KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Providing STEM Opportunities Skill Through Making Biodegradable Plastic Projects in Extracurricular Activities

Meiliana Choiriyah*, Syakti Perdana Sriyansyah, Nugroho Ponco Sumanto

BINUS SCHOOL Bekasi, Jl. Saraswati No.1, Bumiwedari, Vida, Bekasi, West Java, Indonesia

ORCID
Syakti Perdana Sriyansyah: https://orcid.org/0000-0002-3160-8831

Abstract.
The students are prepared to face the global challenges and have a strong desire to act with striving and excellent character values, nowadays. Providing STEM during extracurricular activities can offer the opportunity for students to gain skills that are needed to address the challenges. STEM as a part of the science learning process contributes to increasing the experimental learning skill for the students' academics. Thus, we implemented STEM learning through making a biodegradable plastic project that involved students and teachers during extracurricular activity. To achieve our goal in providing STEM learning, we used nonexperimental and experimental activities. Nonexperimental activities were done by study literate, and discussion and experimental activities were done by students experiment in the laboratory to design, construct, and test the project that students made. We used students post-activity survey and students perspectives in STEM participating learning during extracurricular as the STEM success indicator. They agreed that STEM learning can increase knowledge of post-schooling opportunities and it can develop students' interest and talent in STEM competitions.

Keywords: STEM, biodegradable plastic, extracurricular activities

Corresponding Author: Meiliana Choiriyah; email: meilianacho11@gmail.com

Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

Science and technology develop rapidly in the 21st century, students as young generation should be aware to face the global challenges and have a strong desire to take action and create change. The change, such as engineering innovation, environmental disasters, climate change, and pandemics have many impacts on present and future human well-being and socioeconomic stability. Moreover, the next few years, companies will require competence employee with high knowledge and skills in science, technology, mathematics, and other aspects such as attitudes, habits, and values. Technology in Education (ISTE) in 2017 recognized that increasingly digital world is the effect of 21st century global change. Hence, students need increasing the skills in the following areas, such as creativity and innovation, communication and collaboration, research

and information fluency, critical thinking, problem solving and decision making, digital citizenship and technology operation and concepts. Regarding the following skill areas that students need to achieve, critical thinking is one of the essential skills that is needed to develop from an early age so that students can face complex challenges in the future [1].

Critical thinking skill is important for students in building them to enable dealing effectively with social, scientific, and practical problems [2]. They will be able to solve problems effectively as well. Having an academic skill is not enough, to be effective in the workplace or in their personal lives, students must be able to solve problems and having critical thinking in each making decisions. Critical thinking skill in Indonesia based on the Program for International Student Assessment (PIZA) are still low. It is shown from the 2015 data with a score of 397 which still ranks 62 with a total of 72 countries participants, while the data in 2012 with score 0f 396. Critical thinking skills are also low as seen from the data studied by Handriani (2015) in Mataram, Liberna (2014) in Jakarta, and Hayudiyani in Madura (2017) [3].

This opens a space for education, education is a key sector for preparing the students to develop students' knowledge and skills address this challenge, in this context critical thinking enhancing goal. In addition, education can enhance the students to contribute more to sustainable development due to education has role to implement sustainable development goals through students learning process and students research training at formal school or unformal school. This context, STEM (Science, Technology, Engineering, and Mathematics) education appears as one of appropriate learning process to help students growing in knowledge and skills. STEM education is an approach that integrate science, technology, engineering, mathematics and has especially brought innovation to science education [4]. STEM approaching gives positive impacts in the scientific process, investigation skills and creative thinking of students. STEM can give students opportunity to apply concept and knowledge in an integrated way to solve problem in real world. Beside this, STEM uses a learner-centered approach to develop students' self-direction, problem solving, collaboration and project management. Moreover, students can be involved themselves actively in each activity that promote the use of hand-on that links to the real-world issues by encouraging to seek and to gain a deep understanding on their studying process. Relate to the rapid-growing industry 4.0, STEM can shape students' ability and willingness to grow their critical skill and industrial mindset [5].

