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STEM-BASED INSTRUMENT INTEGRATION: ENHANCING SYSTEMS AND SCIENCE SKILLS IN TEACHING

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Abstract

This research aims to describe STEM-based practicum instrument componentinstrument to stimulate students' system thinking skills based on the views of teachers and students. This research involved 50 middle school science teachers in Lampung Province. The method used in this research is a mixed method with explanatory sequential design to obtain quantitative and qualitative data through questionnaires and interviews. The results of the research show that teachers and students have a positive perception towards the development of STEM-based practicum instrument component. This research found the fact that there are some difficulties experienced by teachers in the use of STEM-based practicum instrument component. Teachers believe that the use of STEM-based practicum instrument component can stimulate the system thinking ability and have an impact on the improvement of students science process skills.

Keywords: STEM; System Thinking Skills; Science Process Skills

INTRODUCTION

The development of the 21st century demands various fields to develop capabilities, especially in the field of education. There are four core competencies that students need to master which are commonly called The 4C's. The 4C's consist of critical, creative, collaboration and communication skills (Unesco, 2018). 21st century skills can be developed through student-centered learning activities. Students will be more actively involved in the learning process so that they can help develop individual student skills (Lipracticum instrument componenta et al., 2020). Through student-centered learning it can be integrated through science learning. Science learning is a complex and abstract learning. This complex and abstract nature tends to require critical thinking and systems thinking (Fuad et al., 2017). To be able to understand the concept of science requires a mind that is not only focused on an outcome but also must understand in detail the processes that occur in it. A detailed understanding of a process in the science concept system requires a complex thinking, namely systems thinking (Anjarsari et al., 2021).

The ability to think systems in science learning can help students to understand the relationship between processes and concepts so that an understanding of a science material will be easier to understand (Nuryani, 2015). Students will understand science material through the level of systems thinking, starting from analyzing to generalizing (Anjarsari et al., 2021). One of the science materials that requires the ability to think systems is climate change material. This material requires a thought that links between processes and concepts, as well as thinking skills in solving problems so that it is referred to as the term science process skills (Meilinda et al., 2018). In addition to these skills, climate change material also needs to be supported with learning tools. One of the learning media activities that supports students in learning climate change material is to do practicum. This activity supports the development of student learning as well if it is equipped with tools that support learning, one of which is the development of Practicum instrument component. In the learning process, practicum is carried out with the hands-on concept. That is, this concept refers to STEM (Science, Technology, Engineering, and Mathematics)-based learning (Rima et al., 2020).

Integrating natural science, technology, engineering, and mathematics in learning is to direct students to become problem solvers, inventors, have innovations, think logically independently, be technologically literate, be able to link their culture and history with

education, and be able to apply their knowledge in real life (Oktavia, 2019; Herak & Lamanepa, 2019). The concept of the STEM approach places students involved in ill-defined tasks into well-defined outcomes through collaboration in groups. The implementation of the STEM approach to learning provides variety and innovation to students. The STEM approach helps students acquire complete knowledge, become more skilled and develop critical thinking (Rohmah, Ansori, & Nahdi, 2019).

The stages of learning with the practicum concept are analyzing and solving problems. This stage is a form of learning that implements the STEM approach method (Widyaseno & Susilo, 2022). The STEM integration program in learning is a learning program that combines two or more fields of knowledge (Handayani, Astuti, & Bhakti, 2020; Prismasari, Hartiwi, & Indrawati, 2019). STEM is an acronym for Science, Technology, Engineering, and Mathematics. Science is the study of the natural world including natural laws related to physics, chemistry and biology. Technology covers various fields that involve the application of human knowledge, skills and abilities in producing something that can facilitate life activities. Engineering (Engineering) is the process of designing in making a product or work steps. Mathematics is the science of numbers, operations, relationships and shapes. Mathematics helps in interpreting, analyzing information, simplifying and solving problems, assessing risks, making decisions, making models, and explaining abstract and concrete conceptual problems (Ananda & Salamah, 2021). Several aspects of the STEM learning process: (1) asking questions (science) and defining problems (engineering); (2) developing and using models; (3) planning and conducting investigations; (4) analyzing and interpreting data (mathematics); (5) using mathematics; information and computer technology; and computational thinking; (6) building explanations (science) and designing solutions (engineering); (7) engage in evidence-based arguments; (8) obtaining, evaluating, and communicating information.

The current problem is that the availability of practicum tools and materials is still very minimal, making it impossible for students to directly learn by trying and experimenting in the laboratory (Putri, 2021). Based on the data from the preliminary study of 8th grade students in Bandar Lampung, it shows that 78% of students enjoy learning using practicum tools. However, the results of a preliminary study of junior high school science teachers in Bandar Lampung showed that 37% of the practicum tools in the school laboratory were easy to use.

