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SUSTAINABILITY OF TEACHERS' TRAINING PROGRAM TO PREPARING STEM BASED LEARNING IMPLEMENTATION IN INDONESIA

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Abstract

Science, Technology, Engineering, and Math (STEM) based education serves as effective teaching method for developing students' critical thinking, creative, and problem-solving skills. However, implementing STEM learning in various parts of Indonesia, including at primary and secondary level at Karimun Regency, remains challenging. Pre-training observational data revealed that none of the 135 surveyed elementary and middle school teachers in Karimun Regency had received training in applying STEM-based learning to their teaching practices. In fact, teachers do not know and understand learning with STEM approach at primary and secondary levels. This international community service initiative offers training on applying STEM-based learning to elementary and middle school teachers in Karimun Regency, Province of Riau Kepulauan, Indonesia. This program conducted during the 2024-2025 academic year, involved 150 teachers. The training measurement outcomes show that: 1) The training program for creating STEM-based lesson plans was successful. 2) Teachers understand STEM-based learning concepts and can develop lesson plans that meet STEM-based learning criteria. This training program enables to incorporate STEM-based learning in their schools, thereby enhancing students' critical thinking, creativity, and problem-solving abilities. The results of this program contribute to teachers, school management, and the government to prioritize sustainability training to increase the effectiveness of STEM implementation.

Keywords: ***Learning, STEM, Sustainability, Training Program***

INTRODUCTION

The 21st century can be said to be the century of knowledge, which is known as a century marked by a massive transformation from an agrarian society to a knowledge society (Messi, 2019). This transformation has become a serious challenge in education. Educators are indirectly encouraged to realize 21st century education to produce human resources who are ready to face the consequences of this century. The aim of 21st century education is to encourage students to master 21st century skills that are important and useful to them so that they are more responsive to changes and developments over time (Afandi, 2016). In addition, 21st century skills, or what is known as the 21st century learning framework, also requires students to have skills, knowledge, and abilities in the fields of technology, media and information, learning skills, innovation, and life skills (Simanjuntak, 2019). To address this challenge, the STEM learning concept, or movement, has emerged. STEM originates from the concepts of STEM (Science, Technology, Engineering, & Mathematics) education. Mu'minah (2020) STEM is a learning approach that expands knowledge, science and humanities for students and develops 21st century skills, in which students use science, technology, engineering and mathematics in real contexts connecting school, the world work, and the global world.

Starzinski (2017) explained that STEM is an integrated learning model of science, technology, engineering, and mathematics, as a forum for developing students' investigative activities, communication skills, and critical thinking in learning. An adaptive education system refers to the need for synergy between the design of the educational process and the latest developments in knowledge (Afand et al., 2016), which Hawes-Neisbit (2005) calls modern education. The existence of STEM is not only modern education but also provides opportunities for children to develop their abilities to communicate their knowledge creatively (Anizal and Hartati, 2022). However, facts in the field reveal that teachers' understanding and implementation of STEM are still ineffective. The research results of Nuragnia et al. (2021) show that the problem in implementing STEM is teachers' low understanding, where 68.75% of teachers do not understand STEM, supporting facilities are still minimal, and 65.62% of schools do not have ideal facilities. Shernoff et al. (2017) revealed a lack of STEM learning provided to teachers and teachers also felt a lack of training regarding STEM learning. Teachers feel that there is a lack of ready-to-use media to support learning (Rafiqa et al. 2020). In addition, 59.37% of teachers experienced challenges in accessing STEM content. These include administrative challenges, budgets, and the availability of STEM content in Indonesia. Previous research also revealed that lack of resources such as facilities, budget (Park et al., 2016), and access to content (Shernoff et al., 2017) were challenges of STEM implementation felt by teachers in STEM implementation.

The results of observations carried out before the training activities for elementary and middle school teachers in Karimun Regency revealed that teachers had never attended training related to the application of STEM in the learning process. From the day of the survey conducted on 20-23 August 2024 of 135 elementary and middle school teachers in Karimun Regency, 100% of the teachers had never participated in training in the application of STEM-based learning, whether conducted by the Karimun Regency Education and Culture Office or conducted by other institutions. This caused all the teachers who were observed to say that they did not fully understand STEM-based learning, both theoretically and practically. From the results of open interviews conducted with teachers, it was revealed that STEM-based learning is new information for teachers in Karimun Regency because previously we had never received this material in various Merdeka Curriculum implementation trainings (August 23, 2024). Based on the problems that occur at partner locations, in this case within the Karimun Regency Education and Culture Office, this international community service is carried out by the Postgraduate Program at the University of Riau, Batam Islands, with several objectives, namely: 1) Providing training to increase teachers' understanding of STEM-based learning. 2) Providing training to improve teacher competency in preparing STEM-based learning plans at elementary and middle school levels in Karimun Regency. This training program is important, considering that teachers in Karimun Regency have never participated in training on STEM-based learning. In addition, this program is an ongoing effort to improve teachers' competency through collaboration between the University of Riau Islands and Karimun Regency Education and Culture Office.

