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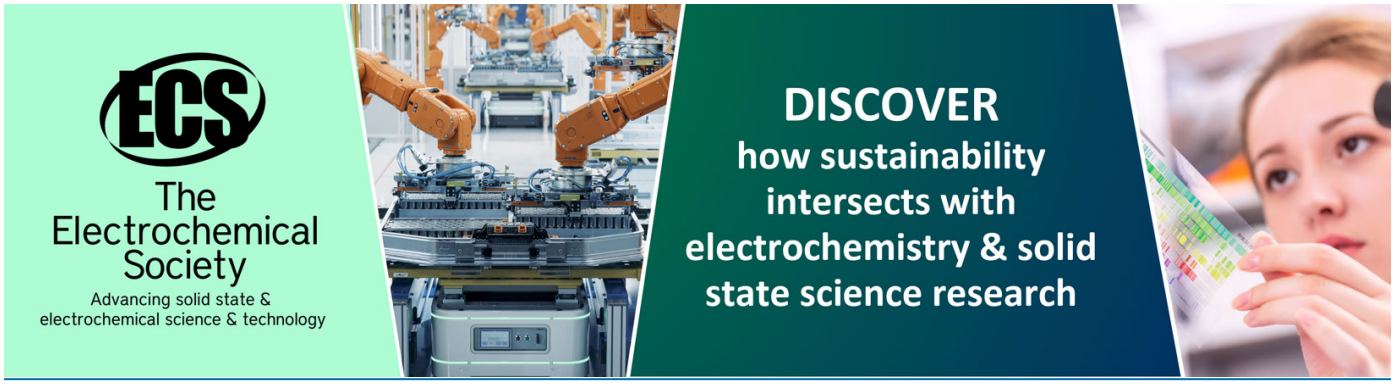

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The implementation of STEM approach through project based learning to develop student's creativity

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Abstract. One of the student's skills that must be developed suggested by the national curriculum through the learning process is creativity. The purpose of this study was to develop the student's creativity through the implementation of Science, Technology, Engineering and Mathematics (STEM) approach using Project Based Learning Method. This research was a design research where the researchers develop the design of an innovative food project made from Salak by integrating the topic of 'ratio' in mathematics and 'food additives' in science. The research subjects were eighth grade students of Budi Utama Middle School. The research instrument used is a student worksheet (LKPD). The method of data collection carried out in this study was the interactive analytical methods of Miles and Huberman. The research showed that the STEM approach could be implemented by using Project Base Learning to improve student's creativity.

Keywords: STEM approach, Project Based Learning, Creativity.

1. Introduction

One of the biggest challenges for teachers is to bring out the creativity of students both in learning and in everyday life. This is very difficult when students have been spoiled with the world of electronics and technology along with its conveniences, which make a lot of students tend to be lazy, passive, and less creative. Creativity is important because high creativity can encourage children to learn and work more so that one day they can create new things (Muhammad Yusri, 2016). For that reason, people involved in the world of education must be able to respond to these developments and challenges by making 21st Century Skills as a global goal of education. Besides, according to Greenstein (2012), 21st Century skills consist of three core components, namely thinking, acting, and living in the world. Thinking include critical thinking, problem solving, creating (creating), and metacognition. The acting includes communication, collaboration, literacy, flexibility, adaptability, initiative, and directing itself. Living in the world also includes as social responsibility, global understanding, leadership, and career preparedness. The growth of thinking skills (acting), acting (acting), and living in the world (living in the world) is what characterizes 21st Century learning.

Creativity is a person's ability to create new things, either in the form of ideas, real works, or combining things that already exist or are relatively different from those that have been there before. In addition, creativity is an instinct that exists since birth, but creativity cannot develop by itself and requires stimulation from the environment. According to Asep (2013), creativity is a person's ability to think of achieving diverse and new products, both in the fields of science, art, literature, and other fields, where products can be accepted and liked by society as a useful thing.Some characteristics of creative people, among others, have a wide and deep curiosity; have a high imagination space; always give ideas

or proposals to a problem; see a problem in various points of view; original in expressing ideas and in problem solving.