Practicum Instrument Component functions as a bridge between students and understanding concepts, so that students can understand concepts from the experiences they do so that students understand the material being taught more quickly. STEM provides opportunities in problem solving, especially in providing adaptive feedback to improve competence. In addition, implementing STEM learning is part of innovation in the science learning process (Putra, Utami, Suyidno, & Fahmi, 2022). The development of Practicum Instrument Component in learning has been done before, including by (Annisa Izzania & Widhihastuti, 2020) who stated that the potential for developing Practicum Instrument Component is feasible to use. Furthermore, Arifuddin et al., (2022) demonstrated the use of the Science Practicum Instrument Component for learning motivation, and assistance in conducting science practicums. Then Subamia, Wahyuni, & Widiasih, (2014) stated that the results of the trial use of the product showed that 87.8% of students said it was good, the teacher's response to the use of the Science Practicum Instrument Component tool stated that it was very feasible.

This study aims to describe teachers' perceptions about the development of STEM-based practicum instrument components on the topic of climate change to stimulate students' systems thinking abilities and science process skills.

METHODS

The research design is mixed methods. The mixed methods strategy used by Sequential Explanatory Design combines qualitative and quantitative data collection and data analysis (Klassen et al., 2012). The sampling technique that we used to determine the sample was using random sampling (Sugiyono, 2016). We used Google forms to collect information shared online. The research subjects used were 50 science teacher respondents in Lampung province. The research design scheme can be seen in Figure 1.

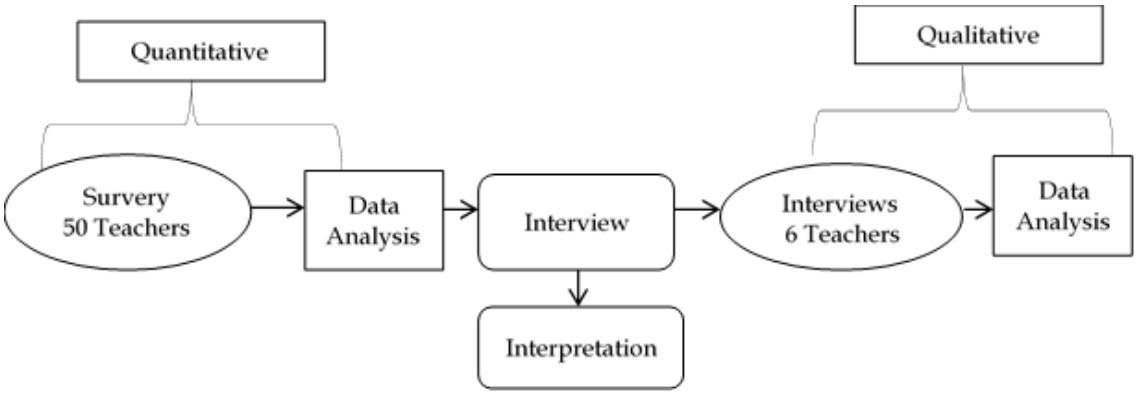

Figure 1. Research Design Scheme

The questionnaire consists of three aspects, namely aspects of systems thinking skills, practicum instrument components, and STEM learning. Then an analysis of the results of the teacher needs analysis questionnaire was carried out which was described in percentage form, then interpreted qualitatively. The survey instrument consists of 10 statements using the Guttman scale which have answer choices according to the contents of the question, namely: "Yes" and "No" with a score of "1" and "0" (Sudjana, 2005). The results of the questionnaire were analyzed using the percentage of responses from each item and the results of the interpretation of the presentation of the respondents' answers in a descriptive narrative form. The next stage was semi-structured interviews with 6 teachers

RESULTS

The results of the data obtained are in the form of a questionnaire. The results of distributing the questionnaire to 50 science teachers in Lampung Province can be seen in table 1 as follows.

Table 1. Questions of the Teacher Interview

No	Questions	Percentage (%)	
		Yes	No
1	The concept of climate change will be easier to understand if it is taught using learning media	90	10
2	Learning media suitable for understanding the concept of climate change is to use practicum tools	70	30
3	The learning method that is suitable for understanding the concept of climate change is the practicum method	70	30
4	Tools and materials for climate change practicum are hard to find	80	20
5	The concept of climate change can only be understood if you understand other	60	40

	supporting concepts		
6	Teachers should use the latest technology related to the concept of climate change	80	20
7	Teachers should teach students to design practicum tools	70	30
8	Teachers and students should arrange their own practicum tools	80	20

The results of the research show that 90% of educators agree that learning the concept of climate change will be easier to understand using the media. 70% of educators agree that the concept of climate change is easier to teach through practical activities, but 80% feel that it is difficult to find tools and materials for climate fertilization practicals. 80% of educators also agree that it is necessary to use the latest technology to learn the concept of climate change.

