

## Research article

# Improving STEAM Knowledge and Skills for Pelopor Literasi Desaku

Ganung Anggraeni\*, Laela Sagita, Endang Susetyawati

Faculty of Mathematics Education, Faculty of Teacher Training and Education, Universitas PGRI Yogyakarta

## Abstract.

The term STEAM, which is an acronym for science, technology, engineering, arts, and mathematics, is an approach to learning to guide students in conducting research, discussion, collaboration and critical thinking. It is hoped that the end result is students who dare to take risks in their research, but still with careful consideration. Students can be directly involved in shaping the learning experience, and encouraged to be persistent in finding solutions to problems and active in collaborating and working through creative processes. Pelopor Literasi Desaku (PLD) are volunteers who provide assistance for school-age children at the State Children's Learning House, Bengkung Village, Retno Temple, Secang Magelang. 10 STEAM activities were prepared for implementation by PLDs. This study used a qualitative descriptive design. There were 10 PLD participants, recruited through purposive sampling. The results of the study can be divided into four parts. General: (1) all participants stated that they had understood the concept of STEAM; (2) all participants were interested in STEAM activities; and (3) 90% of participants stated that they felt motivated by STEAM activities. Implementation of 10 STEAM activities: (1) 60% of the participants stated that the most interesting STEAM activity was the tie technique dye; (2) the most difficult activity was also the tie technique dye; (3) 90% of the participants stated that the tie technique dye activity was the most difficult; and (4) 40% of the participants stated that the CBS power rocket activity was related to learning at school. Relation to the disciplines of science: (1) 80% of participants thought that the simple thermometer activity was related to science; (2) 100% of participants stated that string art was related to mathematics; and (3) 50% of participants stated that string art was related to art. Others: 1) all participants stated that it was difficult to obtain tools and materials for string art; and 2) 60% of participants thought that string art requires high levels of creativity.

**Keywords:** STEAM, community services

## 1. Introduction

Revolution Industry 4.0 are predicted some professions to be lost and replaced by technology. The types of repetitive job are quite vulnerable to being replaced in nature. Marín-Marín described a large of job requirements professions linked to the use of technological media and tools [1], such a system engineers, information technology specialist, programmers, project leader, and biotechnologists [2].

Corresponding Author: Ganung Anggraeni; email: EMAIL

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Education has a role to play in preparing students or school-age children in the 21st Century for the mastery of science and mathematics. It is expected to be the key to success for the development of a country, especially in the framework of competition for 21st-century career in global level. School graduates are required not just good knowledge of school subjects, but also knowledge interdisciplinary, the formation of which is a long process, starting as early as school, and only traditional methods are indispensable. One of these innovative technologies is STEM or STEAM. STEM is considered to be able to develop interdisciplinary competencies, such as Science Technology Education Technology and the latest developments in adding Art. Why? English [3] stated that the implementation of STEAM in the learning process is considered an urgent goal of ensuring the availability of future STEM workforce. Why is STEM or STEAM? STEM or STEAM developed student's critical thinking, creative thinking, and problem solving [4]. Thomas & Watters [5] emphasize the high level of interest and motivation of students in Asia when integrating STEAM in their classes.

STEAM which is an acronym for Science, Technology, Engineering, Arts, and Mathematics is an approach to learning as an entry point to guide students in conducting research, discussion, and collaboration as well as critical thinking. The result is the courage to take risks in research, but still with careful consideration. Students or school-age children will be directly involved in shaping the learning experience, persistent in finding solutions to problems, active in collaborating and working through the creative process. sorted by the history of the entry and joining of "arts", then the correct acronym is STEAM. The choice of the acronym STEAM is able to bring new energy in the modern learning process compared to its predecessor STEM.

Traces the history of STEM and STEAM development born in the United States as an educational approach. STEM and STEAM development efforts are also seen as Out-Of-School [6]. Out-of-School STEM and STEAM activities are structured outside of school to support formal learning. The activities are very flexible and open to many options and can be done indoors or outdoors. This program can be designed with the presence of a companion or resource person for a certain period, then can be continued by the community itself flexibly. The community and children (students) are free to choose activities according to their availability and needs. During training or mentoring by resource persons, knowledge or activities can be focused on specific content through steam's general application in daily life.