METHOD

The community service activity was implemented at the Education and Culture Office in Karimun Regency. This initiative aimed to enhance teachers' comprehension of STEM-based learning and improve their ability to create STEM-based lesson plans for elementary and middle school levels in the region. The program involved 150 educators and school leaders from both Elementary and Junior High School levels. The training sessions were held in the auditorium of SD Negeri 001 Karimun. To accomplish the goals of this program, the project followed a managerial approach, encompassing planning, organizing, implementation, control, and evaluation phases. The following sections detail program conducted at the Karimun Regency Education and Culture Office during each stage of the management process.

Planning

The planning phase involved internal discussions with key university officials, including the Chancellor and Deputy Chancellors, along with faculty members from various institutions and students from the Master's program in Education Management at the University of the Riau Islands. These meetings resulted in the decision to conduct four training sessions. The team then established the training dates, venue, participating schools' schedule, assignment distribution for trainee educators, and submission deadlines. They also coordinated with each school's

principal on the specified dates. During this stage, objectives were established for participants to develop STEM-based learning plans for elementary and secondary schools in Karimun Regency.

Organizing

This organizing stage is the determination or distribution of tasks, obligations, and authority determined in the training to prepare STEM-based learning plans at the elementary and middle school levels in the Karimun Regency over four meetings. The division of duties is as follows.

Table 1. Division of Duties and Authorities

Component of Program	Task on Duty
One Head of District Education Office. Karimun	Approved the implementation of training to improve teacher competency in preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency
Secretary of District Education Office. Karimun - Regency	- Invite training participants to prepare STEM-based learning plans at elementary and middle school levels in Karimun Regency, consisting of teachers and school principals - Providing invitation letters for training in preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency - Coordinate with the Riau Islands University and the Karimun Regency Education and Culture Office, as well as with the Principals of Elementary and Middle Schools in the District.
School Coordinators	- Providing a hall for training in preparing STEM-based learning plans at the elementary and middle school levels in Karimun - Providing advice and facilities needed for training in preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency, consisting of teachers and principals
Postgraduate Director, University of Riau Islands	- Assigned Postgraduate lecturers to act as speakers in training to prepare STEM-based learning plans at elementary and middle school levels in Karimun Regency, consisting of teachers and school principals - Receive reports on the results of training to prepare STEM-based learning plans at elementary and middle school levels in Karimun Regency, consisting of teachers and school principals.
School Principals	- Provided assignment letters to teachers to take part in training in preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency - Participated in training to develop STEM-based learning plans at elementary and middle school levels in Karimun Regency
Instructor (Lecturer from University of Riau Kepulauan and Universiti Malaya)	- Prepare training materials and form power points, creative videos, and training assignment sheet documents to prepare STEM-based learning plans at the elementary and middle - Providing training STEM-based learning plans and checking billing assignments collected by teachers and school principals. - Assess assignments completed and provide feedback on assignments submitted by training participants.
Training Participants	- Participated in training to prepare STEM-based learning plans. - Carrying out billing assignments, namely preparing a STEM- based learning plan.

Implementation

The implementation of training to increase teacher competency in preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency, which was attended by teachers and school principals, was held in four meetings. This training activity consisted of pre-training and direct training in the Hall of SD Negeri 001 Karimun, Karimun Regency. The schedule and description of the training implementation for preparing STEM-based learning plans at the elementary and middle school levels in Karimun Regency.

Table 2. Schedule of Training Program

Day/Date	Activities
Monday, August 26 2024	- Online meeting to discuss training techniques to discuss about the concept of a STEM-based learning approach - Determining the day, date, location, hall and time of training at SD Negeri 001 Karimun Regency - Prepare STEM-based learning training documents.
Tuesday, 27 August 2024	- Educational seminar on strengthening the professional competence of teachers and school principals within the Karimun Regency Education and Culture Service - Conduct panel question-and-answer sessions (discussions) and reflect on training activities.
Wednesday, 28 August 2024	- Training to increase teachers' and principals' understanding of the concept of a STEM-based learning approach - Training in preparing learning plans according to the STEM-based learning approach at elementary and middle school levels.
Thursday, 29 August 2024	- Doing Worksheets for STEM-based learning plan modules according to your field - Evaluate and reflect on the effectiveness of STEM-based learning training at the elementary and middle school levels in the district. - Prepare follow-up programs that will be carried out based on the results of the training provided in the first stage at the elementary and middle school levels in Karimun Regency.