Providing STEM as of appropriate learning to the students by giving students more challenge and give them opportunity in research experience. Teacher accommodated

STEM through project activity during in extracurricular activities through experimental and nonexperimental activities. According to Breiner et al. (2017) STEM with concern in project learning can be a way to motivated low performing students to be more interested in studying hard and decrees the achievement gap [6]. To accomplish these goals, students were trained to design the project under social or economic problem background during pandemic crisis. Students chose to design a biodegradable plastic prototype. The idea of the project itself comes from students concern to COVID-19 virus infection on transmitted through the food package which has been increasing.

2. RESEARCH METHOD

2.1. Participants

STEM learning process course designed to a team high school students BINUS School Bekasi, with significant science program background. Those students designed one of project due to their fretfulness to COVID-19 pandemic situation. They succeed to accomplish the project for 4 weeks in extracurricular activities.

2.2. Nonexperimental activities

Nonexperimental activities have been accomplished by students through study literate and discussion. Study literate is first step that students do, students identify the recent problems from books, journal, prior research, and some bank data to collect data. Then, students and teachers discuss and collaborate to find the idea that best “fit” the problems and formulate hypothesis before doing the experiment in the lab. During the discussion also, students and teachers prepare the materials and equipment for experiment need.

2.3. Experimental activities

Experimental activities have been accomplished by students experiment in the laboratory to design, to construct, to test, and to report the biodegradable plastic project. The workflow experimental activities are on the bellow.

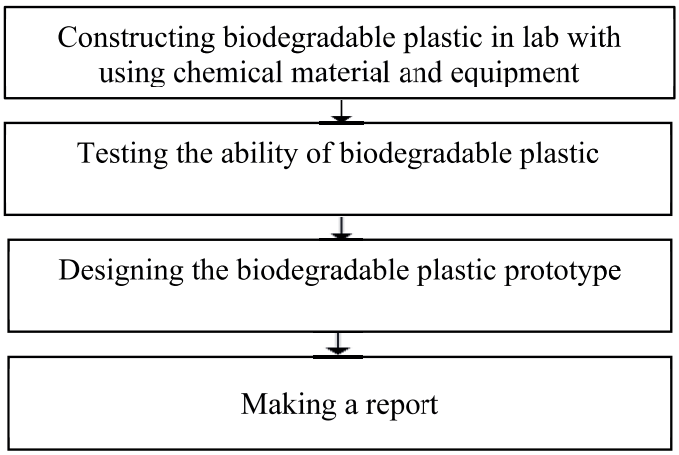


Figure 1:

2.4. Post Survey and Students' Perspective

We used the following measure to assess the success of the project program:

1. Post survey: short survey is created by teachers to assess the interest of students in STEM learning and their comfort with various skill
2. Perspective of students as self-evaluation to the STEM project program

3. RESULTS AND DISCUSSION

3.1. Workflow STEM program

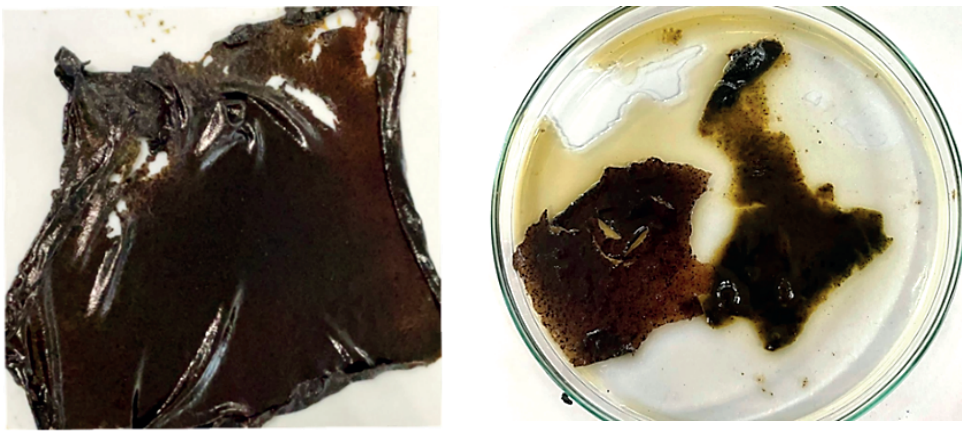
Providing STEM approach in extracurricular activity can enhance the academic lifestyle by providing enrichment to students outside classroom. Students can learn and develop their knowledge and skill and more over students implement the moral and ethical skill to study habits and their live [7].

