. Then the determination of the sample group is done *randomly* (*random*). Class VB as the experimental class received treatment in the form of STEAM learning model, while class VA as the control class applied conventional learning (teacher-centered).

The data collection technique used was the test technique. The data collection tool in the form of a critical thinking ability test on grade V IPAS material on the properties of light in the form of essay / essay questions that have been tested for validity and reliability adapted from research by Kumullah et al. (2018). The data analysis technique used is the *independent sample t-test*, by taking data prerequisites, namely normality and homogeneity tests of data variants. In addition, descriptive statistical analysis was also carried out to obtain an overview of the condition of the research data. The hypotheses proven in this study are: H0: There is no significant difference in critical thinking skills between students who learn with STEAM learning and students who learn conventionally. and H1: There is a significant difference in critical thinking skills between students who learn with STEAM learning and students who learn conventionally.

3. LITERATUR REVIEW

a. STEAM in Childhood Education

STEAM learning is considered to integrate the skills needed by children. STEM encourages children to build knowledge about the world around them by observing, investigating and asking questions. The addition of ‘Arts’ (leading to the STEAM acronym), will give children the opportunity to describe the STEM concept in creative and imaginative ways. This review finds a definition for ‘A’ or ‘Arts’ in STEAM showing that the making of art and the creative process is overshadowed by the emphasis on the final result or product. For example, a study by Perignat and Katz-Buonincontro (2019) explains that students use various techniques to solve problems and demonstrate learning, and this includes attention to the humanities (the ‘A’ in STEAM) because they created media art and short videos written to present their solution. The impact of this learning is that STEAM makes children more active and able to take initiatives with their own knowledge, and teachers who are influenced by the integrated professional development of STEM prompt children to be positively influenced by their teacher's professional learning. Another finding

from this review is that experience of STEAM can increase self-confidence in children (Wahyuningsih et al., 2020).

b. Lesson Study

Lesson Study (LS) is a collaborative professional development approach that has gained significant attention for its ability to enhance teaching practices and improve student learning outcomes. Rooted in systematic cycles of planning, teaching, observing, and reflecting, LS fosters a culture of continuous improvement among educators. The Lesson Study implementation follows the following framework.

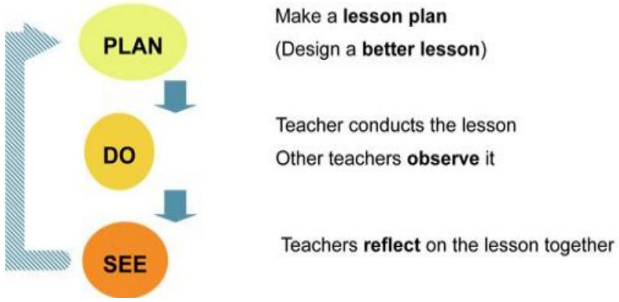

Figure 1. Cycle of Lesson Study
Source: Areni & Syafri (2018)

Research highlights its effectiveness in deepening teachers' pedagogical content knowledge, improving their understanding of student learning processes, and fostering reflective teaching practices. A key strength of LS lies in its focus on real-time classroom observations, allowing educators to analyze and adapt their methods to better meet students' needs. Widely applied across various educational contexts, particularly in mathematics education, LS promotes collaboration among teachers, enabling them to share insights and develop innovative instructional strategies. This structured yet flexible framework not only supports teacher growth but also drives meaningful improvements in student engagement and achievement, making it a powerful tool for educational transformation.

c. Critical Thinking Ability

Critical thinking includes the component skills of analyzing arguments, making inferences using inductive or deductive reasoning, judging or evaluating, and making decisions or solving problems. Critical thinking involves both cognitive skills and dispositions. These dispositions, which can be seen as attitudes or habits of mind, include openand fair-mindedness, inquisitiveness, flexibility, a propensity to seek reason, a desire to be well informed, and a respect for and willingness to entertain diverse viewpoints. Empirical research suggests that people begin developing critical thinking competencies at a very young age. Although adults often exhibit deficient reasoning, in theory all people can be taught to think critically. Instructors are urged to provide explicit instruction in critical thinking, to teach how to transfer to new contexts, and to use cooperative or collaborative learning methods and constructivist approaches that place students at the center of the learning process. In constructing assessments of critical thinking, educators should use open-ended tasks, real-world or "authentic" problem contexts, and ill-structured problems that require students to go beyond recalling or restating previously learned information. Such tasks should have more than one defensible solution and embed adequate collateral materials to support multiple perspectives (Lai, 2011).

4. RESULTS AND DISCUSSION

This section presents the results of the research and discussion obtained based on the data processing process, and is supported by the author's empirical

findings as an accompanying impact that occurred during the experimental activities (research) conducted. The results of the study contain the results of data processing of students' critical thinking skills in experimental and control classes. The summary of descriptive statistics on the posttest results of critical thinking skills of grade V students in experimental and control classes is as follows.

