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Implementation of STEM Local Context in Indonesia

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Abstract

This study aims to analyze the ability of teachers in implementing Local Context STEM learning in the classroom. This research used a qualitative design and a multi case study method of the implementation of STEM learning for elementary, junior high and high school teachers in several cities in Indonesia who participated in the STEM Local Context training. Data were collected through learning observations and interviews as triangulation. The results showed 1) the teacher was able to identify local issues for STEM learning; 2) Engineering Design Process (EDP) as one of the characteristics of STEM learning that can integrate concepts to solve local issues has been illustrated in the lesson plans, 3) teachers are relatively able to implement STEM learning according to the lesson plans; 4) the teacher facilitates students so that they are able to carry out EDP relatively independently; 5) generally the products development is done in the form of homework which is monitored via WhatsApp as a solution to time constraints and other technical aspects that are not easy to do at school; 6) products resulting from STEM learning are varied and reflect local issue-based innovations; 7) get a positive response from students and improve their ability to solve problems; 8) teachers receive good support from school principals and peers in the form of permission to adjust learning schedules and technical support during the implementation of STEM learning.

Keywords: STEM, Engineering Design Process, Local Context.

Introduction

In order to prepare the younger generation for mastery of 21st century skills, the Indonesian government responded by setting it as one of the 2013 curriculum targets and encouraging teachers to use inquiry-based learning not only for science but for other subjects. In the scientific context, in the 21st century, each science no longer has to work alone, but various branches of science can work together, not only within scientific groups, technology or social sciences and humanities, but in many cases between several groups. One of the learning concepts that is in accordance with the scientific context of the 21st century is the STEM approach. Although the term STEM is an acronym for Science, Technology, Engineering and Mathematics, STEM is seen as an integrated learning design.

In the context of learning, STEM is a learning approach that integrates science, technology, engineering and mathematics content to solve problems in everyday life (Reeve, 2013). STEM learning becomes meaningless if only strengthening in the STEM field separately, but must develop an approach that integrates science, technology, engineering and mathematics by focusing on solving real problems in everyday life (National STEM Education Center, 2014). As stated by Morrison (2008) and Tsupros (2008) that STEM education is a "meta-discipline" and this means the "creation of a discipline based on the integration of other disciplinary knowledge into a new 'whole' rather than in bits and pieces. It is an interdisciplinary approach to learning by integrating the four disciplines into one cohesive teaching and learning paradigm. This integration that is aimed at the removal of the traditional barriers erected between the four disciplines is now branded as STEM (Morrison, 2008). According to Tsupros (2008), "STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy (Tsupros, 2009).

In order for STEM learning to run well in schools, Anne Jolly (2014) proposes good STEM learning criteria, one of which is by using the engineering design process (EDP) to integrate science, technology and mathematics. Therefore, EDP is one of the characteristics of STEM learning. EDP is a step to make solutions to contextual problems and provide opportunities for students to apply knowledge of the S, T, E, M subjects in solving contextual problems in an integrative manner. Morrison (2006) provides criteria for effective STEM learning to be taught in class, he suggests that in integrating STEM learning, students must have a role as 1) problem solvers, 2) innovators, 3) inventors, 4) logical thinkers and also be able to understand and develop the skills needed for, 5) self-reliance and 6) technology literacy. In the context of primary and secondary education, Bybee (2013) states that STEM education aims to develop STEM literacy students, which are characterized by: 1) knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM-related issues; 2) understanding of the characteristic features of STEM disciplines as forms of human knowledge, inquiry, and design; 3) awareness of how STEM disciplines shape our material, intellectual, and cultural environments; and 4) willingness to engage in STEM-related issues and with the ideas of science, technology, engineering, and mathematics as a constructive, concerned, and reflective citizen.