TABLE 1: Workflow STEM program through nonexperimental and experimental activities.

Activities	Stages	Goals
nonexperimental	study literate discussion	find the issue and concern based on data learn how to ask research question learn how to create scientific framework develop skill to communicate on group working learn how to make decision learn how to organize the project
experimental	construct the product test the product design the prototype report the product	enhance the lab practical skill develop scientific writing develop scientific investigation learn how to get data and analyze learn how to use unfamiliar chemical equipment develop creativity skill

Regarding the workflow this program which involves nonexperimental activities, such scientific study literate and discussion. Scientific study literate can build a scientifically literate, it also involves mastery of thinking process and using scientific methods to know and to address the social issue [8, 9]. After students discover the social issue, students bring the issue to the discussion forum, discussion is important in helping students to clarify their thinking. Moreover, through discussion, students can also interpret and describe the issue which has been investigated and connect their knowledge to the issue that students found. Science study literate and discussion involve students to think more, and they will process their finding in various components, such us identifying and analyzing the problems, making arguments, judging evaluating, making decisions through using communication effectively. Those process also can enhance their critical thinking skill, where in critical skill is the essential skill that students need to develop in the 21st century [10].

Through experimental activities, students conduct experiment in lab to design the prototype project, to accomplish step by step of making biodegradable plastic, to test the ability of the prototype, and to report scientific research as the project team by making poster and video. Biodegradable plastic project comes from the social and economic issue in Indonesia during COVID-19 pandemic. Community reported that 1.600 restaurants in Indonesia close which is caused by COVID-19 paranoia to food product that can carry virus during processing and transportation. Biodegradable plastic project is innovated by students as the one of solution to address the problem. Students utilize natural resources such as green tea, *Aloe vera*, and chitin to providing antiviral and antibacterial agent [11].



(a) (b)

Figure 2: (a) Platicity test of biodegradable plastic with green tea powder, (b) Dry test of biodegradable plastic with green tea powder.

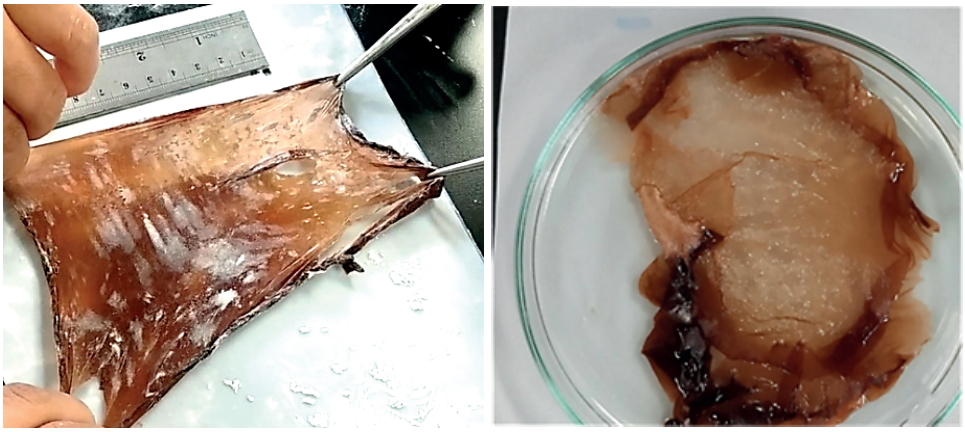


Figure 3: (a) Platicity Test of biodegradable plastic with green tea extract, (b) Dry test of biodegradable plastic with green tea extract.

Figure 4: Design of biodegradable plastic.

The experimental activities are started by contracting the biodegradable plastic (Figure 1 and Figure 2). Students conduct the experiment in lab using the chemical material and laboratory equipment, starting to prepare the raw and materials need such as dissolved 4 % chitosan in 1 % acetic acid, glycerin, and Aloe vera gel as plasticizer, green tea extract and powder, mylar, and other laboratory equipment. Students run the process step by step started making the plasticizer solution, string the solution for 30 minutes, degassing the film-forming solution in a water bath, adding the green tea extract and green tea powder, and stirring the mixture for 30 minutes, pouring and spreading solution into thin mylar, drying the film-forming layer in an oven on 70˚C for 1 hour and peeling the film layer off and store in an airtight container. After

students contracted the experiment on step by step, students will do the plasticity and dry test to the biodegradable plastic **(**Figure 1 And Figure 2). The plasticity test resulted that biodegradable plastic containing green tea extract is more elastic and strength than biodegradable plastic containing green tea powder. The dry test resulted that biodegradable plastic containing green tea powder is faster dissolve in water than biodegradable plastic containing green tea extract. Students completed the project by designing the biodegradable plastic product prototype to demonstrate students' success work and students report the project through making scientific poster and video to give students opportunity to share the project to the community.

