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Strengthening ASEAN STEAM Collaboration: Empowering Chemistry Teachers through Training on Developing STEAM-Based Assessment Instruments

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Abstract: STEAM (Science, Technology, Engineering, Art, and Mathematics) is a learning approach that encourages students to think broadly about real-world problems. However, the limited knowledge of chemistry teachers about the STEAM-based learning and assessment process causes this approach to be rarely implemented. This service aims to train teachers' skills to develop STEAM-based assessment instruments. The workshop method is used with implementation stages including preparation, implementation, evaluation, and reporting. This activity was carried out in a hybrid manner, with presentations by lecturers from Universiti Sains Malaysia and Sebelas Maret University. Participants in this activity were 68 chemistry teachers from various regions of Indonesia. Test instruments totaling 15 questions in the pretest and posttest, as well as questionnaire instruments totaling 18 questions, were used to evaluate the results of this training. As a result, participants' knowledge and skills about STEAM learning increased after the training. In addition, as many as 44% of participants are very interested in implementing STEAM in the chemistry learning process in schools. As evaluation materials, participants gave suggestions to increase the explanation time and provide more examples of STEAM-based instruments.

Keywords: assessment instrument; chemistry; collaboration; steam;workshop

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INTRODUCTION

STEAM, or Science, Technology, Engineering, Art and Mathematics, is an integrated learning approach that encourages students to think more broadly about problems that occur in the real world (Hsu & Yeh, 2019). STEAM also supports meaningful learning experiences and problem-solving, and argues that science, technology, engineering, art and mathematics are intertwined with each other (Kartimi et al., 2021; Shidiq et al., 2020, 2022). In STEAM, science and technology can be

integrated through art and engineering, including mathematical components in the learning process (Smith, 2015; Uskoković, 2023).

The components of STEAM are: 1) problem solving through innovation and design; 2) the linkage between assessments, lesson plans, and learning standards; 3) the combination of more than one subject in STEAM and its usefulness in art; 4) a collaborative learning environment and process based learning; and 5) a focus on things that happen in life (*contextual learning*) (El Nagdi et al., 2018; Srikoom et al., 2018). The foundation of STEAM actually lies in inquiry, critical thinking, and process-based learning. Process-based here means the process of asking questions, arousing curiosity, and being able to find a solution to a problem. The essence of STEAM learning is to make students more creative in finding problem solutions. However, in practice in the field, many students are still not active in the learning process due to the lack of implementation of innovative learning in the classroom. This will result in low 21st century skills possessed by students, such as *communication,* critical thinking, *collaboration,* and *creativity* skills (Jufriadi et al., 2022) To cultivate 21st century skills in learners, teachers must be able to design innovative learning devices (Shidiq & Yamtinah, 2019). This is in line with the vision, mission, and goals of the Merdeka Curriculum.

The Merdeka Curriculum is a learning method that refers to the approach of talents and interests (Sopiansyah et al., 2022). Students can choose what lessons they want to learn according to their interests. In general, the Merdeka Curriculum is a diverse intracurricular learning curriculum. Regarding the implementation of the Merdeka Curriculum in schools, there are still many teachers who have not implemented innovative learning methods such as STEAM-based learning. The limited knowledge of teachers in schools related to STEAM-based learning causes its lack of application in classroom learning (Anugrahana, 2019). In addition, the proficiency in designing STEAM-based contextual assessment instruments owned by teachers is still minimal. Thus, based on the description of the problem that has been presented above, it is necessary to hold training to develop STEAM-based assessment instruments for teachers in collaboration with ASEAN researchers (Widyasari et al., 2022). The urgency of addressing the lack of teacher knowledge when implementing STEAM-based learning and assessment processes is critical. Chemistry teachers in Surakarta and its surroundings, as well as those across Indonesia, face similar challenges in this area. In response, this service aims to collaborate with ASEAN STEAM researchers to provide effective training for developing STEAM-based assessment instrument.