Science, Technology, Engineering, and Mathematics (STEM) as an innovation in science learning has become the focus of studies in SEAQIS. Since 2015, STEM learning has become one of the leading education and training programs in SEAQIS in increasing the competence of teachers and education personnel. In order to develop STEM education, in 2018, SEAQIS held STEM training for 30 junior high school teachers and 90 high school teachers representing 67 teacher working groups in 29 cities from 9 provinces in Indonesia. In the same year, SEAQIS collaborated with SEAMEO QITEP in Mathematics and the Directorate of Junior High Schools of the Ministry of Education and Culture of the Republic of Indonesia to organize STEM Training for teachers from 256 reference schools from 34 provinces in Indonesia.

The initial program for the development of SEAQIS STEM learning is to integrate STEM into the 2013 Curriculum where the identification of issues for STEM learning begins with the demands of basic competencies that can be used as opportunities to raise relevant issues and fulfill the characteristics of STEM learning. Based on the lessons learned from the implementation of STEM learning through integration into the 2013 curriculum, starting in 2019 the STEM Local Context (STEM LC) was developed, as an effort to optimize STEM learning opportunities to solve life problems around the immediate environment. Thus, STEM learning can be used to develop the potential of students to have a concern for their environment and the local values that accompany it and make a constructive contribution as citizens. In addition, through STEM LC students can identify problems in the utilization / processing of natural resources that are abundant in their area so that they have added value to help improve the welfare of the surrounding community. Through STEM LC, the issues raised are more contextual, varied, and have the opportunity to practice entrepreneurial skills and have a direct impact on society through community empowerment.

In order to gather information about the successful implementation of STEM LC, this research was conducted to: 1) compile a profile of the teacher's ability in developing a STEM learning plan; 2) compile a profile of the teacher's ability to carry out STEM learning; 3) identify supporting factors and challenges in implementing STEM learning; 4) and identify the impact of STEM learning on students.

Methods

This research used a qualitative design and a multi case study method of STEM learning implementation. The cases analysed in the study were five classes from several cities in Indonesia, consisting of two classes from elementary, two classes from junior high, and one class from high school. All school located in urban area except one junior high school in coastal area which close to religious tourism destination. The teachers are key teachers or representation of their working group and have participated in the STEM Local Context training as preparation or adjustment for introducing STEM learning as new approach in science learning. The training facilitated teachers to discuss and do some activities on STEM learning, experience in developing lesson plans based on each local issues identified, do peer teaching, and develop action plan. After the training, teachers are given post-training services to prepare for the implementation of STEM learning as part of their action plan in the form of mentoring. In this activity the teachers are assisted in improving lesson plans, preparing for the implementation of STEM learning, and discussing things that need to be considered in STEM learning. Data were collected through learning observations and interviews to teachers and students as triangulation. The observation of STEM learning was recorded and conducted two times with the aim that feedback on the 1st learning could help improve the 2nd learning. The interviews to teacher were conducted after each of observation whilst to students were carried out after second observation. The data collected was analyzed by three steps from Miles and Huberman (1994) which are data reduction, data display, also drawing conclusion and verification. The data collected reduced based on research focus which is implementation of STEM LC learning and displayed based on criteria related to each research question and lastly analyzed and verified to draw conclusion.

Result and Discussion

In order to facilitate the discussion, the findings in the form of a summary of the results of data reduction are presented before the discussion as a source of data to analyze and are carried out in accordance with the sequence of research questions.

1. Teacher's ability in developing lesson plans

The teacher's ability to plan learning plans is a very important factor in the success of learning (Ejiwale, 2013). In the discussion of this research, the focus of the study on the ability of teachers in preparing lesson plans is on lesson plans that have been compiled 1) containing local issues; 2) Conformity of basic competency and knowledge prerequisites; 3) Suitability of EDP indicators; 4) the use of learning models; 5) Contains EDP stages;

The results of the analysis show that each teacher has been able to write down the required components. The problems raised in lesson planning already contain local issues. The basic competencies and prerequisite materials presented are in accordance with the issues raised. Every teacher has been able to write indicators that are in accordance with basic competencies and EDP. STEM learning is carried out not only to gain knowledge, but through STEM learning students are required to be able to apply the concepts that have been obtained to solve problems around them. STEM learning by raising local issues requires students to make a product that can solve these problems. The learning model used by the teacher is project based learning that is in accordance with the needs of students to make products as a solution to the problems raised.