According to Munandar (Hamzah B. Uno and Nurdin Muhamad, 2011: 252), indicators of creativity are 1) having great curiosity; 2) often asking weighty questions; 3) giving lots of ideas and suggestions for a problem; 4) able to express opinions spontaneously and not shyly; 5) having and appreciating a sense of beauty; 6) have their own opinions and can express them, not easily influenced by others; 7) have a high sense of humor; 8) have strong imagination; 9) able to submit ideas, problem solving ideas that are different from others (original); 10) can work alone; 11) happy to try new things; 12) able to develop or specify an idea (elaboration ability).

Innovation is a process of renewal / utilization / development by creating new things that are different from before. It can also be interpreted as new discoveries in technology or introducing new findings that are different from those that already existed. Innovation can occur because of intentional (invention) or occur due to accident (discovery).

Creativity and innovation are two interrelated things. A creative person will produce an innovation, while innovation is a result of creativity. In connection with that, it can be said that creative and innovation have equality, namely about creating new ideas, new ideas, new methods, new ways of solving problems and opportunities that are different from before so they can be accepted by society as something unique or something useful.

Various efforts do reform and innovate in education are carried out by developed and developing countries to realize skills-oriented education in the 21st Century, one of which is Indonesia. Education in Indonesia has begun to implement the 2013 curriculum which uses a scientific approach to learning in schools. In this curriculum, educators are expected to be able to design learning so that students want to think, act, and live in the world like the skills developed in 21st Century learning. In addition, the STEM approach is also combined in the curriculum. STEM is an acronym for Science, Technology, Engineering, and Mathematics. The word STEM was raised by the US National Science Foundation in the 1990s as the theme of the education reform movement that integrates the four fields of the discipline.

Science, Technology, Engineering, and Mathematics are four fields of disciplines that are integrated in STEM learning. Science is a study of natural phenomena that involves observation and measurement, as a vehicle for explaining the objectively changing nature. There are several main domains of science at the level of primary and secondary education, namely physics, biology, chemistry, and earth and space science. Technology contains about human innovations that are used to modify nature to meet human needs and desires, thus making life better and safer. Technologies make people able to travel quickly, communicate directly with people in remote places, find healthy food, and safety equipment. Engineering is the knowledge and skills to obtain and apply scientific, economic, social, and practical knowledge to design and construct machinery, equipment, systems, materials and processes that are beneficial to humans economically and environmentally friendly. Mathematics is the science of patterns and relationships, and provides language for technology, science, and engineering.

In terms of primary and secondary education, STEM education aims to develop students as follows (Bybee, 2013):

a. Having knowledge, attitudes, and skills to identify questions and problems in their life situations, explain natural phenomena, design, and draw evidence conclusions regarding STEM related issues;
b. Understanding the special characteristics of STEM discipline as forms of knowledge, inquiry and design initiated by humans;
c. Having awareness of how STEM disciplines shape the material, intellectual, and cultural environment.
d. Having a desire to be involved in STEM-related scientific studies (eg energy efficiency, environmental quality, limited natural resources) as constructive, caring and reflective citizens using scientific, technological, engineering / engineering, and mathematical ideas.

There are numbers of approach to teach STEM according to Robert and Cantu (2012) and these are:

a. Approach Silo

The silo approach is an approach that emphasizes the opportunity of students to gain knowledge rather than technical skills. The characteristic of this approach is that learning in the classroom provides little opportunity for students to be active and the teacher still plays a role (authority).

b. Embedded Approach
The embedded approach is an approach that emphasizes mastery of knowledge through real world conditions and ways that can be done to solve problems in the social, cultural and functional spheres. This approach prioritizes integration of the subjects and connects material prioritized with supporting material or embedded material.

c. Integrated approach
The integrated approach is an approach that emphasizes the incorporation of various STEM fields and makes it a subject. This approach combines various cross-curricular content such as critical thinking skills, problem solving, and scientific information which is a solution to a problem through the integration of material taught in different classes and times.