METHOD

The workshop method is used with implementation stages including preparation, implementation, evaluation, and reporting. Preparation activities include coordination with STEAM researchers from USM as partner institutions for the implementation of training and data collection for secondary school teachers' needs regarding STEAM learning, determination of training materials, determination and communication with instructors with sufficient expertise, determination of implementation schedules, selection and sending invitations to participants.

The implementation activities were carried out in a hybrid manner with collaboration between researchers from USM, namely Prof. Dr. Mageswary Karpudewan with Research Gorup (RG)

Chemistry and Chemistry Learning Innovation. In this implementation, socialization, training and mentoring will be carried out. Socialization is intended to provide explanations related to the implementation of STEAM learning in schools, along with learning tools. The training will focus on making learning tools with STEAM, especially in the development of STEAM-based assessment instruments for secondary school teachers. The purpose of this training is to provide skills to the participants to develop relevant contextual instruments. The training method used in this training is to provide examples of best practices from the STEAM assessment instrument that has been developed by the RG Chemistry and Chemistry Learning Innovation teams. The instructors in this training activity were representatives of RG and USM.

Mentoring activities are carried out by assisting teachers when constructing STEAM-based assessment instruments. This assistance is carried out periodically. Training participants will be divided into groups to be accompanied in a structured manner by a team from RG. This assistance is expected to produce output in the form of STEAM learning tools made by participants that are ready to be implemented.

Evaluation and reporting are conducted in a hybrid manner to facilitate reflection and follow-up plans for the activities carried out. The evaluation includes pretests, post-tests, and questionnaires to assess participants' responses and perceptions of the training. The evaluation uses 15 questions related to STEAM learning and assessment processes and Likert scale questionnaires. The feedback from participants and the results of these questionnaires become the main materials for evaluation and reporting.

This community service was conducted from 13th October to 3rd November 2023. Participants in this community service were 68 teachers from various regions in Indonesia. The participant distribution data is shown in Figure 1. Test instruments totaling 15 questions on the pretest and posttest, as well as questionnaire instruments totaling 18 questions, were used in this service.

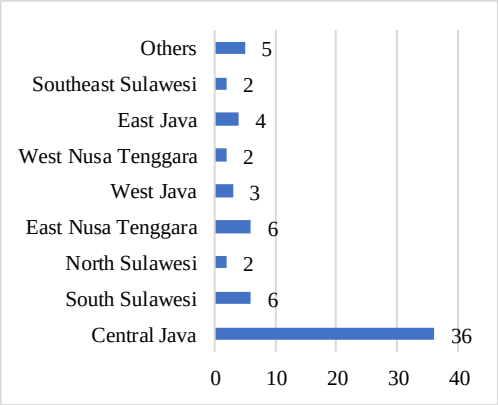

Figure 1 Participant distribution data

RESULTS AND DISCUSSION

The training activity began with a material presentation by STEAM ASEAN researchers from the University Sains Malaysia. In this presentation, she delivered the topic of STrEaM. Sample presentation slides are shown in Figure 2.

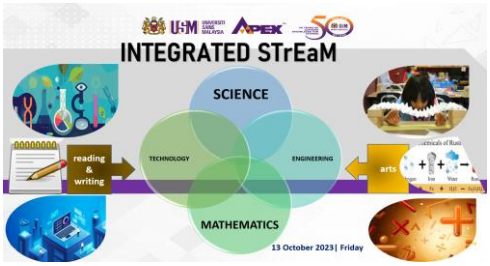

Figure 2 Presentation slides

The lecturers of the Chemistry Education Study Program FKIP UNS implement training as a community service program with the main objective of providing a more holistic approach to learning and assessment that covers various aspects of STEAM, as well as

incorporating art, reading and writing into the approach. This is called the STrEaM (Science, Technology, Reading and Writing, Engineering, Art, and Mathematics) approach.

Professor Mageswary Karpudewan played an important role in conveying his innovation regarding the STrEaM approach, which is the foundation of this program (Subramaniam et al., 2023). She motivates teachers and students to think more creatively and engage aspects of STEAM together with art and reading and writing skills in chemistry learning. In this way, they can help students understand chemical concepts better and relate them to the real world.