A similar idea was recommended by Septiani through his research on the utilization of the Center for Community Learning Activities or Pusat Kegiatan Belajar Masyarakat (PKBM) to facilitate learning needs in the community [7]. Based on the conception, it

will be interesting, develop and invite the community. In this case, school-age children and volunteers in community learning centers to be able to understand STEAM through various creative activities. One of PKBM has a program of children's learning assistance activities located 55 km UPY namely Rumah Singgah Anak Negeri (RSAN) in Dusun Bengkung Candiretno Village District Secang Magelang District.

RSAN, which was established in 2018, has a vision of "Organizing superior education and community service based on empowerment to create an intelligent, fair and prosperous society" and has the full support of the entire community of Dusun Bengkung. Program activities carried out as a manifestation of achieving the vision, including the State Children's Learning House, Pioneer of Literacy Dusunku, Free Internet for the Community. Adequate facilities and infrastructure are available to support activities at RSAN, such as computers, printers, laptops, reading books, and stationery. In terms of human resources, the RSAN in Bengkung Hamlet has 12 volunteers with varied educational backgrounds. These volunteers work together to run programs at RSAN with details of 2 volunteers being responsible for implementing the State Children's Learning Home program, while 10 volunteers are responsible for the Dusunku Literacy Pioneer program and Free Internet for the Community.

Based on the results of an interview with one of the administrators at RSAN, some of the obstacles encountered were the limitations of activities in the program of activities. Currently, learning mentoring activities are fronted by 2 volunteers are only limited to mentoring in mathematics subjects through discussion of questions. This is recognized by the organizers as one of the limitations it has, namely the lack of variety in activities that are carried out regularly and scheduled, besides that it does not yet have a special activity for school-age children, programs and activities are needed that can develop the ability to think critically, creatively, collaborative and communicative in solving a problem of everyday life.

This limitation is an obstacle to making RSAN as one of the companion vehicles for students during online learning. On the other hand, there are several demands that students must have in the 21st century, such as critical thinking skills, creativity, innovation, communication, and problem-solving skills. Beetham & Sharpe stated that there is a need for context-based learning that involves collaboration in several subjects, including mathematics. This is also in line with Ernest who explains that the purpose of learning mathematics is to learn basic skills to solve mathematical problems in everyday life and to provide reinforcement for students to be able to think critically and be able to contribute to society.

RSAN has great potential to develop other activities. The potential is like the facilities and infrastructure in TBM activities which have some books. Constraints found in the development of TBM are the limited number of copies and the variety of types of books. This causes students in Bengkung Hamlet to only take turns reading books on the spot. In addition to the potential for facilities and infrastructure, the availability of volunteers as a driving force and great support from the hamlet community to be involved in activities make RSAN still very possible to develop. Training and mentoring for volunteers is needed to overcome the obstacles that occur in RSAN as Septiani [7] recommends 8 things that can be done to develop a PKBM, one of which is providing potential resources and monitoring and evaluating programs.

## 2. Method

This research was conducted from March until July 2021 at Bengkung Subdistrict, Candiretno, Secang, Magelang, Central Java. A study in community services used a qualitative descriptive approach to see the implementation of STEAM concept to activities by PLD RSAN. Qualitative data was collected through in-depth interview and observations.



Figure 1: STEAM's Phase in Community Service.

This community service study carried out three stages shown in Figure 1 which divided into two activities, namely training and mentoring in conducting STEAM activities.

## 3. Result and Discussion

### 3.1. Preliminary Study

Observations began to be carried out on March 23th 2021, through interviews with the Person in Charge of the RSAN Foundation and the Head of the RSAN Program. Interviews conducted using WhatsApp media resulted in the following information: (1)

Volunteers / PLD at RSAN opened 8 people, (2) Students studying at RSAN were 40 students consisting of elementary, junior high, and high school levels, (3) PLD RSAN had not have received assistance or training on STEAM, (4) obstacles faced by RSAN.