Table 1. Teachers's ability to develop lesson plans

Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5
Local Issue Shellfish and shrimp, sold raw at tourist sites near schools → cannot be souvenirs → limited sales, standard price. **KD and Prerequisites** KD is relatively adequate, there are other basic competencies that are more supportive. Prerequisite knowledge according to the problem. **EDP Indicator** Indicators according to KD and EDP indicators. **Learning Model** Appropriate: Project based learning (PjBL) **EDP Stages** Define the problem, research, imagine, plan, create, test and evaluate, redesign, and communication.	**Local Issues** Vertical garden which is always broken after the long holiday at the end of the learning year. **KD and Prerequisites** KD - prerequisite knowledge: according to the problem. **EDP indicator** Indicators according to KD and EDP indicators. **Learning model** Appropriate: PjBL based learning **EDP Stages** define the problem, research, imagine, plan, create, test and evaluate, redesign, and communication	**Local Issues** The problem of organic waste in schools. **KD and Prerequisites** KD and pre-requisite knowledge according to the problem. **EDP indicator** Indicators according to KD and EDP indicators. **Learning model** Appropriate: Project based learning **EDP stages** ask, imagine, plan, create, and improve	**Local Issues** Limitations of conventional blind stick assistive devices **KD and Prerequisites** KD and prerequisite knowledge according to the problem. **EDP indicator** Indicator according to KD and EDP indicator. **Learning model** Appropriate: 5 E **EDP stages** Define the problem, research, imagine, plan, create, test and evaluate, redesign, and communication.	**Local Issues** Limited school land for agriculture. **KD and Prerequisites** KD and prerequisite knowledge according to the problem. **EDP indicator** Indicator according to KD and EDP indicator. **Learning model** Appropriate: Project based learning **EDP stages** Ask, imagine, plan, create, and improve.

In order to solve problems, STEM learning follows the EDP stages. The results of the analysis show that all teachers prepare lesson plans using EDP, although it appears that the EDP used has different stages. Based on this, it is known that teachers who teach at the SMP and SMA levels use the more detailed EDP stages, while those for the SD level use the simpler EDP stages.

The good ability of teachers in preparing STEM learning plans is the result of mentoring carried out by the SEAQIS team during the implementation of the training. During the training, discussions were held about STEM learning and how to plan learning and draft learning plans. Furthermore, the teacher receives assistance before the teacher begins the implementation of learning and during learning. That way, the success of teachers in preparing STEM learning plans can be assumed as a contribution to training and mentoring. This is supported by Nazuhi (2016) that the implementation of effective mentoring can increase teacher competence in preparing good and correct RPP. This is supported by Sriyati, et al (2018) which states that through workshop activities, designing and presenting STEM-based learning designs is able to develop teachers' abilities in designing STEM-based learning.

2. Teacher's ability in implementing STEM LC learning

Sanders (2009) suggests that integrative STEM education should include technology or engineering design as a basis for making connections to concepts and practices from mathematics or science or both. Bryan et al. (2016) stated that one of the core features of an integrated STEM learning experience includes learning where the integrator is engineering practices and engineering design technology as context and / or a deliberate component of the material to be studied. They added that engineering design or engineering practices related to relevant technology requires the use of scientific and mathematical concepts through design justification.

EDP is an important part of STEM learning. English & King, (2015) shows how STEM learning at the basic level through EDP provides opportunities for students to design and redesign their work to be better by applying science and math concepts. STEM learning through problem-based learning also gives students ideas to integrate math and science concepts in learning. Furthermore, teacher scaffolding in introducing new concepts is also a very important factor.