This collaboration has become an important point in the development of chemistry education in Indonesia. Chemistry teachers in various schools around UNS receive intensive training in applying the STrEaM approach to their learning. They learn how to integrate various concepts of science, technology, engineering, mathematics, and art, as well as reading and writing into their chemistry curriculum. Not only does this make learning more interesting for students, but it also helps them develop skills needed in the real world. The documentation of exposure activities carried out by Prof. Karpudewan is shown in Figure 3.

(a) (b)

Figure 3 (a) and (b) Documentation of offline activities with Prof. Karpudewan

Prior to the presentation by Prof. Mageswary Karpudewan, participants who attended were first given a pre-test to find out their initial knowledge related to STEAM approaches. After the presentation, participants were also given the same questions as the post-test. Through this, the increase in knowledge of participants can be known. The data obtained from the pre-and post-test results are shown in Figure 4.

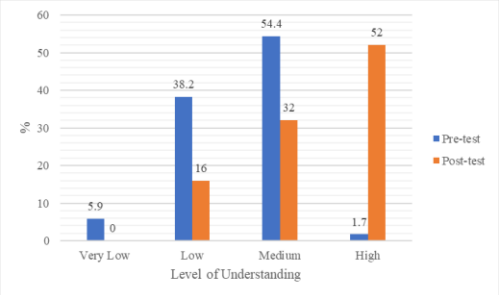

Figure 4 Pre-post test results (%)

Following the collaborative session with Prof. Karpudewan, the service activity resumed on October 20 with a presentation on the development of STEAM-oriented assessment instruments. This presentation was delivered by Dr. Mohammad Masykuri's presentation slides is depicted in Figure 5.

Figure 5 Slides from Dr. Mohammad Masykuri, M.Si

This activity clearly shows the collaboration between various parties in the development of STEAM-oriented instruments. The STEAM-based assessment instrument aims to support education focusing on science, technology, engineering, and mathematics, as well as involving various stakeholders in the development process (Kartimi et al., 2021; Shidiq et al., 2020).

During the mentoring process until November 3, the service team opened a discussion and consultation session for participants who had developed learning tools, especially STEAM-based assessment instruments.

This session provides an opportunity for participants to discuss the challenges and questions they faced during instrument development. The service team can also monitor and evaluate the instruments that have been developed by participants. It aims to ensure the quality of the instrument and provide input for improvement if needed.

This mentoring process aims to assist participants in achieving optimal results in the development of STEAM-based assessment instruments, which will support education focusing on science, technology, engineering, and mathematics. Close collaboration between the service team and participants is key to achieving this goal.

Collaboration between service team members who have diverse expertise and experience is one of the key aspects of the development of STEAM-based instruments. This ensures that the resulting instruments reflect various aspects of STEAM science and education.

Dr. Sri Yamtinah, M.Pd. - Head of community service team. She has a leading role in coordinating all service activities. As an educational evaluation expert, she contributes to directing the service approach and ensuring the key objectives of developing STEAM-based instruments are achieved.

Bakti Mulyani, M.Si. has a strong educational background in chemistry and education. She acts as a member of the accompanying team that assists participants in developing assessment instruments with a focus on chemical aspects.

Dr. Maria Ulfa, M.Si. is a team member who brought additional knowledge and insights into the development of STEAM-based instruments. It provides a broad view of innovation in chemistry learning.

Dr. Ari Syahidul Shidiq, M.Pd. acted as a companion who has an educational background and experience in STEAM implementation. He provides practical guidance for developing assessment instruments that are appropriate to the needs of teaching in the field. Documentation of the Research Group's community service activities is shown in Figure 6.

Figure 6 Community service team

At the end of the service session, to evaluate the service activities carried out, the community service team provided a questionnaire evaluating the activities. The results of the activity evaluation questionnaire are shown in Figures 7. Scale 1 for answers is very inappropriate, and 5 is very suitable.