Table 1. Descriptive Statistics of Student Critical Thinking Ability Data

Value	Class Experiment	Control Class
N	28	27
Max.	100	91.7
Min.	66.7	41.7
Mean	83.3	75.9
Std. Deviation	10.1	12.5
Completeness (%)	74%	37%

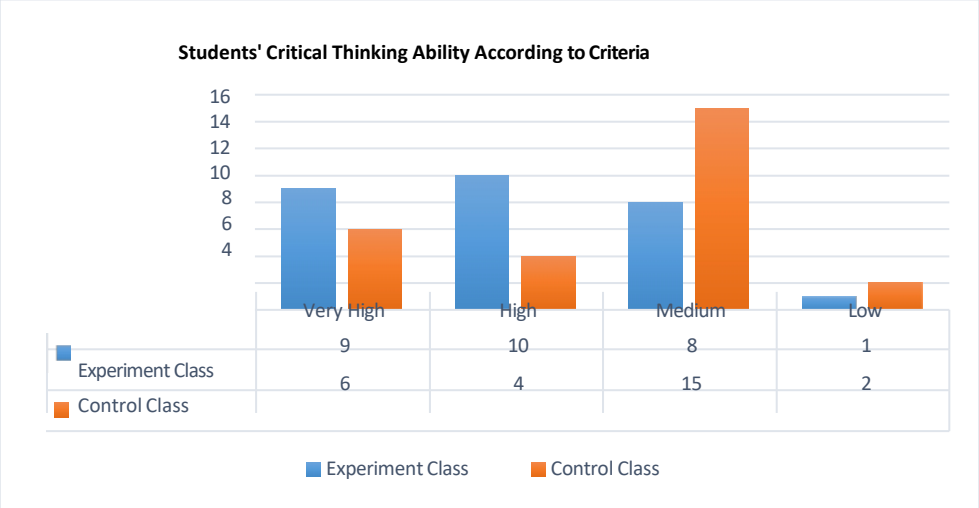

Figure 2. Comparison Chart of Student Critical Thinking Ability Level Data

Based on table 2, it is known that there are differences in the condition of critical thinking ability data between the experimental group and the control group. Data on students' critical thinking skills in the experimental group tended to be better than the critical thinking skills of students in the control group. This can be seen from the average value (*mean*) of the experimental group of 83.3 higher than the control group of 75.9. The experimental group was also superior in terms of score acquisition with students who obtained an SMI of 100, while in the control class the maximum was 91.7. However, in both groups there are still students who score critical thinking skills below the minimum standard (75%). Figure 1 also shows comparative data on the level of students' critical thinking skills measured based on the criteria for critical thinking skills according to Ennis (2011). The experimental class was dominated by students with critical thinking skills scores at the "high" level/criteria, while the control class was at the "medium" criteria. The experimental class is also superior in terms of the number of students with criteria critical thinking ability "very high" than the control class. Furthermore, hypothesis testing is carried out starting with the data prerequisite test, namely the normality test and homogeneity of data variance.

Table 2. Tests of Normality

		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
Ability	Thinking Experiment Class	.214	28	.002

Critical	Control Class	.174	27	.035

Based on the Kolmogorov-Smirnov test with the help of SPSS IBM 25, it is known that the *sig.* value of critical thinking ability in experimental and control classes is smaller than 0.05, so both data on critical thinking ability of grade V students are not normally distributed. This indicates that the data does not meet the requirements to proceed to the *independent sample t-test* stage. Thus, the hypothesis testing technique was switched to the *Mann-Whitney test. The Mann-Whitney* test is a non-parametric statistical analysis method to analyze differences in mean values in two groups of unpaired samples. Because it is a non-parametric analysis technique, the conditions for normality and homogeneity of data can be ignored (Usmadi, 2020). The *Mann- Whitney* test criteria are if the *Asymp Sig* value*. (2-tailed)*> 0.05, then H0 is accepted, and vice versa. The range of results of testing the research hypothesis with the *Mann-Whitney* test is as follows.

Table 3. *Mann-Whitney* Test Statistics

	Critical Thinking Ability
Mann-Whitney U	252.000
Wilcoxon W	630.000
Z	-2.176
Asymp. Sig. (2-tailed)	.030

a. Grouping Variable: Class

Based on the *Mann-Whitney* test summary in table 4, it is known that the *Asymp. Sig. (2-tailed) value* of 0.03 <0.05, then $_{H0}$ is rejected H1 is accepted. Thus, there is a significant difference in critical thinking skills between students who learn with STEAM learning and students who learn conventionally. There is a significant effect of STEAM learning on the critical thinking skills of fifth grade students of SDN 11 Peguyangan. STEAM learning that is applied appropriately is proven to contribute positively to the development of critical thinking skills of grade V students.