3.2. Postsurvey and Students' Perspective

Postsurvey is short survey created by teachers to assess the interest of students in STEM and students' comfort to gain the various skill. Postsurvey assessed using the scale number from number 1 representing strongly disagree until number 5 representing strongly agree.

Table 2: Quantitative Data from postsurvey administrated to students.

Postsurvey questioner	Agree to strongly agree
I am comfortable reading primary literature (scientific, journal article)	100%
I am comfortable discussing with teachers to make decision of the project	100%
I am comfortable conducting the experiment in lab, doing the practical activities to contract, to test, and to design the product	100%
I am comfortable reporting the project, making poster and video	100%
I am comfortable working collaboratively in team	100%

Table 2 describe the quantitative data from students' postsurvey. Students' responses with 100% choose to agree to strongly agree, it means that students feel comfort with reading primary literature, students enjoy discussing with teachers to make decisions of the project during in nonexperimental activities, students enjoy conducting the experiment in lab starting with constructing the product, testing the product, and designing the prototype, students feel comfort to report the project though making poster and video and students enjoy working collaboratively in team as well. This survey has been accomplished after students finished the program. Students showed their interesting in basic research experience skill, such as how to use scientific literate, ask research question, how to read the primary literate, how to collect and analyse data. Students also

showed their curiosity on how to solve the problem if they found technical error during in experiment activity in lab, this matter influence students recognize how science can be used in addressing to their real life. Students also recognize that they can be more critical thinker, this is seen form students' interrupting to teacher's explaining in each stage of activities. Students view are exemplified on the below:

It was my first experience working on the research and participating in the lab, those things were relevant to my class learning which was not discovered during class session. I could build my idea due to reading some journal and article, I could also more caring with the social issue that enormous facing to the world. Through reading the journal and article, my understanding to the science increased, through the discussion, I could share my idea too, it gave the benefit to increase my critical thinking. Trough the experimental activities, my lab skill also increased, I could use the chemical equipment privately due to only some students who joined this program. The process of this project also gave me the opportunity to be selected as the winner in STEM competition.

As reflected by students above, STEM program works on students' development on skill training aspect. The program also motivates students in their competencies, such as students increase the ability to give themselves challenge to join the competition and compete with other students. Student also state specifically commented the view about this program on how the structure of program gave student confidence in learning and participating their scientific skill.

Participating in labs were relevant to my leaning during class session also helped me build off the scientific writing that I had previously never get enough to write due to lack of my scientific literate before. It was also making me more confidence on my method investigation, previously, it always felt risk and like something that I could never do correctly, now my confidence increased to self-directed investigation with some instructions.

Other reflections come on the students view to give feedback to this program relating their capability to think creative and working on build their collaborative character.

Working with other peers enhanced my skill on how communicate with group, provided me the opportunity trusted on the team and built the collaboration on how to organize and communicate working in groups and shared the idea and worked together without giving burden to one person only and other things were my creativity increased since I had to work making scientific poster and video.

Regarding to students' perspective view, this will be continued as an insight to the school and community to concern serving the innovation of learning approach to the students as learners by providing project learning approach where in students will have

opportunity to conduct the authentic research in early, so they have an experience to broad in science research in academic research or application research. The students' perspective view will be studied more as the feedback, and it is used to be consideration on future project framework.

4. CONCLUSION

This study conveys how STEM (Science, Technology, Engineering, Mathematics) learning approach can be used as the pedagogical school program to students through making a beneficial project. Moreover, STEM can contribute to enhance students' knowledge, critical thinking skill and problem-solving skill and offer the research experience opportunity to students in addressing the global challenge.

Acknowledgments

We gratefully acknowledge support from our colleagues, students, and management of BINUS School Bekasi.

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