Table 2. Teachers's implementation of STEM learning Local Context

Teacher 1 (Titis)	Teacher 2 (Novi)	Teacher 3 (Dessy)	Teacher 4 (Lia)	Teacher 5 (Gama)
Define the problem 1) Presentation of the stimulus: video of sea catches sold at tourist sites, data on the number of sales and income of traders 2) Question and answer and discussion with material from the video: identification of data / facts, problems, sources of problems 3) The teacher helps: students ask questions / the teacher asks guidance questions	***Define the problem*** 1) Presentation of the stimulus: a video about a well-maintained and poorly maintained vertical garden 2) Question and answer and discussion with material from the video: identification of data / facts, problems, sources of problems 3) The teacher helps: students ask questions / the teacher asks guidance questions	***Ask*** 1) Presentation of the stimulus: videos of waste in schools and their management 2) Question and answer and discussion with material from the video: identification of data / facts, problems, sources of problems 3) The teacher helps: students ask questions / the teacher asks guidance questions	**Define the Problem** 1) Presentation of stimulus: video a) Challening Obstacle: The Life of Blind People; b) robot wall-E 2) Question and answer and discussion with material from the video: identification of data / facts, problems, sources of problems 3) The teacher helps: students ask questions / the teacher asks guidance questions	***Define the problem*** 1) Presentation of the stimulus: video about aquatic ecosystems 2) Question and answer and discussion with material from the video: identification of data / facts, problems, sources of problems 3) The teacher helps: students ask questions / the teacher asks guidance questions
Research Finding information: basic principles of processing seafood products via literature studies, videos, internet, etc. Students identify several alternative solutions in accordance with the working principles of processing seafood products. The teacher guides via directive questions.	***Research*** Finding information: the principles and methods of making a miniature Smart Watering System via the internet The teacher guides via directive questions.		***Research*** Search for information via the internet and create simple Arduino-based projects 1st meeting: LED blink project, flip flop and traffic light 2nd meeting: turn on buzzer, proximity sensor project and measure the maximum distance using the proximity sensor.	***Research*** Looking for information: how to make a simple aquaponic via the internet The teacher guides via directive questions.
Imagine Group discussion: determining the product to be made and the reasons for choosing Questions and answers: reasons for choosing marine processed products to be made.	***Imagine*** Group discussion: determining the product to be made and the reasons for choosing Questions and answers: reasons for choosing the product	***Imagine*** Group discussion: discuss in groups to analyze the nutritional content needed by plants by utilizing organic waste. Learners collect information from various sources. The teacher guides via directive questions.	**Imagine** Group discussion: determining the product to be made and the reasons for choosing Questions and answers: reasons for choosing the product Based on the identification of problems and information that has been obtained, students in groups are asked to discuss possible solutions to solve existing problems. Each student puts forward his idea, then the best idea is chosen in making a smart blind stick.	**Imagine** Group discussion: determining the product to be made and the reasons for choosing Questions and answers: the reasons for the conceptual and technical aspects of the aquaponics selection to be made

