Implementation of STEM (science, technology, engineering, and mathematics) learning by using toy project

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Abstract. The purposes of this study were to describe the implementation of STEM learning by using toy projects and describing students' perceptions of these learning. This study used a mixed research method. In the process of describing the learning process, the qualitative method was used and followed by quantitative methods to describe students' perceptions. The instruments used were observation sheets and video recorder. For the quantitative, a questionnaire was used. These were perception questionnaires consisting of 7 indicators. The results of this study showed the process of implementing learning was well-acceptable. However, the teacher was very constrained in carrying out to assess the learning process. Meanwhile, from the results of quantitative data, the data analysis proved students agree that this learning was easy, interesting, focused, did not contain many theories, fitted to them, and also well-achieved or able-followed the learning process. On the other side, students could not determine whether this learning had varied content or not. This is indicated by the average student choosing neutral for this indicator.

1. Introduction

STEM learning is a multi-dimensional learning[1]. This learning integrates two or more scientific disciplines, technology, engineering and math in a single learning process[2]. STEM learning is important to teach considering the level of motivation and interest of students in learning mathematics and science is low. So, with an approach that integrates science and mathematics in a project lesson becomes one of the best solutions.

STEM learning is often identified with ordinary project learning. But actually, STEM learning provides a different kind of learning and teaching compared to other learning. STEM learning focuses on how aspects of science, technology, engineering and math discipline can be taught simultaneously in a project learning. So that the teacher will design learning more comprehensively, by thinking about the relevance of the project given at different points of view for each discipline.

According to Hideyuki[3], STEM learning is divided into 3 activities, namely the activities of Information and Communication Technology (ICT), in the real world, and in the Virtual World. These three types of stem learning activities each provide different learning experiences and demand different readiness of facilities and infrastructure. Many schools can apply these three types of activities in learning but not a few schools can only apply STEM learning to real-world projects due to the limitations of internet networks and computers or mobile devices.
The area as described above is widely spread in rural areas or at the border of the city in Indonesia. Usually, this school is not included in the favorite school category. Disparities of facilities and infrastructure that occur in these schools require teachers to be creative in empowering local resources and local wisdom. One easy resource to use is simple toys and often played by children in school. The use of this toy also engages students in the study of environmental science and other topics in local settings [4,5]. The simple toy which familiar with students and teachers in daily life or place where students live will help the teacher to create better engagement[7]. Better engagement will give teachers better confident in teaching STEM[8]. The final result, students’ engagement, understanding, and academic achievement will increase[5,6].

The use of simple toys in addition to facilitating teachers and students in preparing learning also provides new knowledge to students that behind the toys they usually play contain aspects of science. The aspects of science are sometimes not realized. This will form a unique one so that it can make an impression on students' memories longer. One of the lessons that raised the toy project as a stem project was the airplane project[3]. This project is very easy to apply because the tools and materials and types of projects are easy and familiar to students' daily lives. So, this study tries to apply STEM learning by adding tracker (video analysis software) usage in analyzing distance and time and other quantities. The use of video trackers can produce more accurate data for the time which is indeed difficult to measure using a stopwatch, make the learning process more interesting and give a deeper understanding of natural science phenomena[9]. Using video also provides a bridge between direct observations and abstract representations of physical phenomena[10].

2. Methods

This study uses a mixed-method research design. With qualitative data used to describe the learning process given. Meanwhile, quantitative data was used to show how students perceive this learning. This study used one class with the number of students 29 people in a school that is on the border of Jambi city and not including favorite schools and even tends to include lower-class schools.

Qualitative instruments used in the form of interviews, observations and voice and video recording devices. The observation sheet in the form of an open observation sheet contains notes in each stage of the learning process. For the interview, the focus was to explore the teacher's teaching experience and examine the obstacles that occur in the learning process both from the teacher's perspective and the viewpoint of students who experience obstacles in the learning process. Meanwhile, a recording device is used to document all activities that occur during the data retrieval process.

The quantitative instruments used in this study were questionnaires about students' perceptions of the learning provided. This questionnaire uses 7 scales and adapted from the perception questionnaire[11]. Perception referred to covers 1). Difficulty level, 2). Varied content, 3). Interesting, 4). Theoretical courses, 5). Specialization options, 6). Achievement, 7). fits me.

3. Result and Discussion

This learning is carried out during two and a half hour with the type of group learning. Learning begins by explaining the stage setting. This stage briefly tells what an airplane is and what it will do today. At the next stage, a worksheet is provided where afterward the teacher presents the problem that will become the basis for the project. In this project, the problem is "Will the thick paper airplane fly be a greater distance than one made of thin paper?"