Based on the schedule and description of activities carried out at the Karimun Regency Education and Culture Service, the scheme for implementing this activity can be described by analysing the problems faced by partners, namely, teachers and principals of Karimun Regency Elementary and Middle Schools. The solution prepared by the program implementation team is training activities to increase the understanding of STEM-based learning and teacher competence in preparing learning plans in accordance with the STEM-based learning approach. Thus, the procedure for implementing this training activity is illustrated in the following figure.

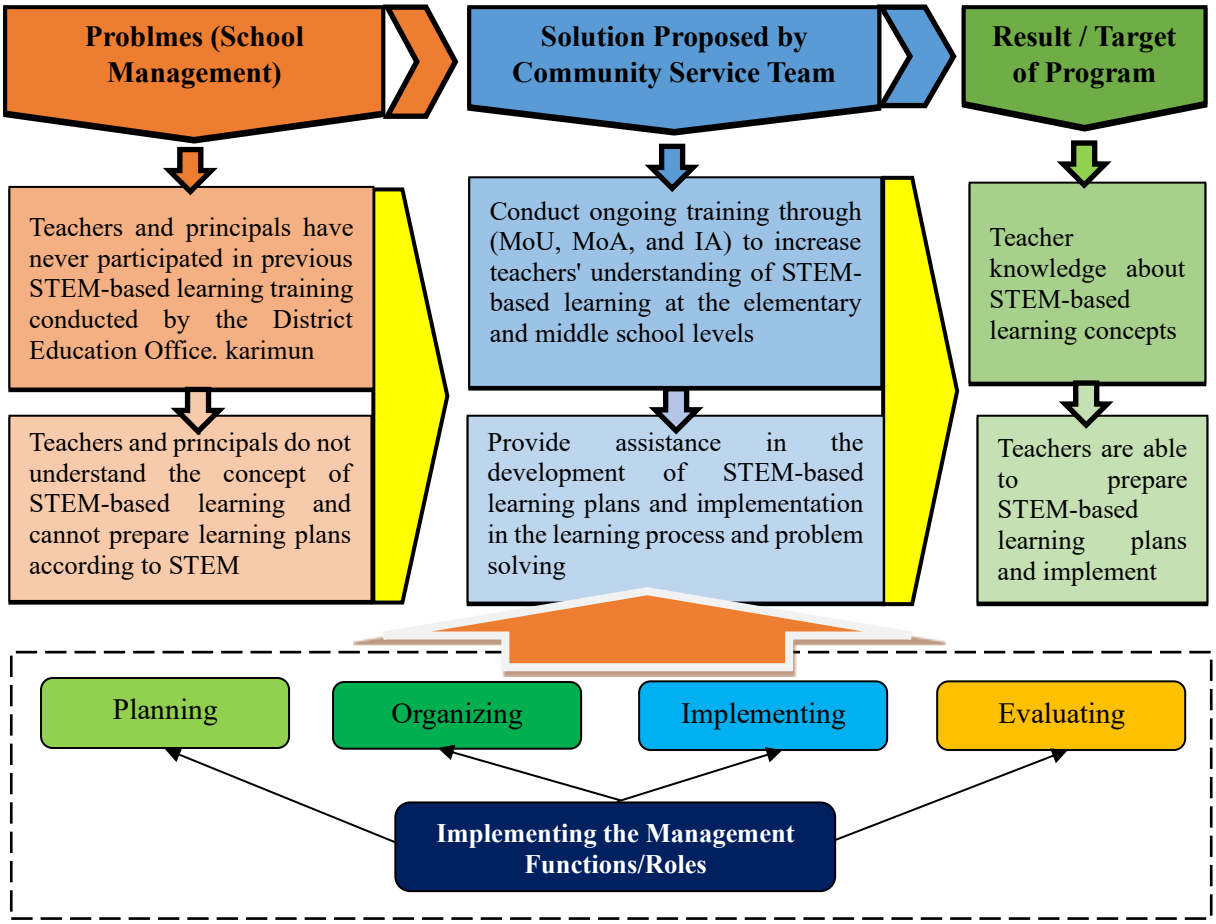

Image 1. Program Implementation Framework at the Karimun Regency Education Office

Evaluating

An evaluation was carried out to measure the effectiveness of the training implementation through online surveys. The instrument used was a survey consisting of 16 questions using a Likert scale 4: Strongly Agree, 3: Agree, 2: Disagree, and 1: Disagree. Details of the training evaluation instrument are provided below.