The STEAM learning model presents complete and integrated learning activities. The process of knowledge construction by students is facilitated by multiple activities that make the learning atmosphere more interesting and challenging. The implementation of STEAM learning in high-grade students also appears to be able to stimulate students' , persistence, and creativity. This is in line with Suryaningsih & Nurlita's research (2021) which found that STEAM learning is good for training students' process skills and creative thinking. Concept understanding can also be formed more naturally, because STEAM learning brings students to thinking activities that are more realistic (able to be realized) into various forms / forms of performance.

The learning process through STEAM learning is able to optimize the involvement of the five senses of students. Indirectly, the focus and concentration of student learning can be focused more effectively. This is one of the factors that make students' thinking activities more conducive since the beginning of learning. Focus and concentration are key factors to create critical thinking conditions in learners (Aviana & Hidayah, 2015; Rane- Szostak & Robertson, 1996). That is why the critical thinking skills of student groups who learn through STEAM learning look better than student groups who learn through the expository method (conventional). Not only in terms of final results (grades), the difference in critical thinking skills between the two groups of students is also very pronounced on the process side.

In the experimental class, almost all group members do learn activities. Students also look more focused in discussions and completing STEAM products in their groups. Students collaborate independently and solve problems through search and discussion with friends. It is not uncommon for arguments to arise between students, but this indicates that students criticize each other or exchange ideas. In contrast to the control class, attention is focused on the teacher's explanation with

the help of an LCD projector, while student learning activities are listening to the presentation of the material and continued with the task in the LKPD. In terms of process, STEAM learning is appropriate for realizing a creative and participatory learning atmosphere (Connor et al., 2015). Knowledge of the material is formed through a series of problem-solving processes and creative activities. Students are optimally involved in criticizing learning instructions, information sources, and ideas/creations that arise during the discussion process.

The impact of the application of the STEAM learning process is the natural development of students' critical thinking skills. This is also indicated by the increasing ability of students to provide explanations in the context of responding to or clarifying an event related to the topic of discussion. Students began to be able to provide logical arguments and conclude something more thoroughly. This behavior is in accordance with the indications of individuals who think critically (Ennis, 1996). Accuracy in determining learning resources and collecting relevant information is also quite visible in students in STEAM learning. Noor & Ranti (2019) found that students who have a critical mindset tend to be more straightforward in communicating their ideas/understandings. Students who think critically are also able to carefully determine valid sources of information and utilize them (Santyasa, 2018). The improvement in students' critical thinking skills is the *instructional effect of* implementing STEAM learning through *lesson study* at SDN 11 Peguyangan.

The process of developing and implementing STEAM learning through *lesson study* is recognized as adding to the pedagogical insights of teachers. Such as simple tips for making HOTS questions, various classroom management techniques, and literacy in the teaching profession can be understood more contextually when planning and reflecting on open class activities. Another impact that follows from this process is the creation of a culture of collaboration between teachers. For example, developing learning content together, to solving problems in their respective classes. The motivation to always implement active and innovative learning can also be seen from the efforts to provide LKPD, learning media, and interesting *games* at each meeting. This indirectly increases teacher literacy to find various inspirations for learning media and educational games on the internet. The habit that arises without realizing it is to reflect on the end of learning. Indirectly, the application of STEAM learning through *lesson study* appears to develop teacher competencies in pedagogical, social, professional, and personality.

The application of STEAM learning in the frame of *lesson study* also has an indirect impact on the leadership side of the principal. Through a series of *lesson study* processes, various things can be found. The personal character of each teacher related to how he places himself, his responsibility, the spirit of his work, to his perspective on things can be observed more accurately. Needs related to more actual learning facilities can also be mapped more clearly. After participating in this program, the impetus to make breakthroughs in developing teacher competencies became higher. The closest innovation is to conduct *lesson study-based* teacher supervision. Through this method, it is expected to produce a more authentic assessment, so that it will be more aligned with the recommendations and follow-up provided. This program builds awareness about the importance of building collaboration with external parties such as LPTK lecturers, experts, students, and even the private sector. It is hoped that there will be more downstreaming of science and technology products to schools to improve the quality of learning and the quality of students at SDN 11 Peguyangan.

5. CONCLUSION

Based on the results of research and discussion, it is known that there is a significant difference in critical thinking skills between students who learn with STEAM learning and students who learn with expository learning (conventional) with *Asymp. Sig. (2-tailed) value* of 0.03 <0.05. Thus, STEAM learning has a significant effect on the critical thinking skills of fifth grade students of SDN 11 Peguyangan.

This is also supported by the accompanying effects that are observed empirically during the application of the STEAM learning process. Improving students' critical thinking skills along with developing teacher competence is not an instant process. Therefore, efforts to strive for it through various important innovations need to be realized and carried out by various parties. The application of STEAM learning through *lesson study* activities at SDN 11 Peguyangan is a reflection that efforts to develop students' critical thinking skills as well as teacher competence in producing quality learning actually emerge through collaborative methods. STEAM learning is highly recommended to be applied to learning situations that are oriented towards developing students' critical thinking skills, especially in grade V elementary schools.

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