Plan Group discussion determines product design: product quality indicators, materials to be used, manufacturing procedures, time allocation Questions and answers: the reasons in terms and technical aspects of the selected design Group work: making designs in the form of recipes for marine processed products. Each group makes a different type of product / recipe. The teacher provides guidance at each stage of the activity via directive questions.	***Plan*** Group discussion determines product design: product indicators, materials to be used, manufacturing procedures Questions and answers: the reasons in terms and technical aspects of the selected design Group work: make a design in the form of a sketch. Each group made a different sketch The teacher provides guidance at each stage of the activity.	***Plan*** Group discussion determines product design: indicators of product quality, materials to be used, manufacturing procedures Questions and answers: reasons for determining the design Group work: design a mole recipe for hydropinics. Each group makes a different recipe. The teacher provides guidance at each stage of the activity via directive questions.	**Plan** Group discussion determines product design: indicators of product quality, materials to be used, manufacturing procedures, Question and answer: the reasons in the conceptual and technical aspects of the selected design Group work: create designs in the form of sketches and Arduino source code. Each group made a different sketch The teacher provides guidance at each stage of the activity	**Plan** Group discussion determines design: product quality indicators, materials to be used, manufacturing procedures, time allocation Question and answer: the reasons in the conceptual and technical aspects of the selected design Group work: make a design in the form of a sketch. Each group made a different sketch. The teacher provides guidance at each stage of the activity
Create Students make processed marine products at home according to the design of each group with the guidance of the teacher	***Create*** Students make a Smart Watering System according to the design of each group with teacher guidance	***Create*** Students make hydroponic moles according to the design of each group with teacher guidance	**Create** Students make smart blind sticks according to the design of each group with teacher guidance	**Create** Students make simple aquaponic according to the design of each foreign group with the guidance of the teacher
Test and Evaluate Product trials through organoleptic testing by other groups Guidance questions from the teacher: identify things that need to be improved based on the results of the trial Another group made suggestions	***Test and Evaluate*** Product trials Guidance questions from the teacher: identify things that need to be improved based on the results of the trial	***Improve*** Product trials via hydroponic use of moles in plants. Observation of plant growth and identification of advantages and disadvantages of moles Redesigned the mole recipe based on test results	**Test and Evaluate** Product trials The tool indicator functions in the form of a varied sound ("beep" "beep-beep" to ringtone music) even though, the teacher asks only for a "beep" sound. Guidance questions from the teacher: identify things that need to be improved based on the results of the trial	**Test and Evaluate** Simple aquaponic product trial in a school pond. Guidance questions from the teacher: identify things that need to be improved based on the results of the trial Another group asked questions and made suggestions
Redesign Discussions in groups to redesign according to input from peers	***Redesign*** The redesign was not done		***Redesign*** The redesign was not done	***Redesign*** The redesign was not done
Communication The design presentation included the advantages and disadvantages of the product as well as a trial demonstration of processed seafood products Another group asked questions and made suggestions	***Communication*** The design presentation included the advantages and disadvantages of the product as well as a demonstration of the Smart Watering System product trial Another group asked questions and made suggestions		**Communication** The design presentation includes the advantages and disadvantages of the product as well as a demonstration of the Smart Blind Stick product trial Another group asked questions and made suggestions	**Communication** The design presentation includes the advantages and disadvantages of the product as well as a simple aquaponic product trial demonstration Another group asked questions and made suggestions

The results of the analysis show that most of the engineering design stages can be carried out by the teacher. However, in general, from all the case studies observed, each teacher experienced difficulties in carrying out the redesign stage. In case study 1 (Teacher 1), the EDP stage that was not implemented in the classroom during learning was create and redesign stages. This occurs due to the limited time available to make marine processed products in schools and the difficulty in bringing tools and materials to school. The solution taken is to carry out the create stages at home and outside class hours. As proof that each student did a create activity, they made videos and photos during the activity and then sent them to the teacher. Furthermore, the redesign stage was not carried out because it took time to repair and make more processed seafood. At this stage, students only record input from the results of tests conducted by teachers and peers.

In case study 2 (Teacher 2), the research stage was not optimal. At this stage students are asked to find relevant sources related to the project to be implemented through the internet media. However, at the time of implementation there were network constraints so that the search for relevant sources was hampered. The solution is to provide a hotspot to facilitate the search process from the internet.

Furthermore, in case study 3, the EDP stage that is not fully implemented is create and improve stage. At the create stage, in addition to the participants being asked to make a product according to the design, students are also asked to test their work. This stage is not carried out well because it takes a long time to carry out the testing process until the results are visible. The results of the liquid fertilizer that have been made by students are tested for reliability by looking at the growth of the fertilized plants and this process takes 1-2 weeks so that it cannot be implemented in a series of lessons. The solution given is to do the create stage outside of learning.

In case study 4, the EDP stage that was not implemented was the redesign stage. Students do not get the opportunity to improve their work. This happens because of limited learning time in the classroom. So that students only record input from the results of the trial.

Furthermore, in case study 5, the EDP stage that was not implemented was also at the redesign stage. The re-creation of a student project in the form of a floating aquaponic took a long time. So that students only redesign the aquaponic according to input from teachers and peers.

From the data in the table above, it appears that all the teachers are relatively successful in implementing the lesson according to the lesson plans and following the EDP flow well. Possible explanations for this are as follows. When discussing the characteristics of EDP and STEM learning materials, discussions are carried out in detail regarding the targets, roles of teachers and students at each stage of EDP including discussions about things that need to be considered or anticipated. This helps teachers have an overview of the details of STEM learning. This picture was clarified through peer teaching, reflection, and in-depth discussion which was carried out at the end of the training. This experience coupled with his knowledge, skills, and experience as a teacher who is actively involved in discussing and sharing in the working group, provides provisions for them to carry out learning in class. Relatively intensive discussions during mentoring, reflection, and feedback after the first learning strengthen their understanding and require provision.