Having the era of global competition, Indonesia needs to prepare reliable human resources in the STEM discipline in a quality and sufficient quantity. This is not an easy thing because without any effort to develop basic skills, soft skills (collaboration, communication, creativity, problem solving), and prerequisite values in STEM through primary and secondary education, it would be difficult to get young people ready to pursue STEM fields.

The current 2013 curriculum in Indonesian education will not be able to overcome the problems of the quality and quantity of Indonesian human resources that are globally competitive, if not appropriately, quickly, systematically, and sustainably prepare the young generation to develop the knowledge, skills and attitudes required 21st Century work world as intended in STEM education. Knowing this, Indonesian education experts began directing the 2013 curriculum using a scientific approach to be integrated with the STEM approach in an effort to create a young movement capable of competing in the global arena. Therefore, the STEM education approach needs to be a reference framework for the education process in Indonesia.

Contents in the 2013 Basic Curriculum Framework and Structure Level of Junior High School / Madrasah Tsanawiyah (Kemdikbud, 2013), that the 2013 curriculum aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of the community, nation, state and world civilization. It was also stated in the curriculum that one of the new mindsets used as the basis for developing the 2013 Curriculum was the learning pattern of single science (mono-discipline) into multidiscipline learning. The formulation of the objectives and mindset in developing the 2013 Curriculum proposed that the 2013 Curriculum provides space for the development and implementation of STEM education in the context of the 2013 Curriculum implementation, which prioritizes the integration of S, T, E and M in multi-discipline and trans-disciplinary development critical thinking, creativity, innovation, and problem solving skills.

The formulation of the problem in this study are:

a. Can the STEM method bring out the creativity of students in learning?
b. Can the innovation of processing food with Salak raw materials bring out the creativity of students?

2. Research Method

This research was a qualitative descriptive research that is to provide the description of how the creativity of students in making processed food (food innovation) made from Salak. The teaching was made possible by integrating science and mathematics where the topics of "ratio and food additives" were integrated. The research subjects were class VIII Budi Utama Middle School students. The research instruments used in this study were guidelines for observation, and documentation. The method of data collection was carried out in the following ways:

a. Observations during the field study, namely in "Salak Pondoh Tourism Agro" in Turi, were center for innovation in processing salak such as ‘bakpia’, ‘sweets’, ‘dodol’, and ‘salak chips’.

b. Observation of the creations of students in processing Salak as raw material into food innovations and exhibitions in schools.
c. Assessment of presentations, reports and posters.

Data was analyzed by using the interactive analysis model Miles and Huberman. This data analysis model consists of four stages, namely:

a. Data collection
   Data obtained from interviews, observations and documentation are recorded in the field notes consisting of 2 parts, namely descriptive and reflective parts. Descriptions are natural records (about what is witnessed, heard and seen). Reflective notes are notes that contain messages, impressions, opinions or comments and interpretations of events encountered.
b. Data reduction
   Data reduction was carried out to select the data that is relevant and meaningful, to focus on solving problems and answering questions on the research objectives. In the process of data reduction only data relating to research problems are used while unrelated data will be discarded.
c. Presentation of Data
   Presentation of data can be in the form of writing, images, tables and graphs. The purpose is to combine information so that it can provide an overview of the situation that occurs.
d. Inferring the Conclusion
   The conclusion has taken throught the process of the research, as well as data reduction process and after gathering the data, the hypothesis could be taken, and lasted the conclusion could be obtained.

3. Research Result

This research was a design research that is an activity in the form of an innovation-based food project made by Salak which integrates mathematics subject matter on "comparison" and science lesson material about "food additives" through the STEM approach, and aims to see the impact on students' creativity in making products processed food made from Salak.

The stages of teaching activities that implement STEM approach by using project based learning presented in Figure 1.