Based on the questions above students are asked to make hypotheses and determine variables. After those students are asked to determine the tools and materials to be used. Determination of tools and materials is determined independently by students under the guidance of the teacher as a facilitator. The tools and materials have been prepared before by the teacher before teaching.

From the initial three stages, in general, the implementation process did not have problems. Student activities began to appear in the session on determining tools and materials. The difference between active students and those who only watch the learning nets begins to appear. The dominance of several students in the group is clearly visible. On the teacher's part, the role of the teacher as facilitator begins
to appear when guiding students to discuss the tools and materials to be used, as well as how the concept of paper airplanes to be used (Figure 1).

To teach the ability to use technology, this learning requires students to make a brief description of how airplanes can fly in the air. In addition to teaching literacy to students, students are also required to make a description of the history and development of aircraft along the time. The process of searching for this information uses internet sources that they can access via a smartphone. This activity also made students have long-term retention by web-base learning[12].

The use of smartphones is also very important in order to make students learn how to find information using the internet. In addition, this can also train students on how to get good and true information in cyberspace. While this process the teacher will often supervise whatever is written by students. This supervision aims to provide judge the source of information that is read by students.

![Figure 1. Found Information About Air Plane Using Smartphone](image)

The next Learning Phase is Identify Design Requirements. At this stage, the teacher provides an opportunity for each student to draw the design of an aircraft that will be used as a test material to answer the main problem formulation (Figure 2). At this stage, students are given the opportunity to make 2 patterns of paper airplanes with 2 paper airplanes (thick and thin paper) in each pattern. In learning applied thick white paper (100gr) and thin yellow paper (70gr). This is done to facilitate the identification process.

![Figure 2. Using tracker to analyze distance, time, velocity and speed](image)

This stage is a step that is enough to make the teacher hassle because at this stage many students ask about the design they make. Initially, in the learning plan, information was made that each design was different from one another. The implementation is quite troublesome so that an agreement was
reached that the designs used by each group may be the same. Note that each group makes 2 different designs. After Design each of their designs, students are directed to make what they design. This stage takes place quickly and easily. It is not difficult for students to make paper airplanes as they are designed. When all four planes are finished, the trial process begins. To measure sliding distance, a meter tape is used and combined with the use of tracker software. Through the use of tracker, it is also expected that the data obtained by students is more accurate, and can instill in students the importance of persisting and at the same time teach students how to move files that have been recorded via smartphone to laptops that indeed become very common things every day.

In the process of conducting a trial, something unexpected happened. The distance of the paper plane and the room width are almost the same so that it can only be done in 2 places, namely behind and in front of the class. While the number of groups is 6 groups so they have to take turns and take quite a lot of time. Added again the recording process cannot immediately get a good video due to technical factors. At this stage, we recommend using a tripod in the recording process.

The process of using the tracker in this study does not become a matter of draining teachers. This is because students have got peer teaching assignments about how to use the tracker before. So, it is not difficult for teachers to guide students. The using of tracker also make a variation in learning. The variation is aimed to improve long-term retention[13].

According to the results of observations and interviews obtained information that the biggest challenge during learning is giving questions to direct students in determining the tools and materials as well as the guiding process during drawing the initial design of the aircraft. In addition, the total teaching process forgets the process assessment. There is no single assessment of the process carried out. The results of the interview, information was obtained that the process evaluation seemed to escape the teacher's mind due to the busyness in guiding students and it was not unusual for the teacher to conduct a process assessment during the learning process. After completion of learning students fill out a questionnaire for responses regarding ongoing learning. The results are presented in Figure 3.

![Figure 3. Quistionnaire Result](image)

From the results of the questionnaire, information was obtained that the lowest results were in content variations. This shows that students feel doubtful about the variation in the content taught or not. While the average student responds that learning is interesting. Students' interest in learning can be caused by different and new learning systems for students there.

4. Conclusion
This study found that STEM learning using simple toys project could be accepted by students well. All stages could be done well. In general, students could be active and followed instructions from the teacher. The main obstacle in this learning was seen in the implementation of the assessment process.
All process assessments could not be carried out. The results of the interview, founded that the STEM learning process made the teacher focused on teaching students. Especially when the process of guiding students by giving guided questions while the process of designing and choose the tools and materials of the toy. Thus, teachers were more concerned with how to guide students to complete projects and fill out worksheets and it was unusual for teachers to carry out the assessment of the learning process during the teaching process. On another side, The results of the questionnaire showed if students could not decide whether the learning experience varied or not.

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