In the table it also appears that generally teachers face limited time constraints, especially in learning where all work is done at school so that there is an EDP stage which is likely to be implemented less optimally. Relatively adequate time is needed in activities when students search for literature to identify relevant ideas, study the literature obtained, develop designs, making products, and present designs and trials. Another obstacle in making products is the availability of equipment that is inconvenient when done at school.

For teachers who assign the task of making products at home, the constraints on materials and time for making products can be resolved properly. For the implementation of activities at other EDP stages, especially teachers who decide to carry out all activities in the classroom still face obstacles related to the limited time allocation so that the implementation of the EDP activity stages has a chance to be less than optimal, even if the product is successfully completed. Optimization of activities at each stage of EDP is needed, because when students search for literature to identify relevant ideas, study the literature obtained, develop designs, make products, and present designs and trials, teachers have an excellent opportunity to facilitate skills development. Critical thinking, creativity, working together, and communicating. At the same time students also have the opportunity to strengthen the basic concepts and other supporting concepts used to develop products.

If time is sufficient, the teacher has the opportunity to use it through the use of asking techniques and asking a series of questions both orally and through worksheets so that students can uncover the logical, scientific, and technical reasons behind all group decisions in developing products. The teacher can also organize classroom strategies and management to optimize the development of these skills in advance.

3. Supporting Factors and Challenges in STEM LC Implementation

According to Stohlmann, Moore, Roehrig (2012) the factors that need to be considered in STEM learning consist of 4 factors with the acronym s. t. e. m. These factors are 1) S or support, namely support from various parties such as the principal, teacher colleagues, or universities as well as support in the form of increased competence; 2) T or teaching, which is all aspects related to STEM learning including the ability to plan such as compiling lesson plans and implementing learning including assessment; 3) E or efficacy, which is the teacher's self-confidence in carrying out tasks including having knowledge and skills that contribute to the formation of self-efficacy, commitment, skills in planning and organizing activities; 4) M or material, namely the availability of adequate infrastructure for the implementation of learning

Based on Table 3, all teachers receive support from the principal, peer teachers, and education personnel. A possible explanation is that from the start the principal has supported the teacher by allowing the teacher to attend the STEM LC training and understand the program the teacher is participating in so that this support has an impact on the support of other school members such as teacher peers and education personnel. Meanwhile, the provision of teachers to implement STEM learning was obtained by teachers when they attended training and post-training services in the form of mentoring during the preparation for implementing STEM learning which was carried out relatively intensively both through social media and face-to-face before the first and second observations.

Table 3. Supporting Factors and Challenges in STEM LC Implementation

Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teacher 5
Support and Constraints General support: Principals and teachers and education personnel (GTK) in schools ◊ adjusting the learning schedule and technical assistance during learning. SEAQIS: competency improvement via STEM LC training from SEAQIS. Teaching Support: Increased competence in planning and implementing STEM	***Support and Constraints*** General support: Principals and teachers and education personnel (GTK) in schools ◊ adjusting the learning schedule and technical assistance during learning. SEAQIS: competency improvement via STEM LC training from SEAQIS Teaching Support: Increased competence in planning and implementing STEM	***Support and Constraints*** General support: Principals and teachers and education personnel (GTK) in schools ◊ adjusting the learning schedule and technical assistance during learning. SEAQIS: competency improvement via STEM LC training from SEAQIS. Teaching Support: Increased competence in planning and implementing STEM	***Support and Constraints*** General support: Principals and teachers and education personnel (GTK) in schools ◊ adjusting the learning schedule and technical assistance during learning. SEAQIS: competency improvement via STEM LC training from SEAQIS. Teaching Support: Increased competence in planning and implementing STEM learning via STEM LC Training.	***Support and Constraints*** General support: Principals and teachers and education personnel (GTK) in schools ◊ adjusting the learning schedule and technical assistance during learning. SEAQIS: competency improvement via STEM LC training from SEAQIS. Teaching Support: Increased competence in planning and implementing STEM learning via STEM LC Training.