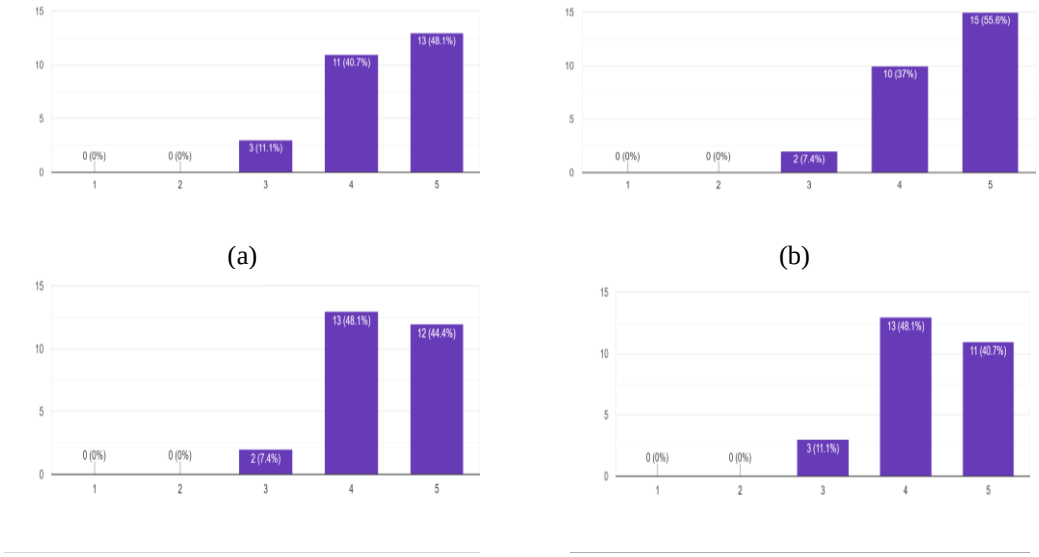

Figure 7 (a) with the question: Was the community service activity material in STEAM implemented as expected?, (b) With the question: In your opinion, is the material presented clear and easy to understand?, (c) With questions Whether every complaint/ question/ problem raised was followed up properly by the service team, and (d) With the question how satisfied are you with the dedication activities carried out?

In addition to being quantitative, evaluation is also carried out qualitatively, namely by providing opportunities for participants to provide input and suggestions for improving the service process. There are some comments from participants, namely:

"*What needs to be improved in the delivery of STEAM assessment instrument material are examples of STEAM instruments that distinguish them from PjBL and PBL learning models or other models of learning.*"

"*What needs to be improved is the time to discuss the assessment instrument because I also just learned how much steam we make for the community. Usually in schools only in the form of PJBL so that the instrument is also only useful for teachers and schools.*"

"*My suggestion in the future may be to have more specialized and intense mentoring so that we can focus on this STEAM.*"

The participants have provided valuable input to improve this service process. Some participant comments highlight the need for STEAM examples that distinguish from other learning models, such as PjBL and PBL, so as to more clearly understand the differences in these learning approaches. In addition, participants also expressed a desire for more time allocated to discuss the STEAM assessment instrument, as this is a new concept for some of them. Finally, participants proposed more specific and intensive mentoring going forward to allow for a greater focus on this STEAM approach. This feedback is invaluable and will be the foundation for further improvement and development in our dedication efforts.

The training program focused on developing STEAM-based assessment instruments for chemistry teachers and aimed to enhance their ability to design

and implement effective STEAM methodologies. The program was designed to address the gaps in teachers' knowledge and skills regarding STEAM education and assessment. The STEAM-based assessment training significantly enhanced participants' ability to design and implement effective STEAM assessment methods. This improvement suggests a potential increase in the quality of teaching, leading to more integrated and contextualized learning experiences. Enhanced teacher skills in STEAM assessment may lead to more innovative and relevant chemistry instruction in schools.

CONCLUSION

Based on the evaluation of the service program that has been carried out, it can be concluded that there is an increase in the knowledge and skills of chemistry teachers to implement the process and develop STEAM-based chemistry learning instruments.

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