The results of the teacher's questions and responses can be found in Table 2.

Table 2. Results of the Teacher Interview

No	Questions	Teacher's Responses
1.	How do you teach the concept of climate change to students?	• Through video screenings • Using a PPT that I made myself • Ask students to discuss a case
	Have you ever used the practical method in teaching the concept of climate change?	• Never, I use videos more often • There is no climate change practicum tool in my school • Have been through a simple trial
	Do you know what systems thinking is?	• System thinking is a person's ability to think structurally and globally • Looking globally • Organized thinking
	Have you ever applied learning to stimulate system thinking skills?	• Not yet, I don't understand • Not yet • Maybe through the discussion method
	Can the learning media you use stimulate system	• It seems that it is still low, but it can still be improved even if only a little. Don't pay too much attention to it • They have never developed an instrument to assess system thinking

	thinking skills?	ability so they don't know • Not yet, because there are still a lot of learning media that have been used so far that are only made complete with administration or made inadequate
	Can PRACTICUM INSTRUMENT COMPONENT practicum help students understand the concept of climate change more clearly	• Very helpful because children tend to understand things more easily when they do it directly • Yes, it can make students understand the concept more clearly • Yes, that's right. The goal is to strengthen the concept

The use of practical Practicum Instrument Component is believed to help students understand the topic of climate change. Unfortunately, many educators have not yet created or designed suitable practicum instrument components. Through the use of practical Practicum Instrument Component, students will have a better understanding of the learning process and their understanding of climate change. The topic of climate change is a topic that requires a leveled understanding such as systems thinking. Learning Natural Science through practicum can help students relate two domains of knowledge, namely the domain of real objects that can be observed and domain of mind knowledge (Murniati & Yusup, 2015). Hence, within the laboratory activities of the students, they correlate the outcomes of their observations with the knowledge or theories they possess.

DISCUSSION

The teacher tries to realize the application of practicum learning with using the Student Worksheet (LKPD) that is already available at school. Analysis of LKPD in schools found that still many shortcomings in presenting relevant objects or phenomena.

The deficiency is caused by (1) less precise procedures, (2) tools and materials that are less relevant, and (3) the activity time is too long. According to teachers, learning with practicum method is liked by students and more meaningful. The teacher revealed the weakness of practicum learning limited time and availability of tools. In public schools, there are generally many learning groups, making it difficult for teachers to schedule activities practicum (Usmeldi & Amini, 2021).

In order to be able to grow students' science process skills, educators need a Practicum Instrument Component practicum development plan on the topic of climate change so that students will be clearly seen to be doing a positive science process. All this time, educators teach the topic of climate change only by relying on Power point, it turns out that through this learning, students are less able to see how the science process emerges.

Scientific process skills need to be taught to students to explore and understand the environment. IPA learning should train skills scientific process to develop observation skills, planning research, interpret data, and conclude.

Process skills science can be trained through laboratory or practicum activities. Practicum is the most important part of IPA learning because IPA is based on physical symptoms in daily life. In science subjects, concepts and sub-concepts are learned through simple research, experiments, and a number of activities to develop process skills. The essence of IPA is a process discovery. Every IPA learning topic should be taught through experiments or demonstrations carried out in the laboratory. Practicum learning has many advantages, among otherspracticum learning provides experience for students to observing and understanding natural phenomena (Hasruddin & Rezeqi, 2012).

The development of practicum instrument component that is currently needed is a Practicum Instrument Component that is integrated with STEM. The subject of climate change is very complex and requires multidisciplinary science in the process of understanding it. This will make it easier for students to accept and process the concept of climate change. In a multidisciplinary approach such as a combination of science, technology, engineering, and mathematics (STEM). Raising environmental issues is very appropriate to do with a problem-approached based learning (PBL). The integration of PBL in STEM makes it possible to actualize literacy environment and creativity (Ratna Farwati, 2017)

CONCLUSION

Teachers and students have a positive view of the use of STEM-based practicum instrument component in science learning to improve systems thinking ability and science process skills. Based on the results of the teacher interview, the teacher believes that the implementation of Practicum Instrument Component practicum can make students master the concept of climate change which is complex. Students can also gain meaningful

learning by making discoveries directly during learning activities using the practical practicum instrument component so as to develop science process skills. In addition, teachers also need the learning media to be used in IPA learning so that they can train system thinking skills.

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