learning via STEM LC Training. Material support: school infrastructure is adequate to complete the product. Obstacles: internet access is not strong and stable bring equipment for making processed seafood products to school.	learning via STEM LC Training. Material support: school infrastructure is adequate to complete the product. Obstacles: internet access is not strong and stable	learning via STEM LC Training. Material support: school infrastructure is adequate to complete the product. Obstacles: relatively face no significant obstacles	Material support: school infrastructure is adequate to complete the product. Obstacles: relatively face no significant obstacles	Material support: school infrastructure is adequate to complete the product. Obstacles: internet access is not strong and stable bring equipment for making processed seafood products to school Obstacles: relatively face no significant obstacles

In the Teaching aspect, provisions in planning and implementing STEM learning are obtained through STEM LC Training. Based on the explanation in the implementation of STEM learning in advance, the competencies obtained through training can relatively help teachers to implement STEM. In the material aspect, the infrastructure in schools is adequate in completing the product.

The obstacles faced are the lack of strong and stable internet access and the difficulty of bringing the equipment to make processed seafood products to schools. Another obstacle faced by teachers is the limited learning time. Relatively sufficient time is needed for activities when students search for literature to identify relevant ideas, study the literature obtained, develop designs, making products, and present designs and trials. Another obstacle in making products is the availability of equipment that is inconvenient when done at school. For teachers who assign to make products at home these two obstacles can be resolved well, but for teachers who decide to do all activities in class, they still face obstacles related to the limited time allocation so that the implementation of the stages of EDP activities is not optimal, even though the product is successfully completed.

Why is that, because when students search for literature to identify relevant ideas, study the literature obtained, develop designs, make products, and present designs and trials, teachers have an excellent opportunity to facilitate the development of critical thinking skills, creativity, cooperate, and communicate. At the same time, teachers also have the opportunity to strengthen the basic concepts and other supporting concepts used to develop products. If time is sufficient, the teacher can optimally implement these opportunities in each of these activities in advance through a series of questions for students to reveal the logical, scientific, and technical reasons behind all group decisions in developing products.

Relatively all teachers do not find problems in terms of tools and materials because they are easily obtained at affordable costs. Unfortunately, data regarding how high the self-efficacy of teachers is in implementing STEM learning after participating in debriefing through training and post-training services are not available. This is a note for SEAQIS in preparing teachers in the future so that the provisions needed by teachers are more complete.

4. Impact of STEM LC Learning on Students

As shown in Table 4, students generally gave a positive response to STEM learning by following it enthusiastically. Teacher 4 even measures the impact of learning on student activity. This response shows that students have an interest in participating in STEM learning according to the definition proposed by Walgito (2004) interest is a condition in which a person pays attention to an object accompanied by a feeling of pleasure because it is considered to have benefits. Shahali et al., (2016) stated that STEM learning can increase students' interest in the STEM field and careers in the STEM field. The interest of these students will ultimately improve students' STEM literacy.

As stated by Bybee (2013) knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM-related issues.

Table 4. The Impact of STEM Learning on Students

Teacher 1	**Teacher 2**	**Teacher 3**	**Teacher 4**	**Teacher 5**
Learners: ♣ excited about learning. ♣ Able to carry out the EDP stage (problem identification up to testing and redesign of the product) as a solution to the problem. ♣ increased learning outcomes with N-gain 0.417 (moderate category) ♣ increased interest in entrepreneurship	Learners: ♣ enthusiastic and actively involved in learning ♣ Get satisfying learning outcomes. ♣ Able to carry out the EDP stage (problem identification up to testing and redesign of the product) as a solution to the problem.	Learners: ♣ enthusiastic and actively involved in learning ♣ Get satisfying learning outcomes. ♣ Able to carry out the EDP stage (problem identification up to testing and redesign of the product) as a solution to the problem.	Learners: ♣ Excited about learning. ♣ increased learning outcomes with N-gain 0.6 (medium category) ♣ actively participate in teaching (good category) ♣ Able to carry out the EDP stage (problem identification up to testing and redesign of the product) as a solution to the problem.	Learners: ♣ Excited about learning. ♣ increases in thinking skills, creativity, communication, and collaboration (relatively obvious) ♣ Able to carry out the EDP stage (problem identification up to testing and redesign of the product) as a solution to the problem.