Findings from observations used by the service team to determine the STEAM activities, develop a manual book for implementing STEAM activities used by PLD, and develop a test for STEAM initial knowledge. Based on these considerations, the service team compiled 10 STEAM activities, such as balloon-powered cars, *katapel* ice cream stick, string-art, straw-bridge, flower plastic bags, rocket-powered CBS, simple thermometer, tie-dye, water filter, and paper speaker. All STEAM activities outlined in the manual book are divided into five sections, namely purpose, descriptions activities, materials and tools, manufacturing methods, and STEAM analysis.

### 3.2. Implementation

Activities carried out at the implementation stage are: 1) develop a WhatsApp group for media communication, 2) initial perception and explanations, 3) preparation of tools and materials for STEAM activities, 4) training for volunteers, 5) volunteer assistance to children in RSAN, regarding STEAM activities, 6) evaluation and supervision of the Service Team on STEAM activities, 7) management/ recording of supervised data.

Based on the results of the planning activities, the targets of the training activities are eight PLD RSAN who are tasked with assisting study groups in RSAN. This training is an effort to provide potential resources. To find out the knowledge possessed by PLD about STEAM and its activities, the service team conducted an initial ability test consisting of five open questions conducted through WhatsApp.

Based on the findings of observations where PLD does not yet know or have the ability about STEAM and its activities. This can be seen from the answers to the initial ability test questions, where all PLD answered that they did not know about STEAM. The average value of the test results on the initial ability of PLD about STEAM is 79.5.

Community services training was conducted online through WhatsApp media on April 15, 16, and 19 2021. The initial explanation contained an introduction to STEAM activities and an outline of the stages of STEAM activities. The materials provided during the training are videos about STEAM activities, product pictures from STEAM activities, and manual book that have been prepared at the preliminary stage. The obstacle found during the implementation was an unstable internet network so that PLD could not download material in the form of videos. On the other hand, the training conducted for 1 hour has increased PLD's knowledge of STEAM

The next activity at the implementation stage is mentoring the implementation of STEAM in the form of direct practice on activities 1 to 10 that have been designed by the service team. Based on the learning contract, it was agreed by all participants that the first mentoring was carried out offline on Monday, April 26, 2021, at 14.00-16.00 at Bengkung Subdistrict, Secang, Magelang. The first mentoring activity was attended by 8 PLD with the initial material presented was an explanation of STEAM Activities (Science, Technology, Engineering, Arts and Mathematics) from the STEAM Activity Guidebook that had been prepared by the service team. During the mentoring, participants practice 10 STEAM activities using materials that have been prepared by the community service team.



**Figure 2:** STEAM's products phase 1.

Figure 2 shows the STEAM's product from mentoring process with collaboration and participation from PLD by experimenting with 10 STEAM activities. The success rate of the experiments carried out in the first mentoring was 80% where only 8 activities were successful, the obstacles found were: (1) rocket-powered CBS activity has not been successful where the ratio of ingredients (vinegar and baking soda) cannot push the

bottle cap, (2) the simple thermometer activity cannot be carried out due to material constraints.

After PLD RSAN was provided with knowledge about STEAM and practiced STEAM activities, the next activity was PLD sharing knowledge to students at RSAN about STEAM activities. This activity can be seen in Figure ?? which was carried out on May 2, 2021, which was attended by 8 PLD and 23 RSAN students. Based on observations sourced from videos on the implementation of phase 2 mentoring, PLD and students were able to complete 10 STEAM activities well. The obstacles found in the mentoring phase 1 can be corrected in the mentoring phase 2, where the PLD can run CBS rockets and make a simple thermometer.

String art is the art of forming images or writing using thread as the main material. String Art began to bloom in the 1960s, a form of string art that exists as decorative art. PLD makes string art with patterns that have been provided by the service team. With the Engineering Design Process, children can explore the concept of String Art as the art of weaving threads to make wall hangings in various forms. Meanwhile, for the Straw Bridge activity, students designed the strongest bridge made of plastic straws. One of the parts that make the bridge design sturdy apart from the materials used is the shape of the truss design or commonly known as the truss. The engineers make various designs of bridges and their supports that are able to stand firmly. In making this bridge design, the STEM concept plays an important role.