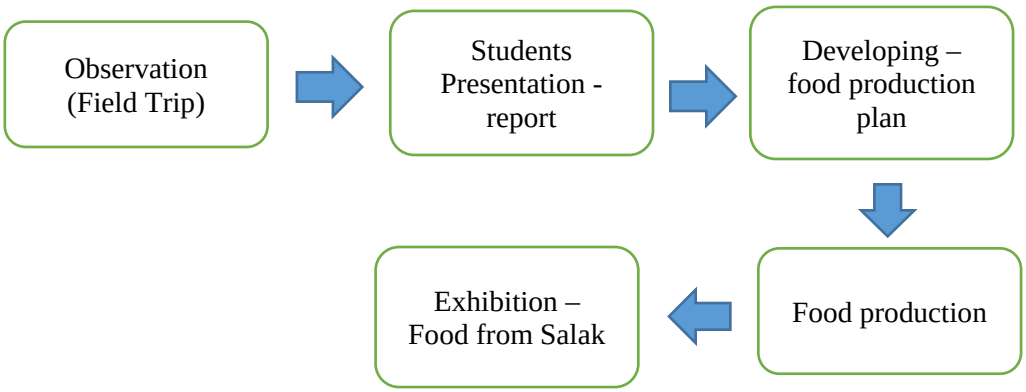

Figure 1. Teaching Processes

The research began with, the first step that is preparatory activities in which the researcher prepared student's worksheets related to learning, and selected the venue for field trip activities among several choices. "Salak Pondoh Tourism Agro" in Turi, Sleman, Yogyakarta which was selected as the venue for several reasons including there are innovation centers for salak processing such as salak bakpia, candied salak, dodol salak, and salak chips. At this stage, the researchers coordinated with the venue manager to prepare the needs such as a tour guide as a facilitator/source of information that could explain the history of the establishment of the place, starting from the management of Salak gardens, nursery

tree Salak, maintenance of Salak trees, Salak harvest to the establishment innovation of processed Salak as the livelihood of the surrounding population; and the need for places for learning to students where each center also prepares ingredients for processed Salak products and their equipment so that students can try to do a demonstration of making bakpia from salak, candied salak, dodol salak and chips of Salak. The preparation for students is directing from the school about fieldtrip activities, assignments/activities during field trips, receipt of worksheets, and division of work groups for the project.

Observation. The first of core activities of the learning was filed trip and observation. The fieldtrip was held on October 4, 2018 at the Salak Pondoh Tourism Agro. At the location, 68 students of Budi Utama Middle School with a total of 68 participants were divided into groups and each group consisted of 3-4 students so that there were 23 groups. The groups were spread out in 4 centers for production of salak processing, namely processing centers for salak bakpia, candied salak, dodol salak, and chips of salak. Prior to the activities, the teachers debriefed whole class. After the question and answer session, the tour guide invited students to go to the salak field / plantation. Salak farmers who are located in the location, taught students how to graft Salak plants, did manual pollination, growed salak plants and harvest salak. After they had visited the salak garden, the tour guide directed the students to the centers that had been prepared to be used by students to explore further about the Salak innovation products. In each of these centers, students began to learn to make innovative food products from Salak raw materials, which in turn could provide students with creative ideas in making innovations made from Salak. Students were asked to record the composition of food ingredients used to make Salak innovation products. During the observation, students wrote the information including important data regarding ratio. The Students were also asked to write food additives (additives) needed in the product.

Presentation. Students presented their findings based on their observation and interviews. Prior to the presentation, the students discussed their findings, especially the information related to the concept of ratio and additive substances. The summary of students finding presented in table 1.

Table 1. Data Collected by Students from Filed Trip

Production	Ingredients	Additive substances
1. Bakpia Salak	- 200 gram wheat flour, 50 gram sugar flour, salt (to taste), 80 ml milk, ½ tbsp white butter (as a wrapper / skin) - Salak jam (as a bakpia filling): a ratio of 1/2 kg of large size bark, 200 grams of sugar, 1 tablespoon of lemon juice, and a little salt. -	White butter, milk, lime.
2. Salak Picles	1 kg ofSalak; ½ kg of sugar; 2.5 liters of water; 2-3 tablespoons of salt to taste, 1 gram of ascorbic acid	Asam askorbat
3. Dodol Salak	Glutinous rice flour; zalacca meat; brown sugar / sand; coconut milk; water	Coconut milk
4. Salak Chips	1 kg of zalacca; 100 grams of sugar; 2 tablespoons of salt (to taste); 2 tablespoons of whiting water; 2 liters of clean water; enough cooking oil	Betel lime water

Table 1 shows that the students have learned mathematics about "ratio" that in the composition of food ingredients/processed products, and learning science about "additives" or "food additives" used in the product -the product. Field trip has provided real life experience to learn some concept. This is one of the strengths of the utilization of the STEM approach.