Table 3. Training Evaluation Instrument Items

No	Butir Insturmen Evaluasi Pelatihan
1	Training information is conveyed clearly by the committee
2	The committee provides training invitations to participants (electronic or non-electronic)
3	The training committee provides supporting facilities for training activities
4	The training committee provides services to participants during the activity
5	Training speakers have the ability to explain material substantively
6	Training speakers explain the material clearly and understandably
7	Training speakers presented PPT material in a coherent, structured and visual way
8	Speakers present the PPT with appropriate colours and clear font selection
9	Training participants can understand the material presented by the speaker well
10	Training participants receive clear and appropriate answers to questions
11	Training speakers gave good responses to all questioners
12	Trainees can take part in training comfortably in the activity room
13	Training materials are available and accessible to participants before and after the event
14	The implementation of training runs effectively and on time
15	In general, the training ran effectively and participants participated enthusiastically
16	In general, the training materials can be understood and used by participants

RESULTS AND DISCUSSION

Based on international program community services activities implemented from the period 26-29 August 2024 through training activities to increase teacher competency in understanding STEM-based learning and preparing STEM-based learning plans, the results are presented qualitatively and quantitatively below.

Description of the Training Program at SD Negeri 001 Karimun

Increasing teacher competency in understanding STEM-based learning and preparing lesson plans in accordance with STEM-based learning is carried out in a planned, organized, implemented, controlled, and measurable manner, so that the implementation of this training activity can have a positive impact on teachers and school principals as staff. teacher at school. Thus, the STEM-based learning concept can be applied by teachers and school principals in their respective educational units to improve students' thinking abilities, creativity, and problem-solving abilities. This training procedure was carried out managerially over four meetings, where participants came from different elementary and middle schools. Photos of STEM-based learning training activities at SD Negeri 001 Karimun.

Quantitative Description of Training Effectiveness

Training or mentoring programs can be said to be running effectively if the process of implementing all planned and organized activities can be carried out in accordance with the plans set at the beginning, and the results can be measured objectively. In Indonesian Dictionary, in 2022, the word effective can be said to be a result that is positive and successful. According to Drucker (2014), effective is doing the right work (doing the right things), while, according to him, being efficient is doing the work correctly (doing things right). Furthermore, effectiveness can be interpreted as achieving various specified targets on time by using certain resources that have been allocated to carry out certain activities (Usman, 2016; Siagian, 2018; Drake and Dezhbankhan et al. (2021).

To measure the effectiveness of training in increasing teacher competency in understanding STEM-based learning and preparing lesson plans in accordance with STEM-based learning, the team conducted an online survey of 150 participants using a 16-item questionnaire using a Likert scale 4: Strongly Agree, 3: Agree, 2: Disagree, and 1: Disagree. In addition, the resource personnel conducted closed interviews by asking participants questions via Google form, which aimed to explore the shortcomings of the training implementation, advantages, and suggestions for improvement of STEM-based learning training in the next training. The following are the results of an online survey that illustrates the level of effectiveness of STEM-based learning training activities carried out at SD Negeri 001 Karimun to increase teachers' competency in understanding STEM-based learning and preparing lesson plans.

Table 4. Result of Program Evaluating

No	Butir Insturmen Evaluasi Pelatihan	Persentattion (%)			
		4	**3**	**2**	**1**
1	Training information is conveyed clearly by the committee	50	46,9	3,1	0
2	The committee provides training invitations to participants (electronic or non-electronic)	53,1	46,9	0	0
3	The training committee provides supporting facilities for training activities	34,4	62,5	3,1	0
4	The training committee provides services to participants during the activity	50	50	0	0
5	Training speakers have the ability to explain material substantively	56,3	43,8	0	0
6	Training speakers explain the material clearly and understandably	34,4	56,3	9,4	0
7	Training speakers presented slides material in a coherent, structured and visual way	43,8	53,1	3,1	0
8	Speakers present the slides with appropriate colours and clear font selection	31,3	56,3	12,5	0
9	Training participants can understand the material presented by the speaker well	40,6	59,4	0	0
10	Training participants receive clear and appropriate answers to questions	46,9	53,1	0	0
11	Training speakers gave good responses to all questioners	53,1	46,9	0	0
12	Trainees can take part in training comfortably in the activity room	21,9	62,5	15,6	0
13	Training materials are available and accessible to participants before and after the event	18,8	59,4	12,5	9,4
14	The implementation of training runs effectively and on time	31,3	50	9,4	9,4
15	In general, the training ran effectively and participants participated enthusiastically	25	75	0	0
16	In general, the training materials can be understood and used by participants	46,9	53,1	0	0
Totally		**39,86**	**54,7**	**4,29**	**1,18**