### 3.3. Evaluation

The activity evaluation stage is the last stage in this PkM activity, at this stage the service team evaluates the achievement of outputs in the form of services and products as presented in Table 8. Evaluation of PkM implementation is carried out on May 4, 2021. This reflection aims to: (1) measuring the level of understanding, motivation, and interest of PLD and RSAN students about STEAM activities, and (2) mapping 10 STEAM activities based on 8 criteria related to learning in schools and products that have selling points. Table 8 shows the results of reflection based on data from the questionnaire responses to 8 PLD and 2 RSAN students.

The results of the responses of these community service participants on average stated that they were happy and motivated after getting knowledge about STEAM. Some participants also wanted to develop their works and stated that there were several products that had selling points. The initial ability test at the preparation stage showed that all PLD did not understand STEAM. An increase in the number of PLDs

who understand STEAM and their activities by 100%. The data shows in Figure 3 that 90% of PLD and RSAN students choose the STEAM activity tie-dye to have a selling value, while the other activity is flowers plastic bags.

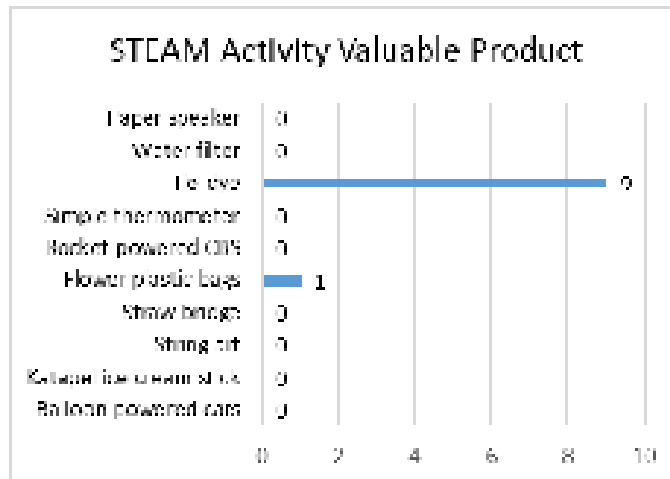


Figure 3: STEAM Activity Valuable Product.

Figure 4 describe more than 50% of PLD and RSAN students chose the Rocket-powered CBS activity, and the reasons are (1) looking for a ratio of vinegar and baking soda so that the results were optimal, (2) in accordance with learning chemistry, physics, science, mathematics, crafts, and science.

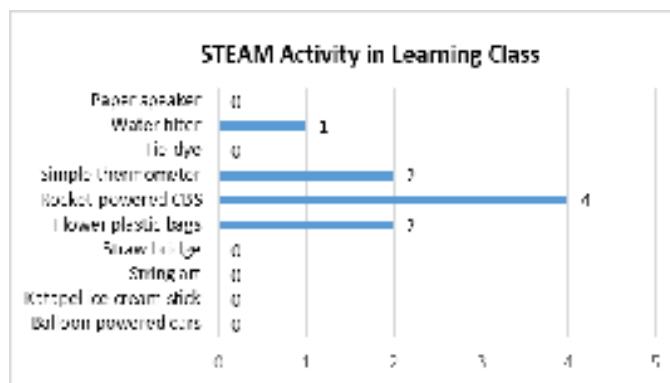


Figure 4: STEAM Activity in Learning Class.

As many as 80% of PLD and RSAN students chose the simple thermometer activity as a STEAM activity related to science, various reasons were stated, namely: (1) related to physics, (2) being able to measure temperature, (3) discussing motion and simple tools related to technology, (4) using speed and time power, and (5) because it requires steam and hot water. The reasons put forward by PLD and 50% of RSAN students chose String Art as a STEAM activity, namely: (1) having artistic and aesthetic values, (2) requiring skills in mixing and matching colors, (3) creating embossed images that have different shapes. All PLD and RSAN students choose string art as activities related to



mathematics. The reasons for the selection are: (1) there must be an appropriate pattern of translation and reflection, (2) related to the Pythagoreans, (3) calculating the right amount so that the shape is balanced.