Developing food production plan. The next activity was developing food production plan. Each group of students were asked to develop proposal to create an innovative food products by using Salak as the main ingredients. Each group had consulatation with teachers to refine their proposals. The proposal also included their plan about exhibition and posters to present their products to the audiences. These stage was challenging to the students. They were encouraged to be creative and innovative to produce food and posters. This was the activity that provide opportunity for students to develop their creativity.

Food Production. The students executed their proposal to produce an innovative food by using Salak as the main ingredients. This stage provide students the experiences with different skills including collaborative works, experimentation, communication skills,

Exhibition. In the exhibition, each group displayed the results of their processed food products and posters on the stand provided. And next visitors came to their booth, one of the representatives from the group presented the results of their processed products and then offers to taste the product. Then the visitor was asked to write impressions and messages on the list made by the group. In addition, students at the stand must also be able to answer the questions raised by visitors about their products or about their creations.

The following is an example of the results of innovation creations processed by salak several groups:

Table 2. Students Activities: Food production and Exhibition

Activities	Duration	Remarks
Writing Proposal	1 week	
Food Production	4 weeks	Making innovation products and food creations and then conducting public testing / testing as well as collecting criticism and suggestions from product tasters for repairs
Writing report and poster	3 weeks	
Exhibition	2 days	- 1 day installation of posters at stands provided for the exhibition (the day before the exhibition) and 1 day for product exhibitions and posters (exhibitions were carried out during semester 1 report cards) - During the exhibition each group is required to have a visitor's attendance list

Group	Name of Product	Remarks
1. Group 1.	Churros Salak	Churros is a type of food from Spain. This group combines the Churros mixture with group-made salak dough, then fried and added toppings.
2. Group 2	Salak Ice Cream	Ice cream made by this group like ice cream in general, only salak is added in it.
3. Group 3.	Salak Ice lolly	Ice Lolly with Salah flavoured
4. Group 4	Salak Candy	This candy is made by blending the wrong fruit that is ripe and made like cotton candy.
5. Group 5	Salak Jam	Jam made with the main ingredient of salak.
6. Group 6	Salak Pudding	Pudding made from salak

The final activity was assessment. The assessment was carried out based on reports, the results of innovative creations made by salak, posters and presentations at the exhibition.

a. Assessment of reports
   Reports are assessed based on their completeness such as the order of reports starting from title, introduction (background, problem formulation, objectives), theoretical basis, discussion and analysis of data, and conclusions. In addition to the order of the ranking, the contents of the report are also assessed.
b. Evaluation of the results of innovation made by salak
   The creativity of the students in the group in making innovations in processed snake fruit is assessed based on the results of observations during exhibitions such as the taste of food products, color, aroma and feasibility.
c. Poster
   Poster assessment is carried out on the contents of a brief summary of the report accompanied by photos of the product (if any), whether it is interesting or not to be displayed in the poster.
d. Presentation
   Assessment is also carried out when students make presentations and question and answer sessions at the exhibitions such as whether or not students actually make the product, how to make it, how long it takes to make it, how much it costs to make, the difficulties experienced, etc.

4. Conclusionn

a. Student creativity appears from the type or names of products that are produced by food processing from Salak,
b. The STEM approach can be applied through innovation-based food project based learning from Salak. In connection with that, also they learn about both mathematics and physics through measuring the ratio of materials needed in making the inovation and aditives which are used in the process.
c. The STEM approach which based on the project as in this study can also improve several soft skills of students such as collaboration when making products, communication skills such as presentations and question and answer at exhibitions, and entrepreneurial abilities.

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