Teachers 1, 2, and 4 measure that STEM learning improves learning outcomes even though the N-gain results of teachers 1 and 4 are in the moderate category. The impact on learning outcomes is supported by the results of research by Suwarma and Endah (2015) which state that STEM learning can increase motivation and creation in learning science and increase students' understanding of concepts. Other research shows that students who carry out project-based STEM learning show higher scores on the concepts being taught (geometry, probability, and problem solving) than those who carry out project-based learning alone (Han et al., 2016)

In general, teachers stated that STEM learning facilitates the development of problem-solving skills. In STEM learning the form of assignments is relatively open so that students must be more independent in completing them. Teachers must function themselves as facilitators so that the inquiry process can be carried out by students properly. The success of students in completing assignments shows that STEM learning can facilitate the development of problem-solving skills. Teacher number 5 also found that critical thinking, creative thinking, collaboration, and communication skills improved. This shows that the EDP stage which provides opportunities to develop these four skills in advance has been successfully utilized by the teacher.

Another impact that was measured by teacher number 1 who raised problems related to the economy was the increased entrepreneurial interest of students which became an added value. This shows that there are opportunities for teachers to use STEM learning to provide added value to students according to the issues raised and the local context used.

Conclusion

Based on the result of this study, we can conclude that: 1) the teacher was able to develop lesson plan which indicated by the ability to identify local issues for STEM learning and to implement EDP as one of the characteristics of STEM learning that can integrate concepts to solve local issues has been illustrated in the lesson plans; 2) teachers are relatively able to implement STEM learning according to the lesson plans and facilitates students so that they are able to carry out EDP relatively independently; 3) teachers receive good support from school principals and peers in the form of permission to adjust learning schedules and technical support during the implementation of STEM learning; 4) get a positive response from students, improve students’ achievement and their ability to solve problems; 5) training subjects which cover topics needed for STEM learning and their delivery which very similar to real STEM learning contribute to teachers ability in planning and implementing STEM learning; 6) post training service in forms of intensive mentoring before teachers implement STEM learning, STEM learning observation which conducted two times and discussion right after each observation to give feed back for better STEM learning contribute to teachers be able to deliver STEM learning more effectively and confidently.

Several things need to be considered are: 1) to improve the time constraints faced by the teachers, it is necessary to consider alternatives to implementing STEM learning as a school project or part of the Youth Scientific Group program which can provide more time and a more flexible schedule. If it will be integrated into the intracurricular system, it is necessary to comprehensively organize the time allocation including the layout of the learning schedule on the daily lesson schedule. If additional time needed but do not allow it to be used as homework, teachers need to consider carrying out assignments at school outside of class hours. For elementary school level, it is necessary to consider using a special time allocation for integrated learning or projects that are usually available at the end of each sub-theme; 2) to resolve time constraints and access to information, especially at the basic level, it is necessary to consider teachers providing an excessive amount of information assistance so that students still have the opportunity to have skills in selecting and sorting the information needed. Even though it is assisted by the teacher, it can still facilitate students in developing critical thinking skills, creative thinking, working together, and communicating; 3) based on the importance of self-efficacy as one of the considerations for STEM learning, it is necessary to consider measuring teachers self-efficacy when attending training sessions to provide the necessary support to strengthen content knowledge and pedagogical knowledge; 4) to improve the quality of measurement of improvement in problem-solving skills, there is a need to improve the process by using instrument so that the quality of the improvement can be measured; 5) to be able to implement STEM learning effectively, teachers need sufficient provision in term of knowledge, skills, and assessment in STEM learning; 6) teachers provision needed may be delivered through competency based training with intensive post training services to support teachers comprehension knowledge also develop skills and self esteem in implementing STEM learning effectively.

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