The table above shows that training to increase teachers' understanding and competence in preparing learning plans based on the STEM approach, which was carried out over four meetings, was effective. This can be seen from the percentage of responses given to 150 teachers and school principals, where responses in the Strongly Agree category indicating that this training activity was effective was 39.86%. Furthermore, the response in the Agree category indicating that this training was effective was 54.7%. Meanwhile, in the Disagree category, this training was only 4.29% effective, and in the Disagree category, it was only 1.18%. All participants felt that this training ran effectively, influenced by the resource person's ability to explain the training material, as shown by the responses of all participants, which showed that 56.3% stated that they Strongly Agree and 43.8% stated that they agreed that the speaker had the ability to explain the material. In addition, this training was said to be effective because 46.9% of the training participants strongly agreed, and 53.1% agreed that they received clear and appropriate answers to the questions asked to the speaker. Training participants were also satisfied with the training held because 53.1% stated that they strongly agreed that the training speakers gave good responses to all questions while the training was in progress. Another aspect that can support the effectiveness of this training is that the training speaker presents the slide material in a coherent, structured, and visual manner so that the training participants can easily understand it. The quantitative data above are in line with the results of closed interviews conducted after the training was completed, which stated that this training was effective because the resource person had the ability to explain the material, master the material, and present the material. The summary of the closed interview results shows: (1) The material was conveyed clearly, the speaker who delivered the material was very easy to understand, (2) the speaker explained clearly and the presenter delivered according to the expected objectives; (3)

The advantage of this training is that it is able to bring the participants to understand and comprehend the content of the material with the ability to tell stories and the learning experience of the presenter; (4) The material presented by the presenter provides a lot of inspiration and encouragement to establish oneself as a professional teacher and continue to develop, and (5) in my opinion, the effectiveness of training with the material provided very well conveyed Well, remind yourself of your duties and responsibilities as a teacher that must be carried out with full responsibility and sincerity. Teachers should always remind teachers of materials like this so as not to eliminate the important essence of teaching and education in schools. However, this training also has shortcomings regarding the effectiveness of its implementation in the field. One of the shortcomings of this training is that time management is not yet effective, and training is delayed from the planned time. This can be seen from the results of the responses given by the participants, where 18.8% of participants stated that they disagreed about the timeliness of the start of the event. In addition, there was interference in the field while the training was taking place, namely, the sound of the sound system from an event being held outside the training room. This noise was very disturbing to the participants, so it was difficult for the participants to hear the speaker's voice, especially the participants who were at the back. As many as 15.6% of the participants responded Disagree that this training could be followed comfortably. However, participants can ask the resource person various questions for explanations and information that cannot be heard when there is sound system interference from outside the training room. In this condition, participants suggested that the next training could be carried out in a different place and in a timely manner so that there would be more time for presenting material and question and answer sessions.

CONCLUSION

The evaluation of the international community services program's implementation indicates that this training effectively enhances educators' comprehension and proficiency in developing STEM-based learning plans for elementary and middle schools in Karimun Regency. Furthermore, the training successfully boosts teachers' enthusiasm and inspiration to enhance their professional skills in fulfilling their primary responsibilities as instructors at these educational levels. The training initiative has proven to be managerially effective, as participants demonstrated a grasp of the course material. However, some practical challenges were encountered, such as time management issues due to delayed commencement, insufficient duration, and suboptimal training room conditions. Consequently, future training sessions aimed at improving understanding of STEM-based learning will be conducted in subsequent periods. These upcoming sessions will strive to achieve more favourable outcomes and further augment teachers' understanding and competence in crafting STEM-based learning plans for elementary and middle schools in Karimun Regency. This training program enables to incorporate STEM-based learning in their schools, thereby enhancing students' critical thinking, creativity, and problem-solving abilities. The results of this program contribute to teachers, school management, and the government to prioritize sustainability training to increase the effectiveness of STEM implementation.

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