String Art raw materials are difficult to obtain, this is because the materials used for String Art boards are difficult to obtain in the Secang area, Magelang.

TABLE 1: Observation result of STEAM activities in community services RSAN.

STEAM Activity	Observation
Science	Participants understand: the utilization of early knowledge about STEAM, as well as materials prepared, especially waste materials, such as cardboard / cardboard used, used mineral bottles, used cresek bags can be made into useful products, for example: for balloon-powered cars, flowers from plastic bags, paper speakers, and others.
Technology	participants understand: the use of simple equipment, and waste materials to be able to support innovative creations that are useful in daily life
Engineering	participants understand: designing product design using equipment and simple materials that exist.
Arts	participants can synergize or combine aspects of art in designing and making products. Thus, it is expected that there is a balance between the academic and artistic side for a product.
Mathematics	participants understand some form of flat build geometry, measurement, and forecasting.

The increase in knowledge about STEAM is associated with the implementation of 10 STEAM activities has been seen from the work of community service participants.

#### 4. Conclusion

Community service activities in RSAN, Bengkung Village, Retno Temple, Secang Magelang were welcomed by volunteers and children, as well as community service program coordinators and administrators of rumah Singgah Anak Negeri Foundation. This can be seen from the response of volunteer participants as follows:

1. General: (1) all participants stated that they understood the concept of STEAM, (2) all participants were interested in STEAM activities, and (3) 90% of participants stated that they felt motivated by STEAM activities.
2. Implementation of 10 STEAM activities: (1) 60% of participants stated the most interesting STEAM activities are Ikat Technique Dyes, (2) the most difficult activities are also Ikat Technique Dyes, (3) there are 90% of participants who state Ikat technique dye activities that have the opportunity to be developed into activities that have a selling value, (4) CBS Power Rocket activities are stated by 40% of participants as activities related to Learning in schools.

3. Association with Disciplines: (1). Simple Thermometers related to science, stated by 80% of participants, (2), participants as much as 100% stated that String Art is related to mathematics, (3) while 50% of participants stated String Art related to arts.
4. Tools and Materials that are difficult to obtain: is String Art, expressed by 100% participants, Need high creativity: is String Art, expressed by 60% participants.

## References

- [1] Marín-Marín JA, Moreno-Guerrero AJ, Dúo-Terrón P, López-Belmonte J. STEAM in education: A bibliometric analysis of performance and co-words in Web of Science. *International Journal of STEM Education*. 2021;8(1):1-21.
- [2] Anisimova T, Sabirova F, Shatunova O. Formation of design and research competencies in future teachers in the framework of STEAM education. *International Journal of Emerging Technologies in Learning (IJET)*. 2020;15(2):204-217.
- [3] English LD. STEM education K-12: Perspectives on integration. *International Journal of STEM Education*. 2016;3(1):1-8.
- [4] Marín-Marín JA, Costa RS, Moreno-Guerrero AJ, López-Belmonte J. Makey makey as an interactive robotic tool for high school students' learning in multicultural contexts. *Education Sciences*. 2020;10(9):1-14
- [5] Thomas B, Watters JJ. Perspectives on Australian, Indian and Malaysian approaches to STEM education. *International Journal of Educational Development*. 2015;45:42-53.
- [6] Bevan B, Michalchik V, Bhanot R, Rauch N, Remold J, Semper R, Shields P. Out-of-school time STEM: Building experience, building bridges. *Exploratorium*. 2010;29(1):1-49
- [7] Septiani M. Pengalaman pusat kegiatan belajar masyarakat (PKBM) dalam memfasilitasi masyarakat belajar sepanjang hayat. *Jurnal Ilmiah Visi*. 2015;10(2):67-76.