

Potatoes on my Head: A Stem Based Learning Model for 2nd Grade Elementary Students

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Abstract

Education in the age of the industrial revolution 4.0 requires teachers to become innovative; teachers need to be able to adapt science and technology innovations to learning trends in the classroom. Science, Technology, Engineering, and Mathematics (STEM) approach is an alternative learning approach that allows students to have the complete skills desired by 21st century learning. Utilizing the STEM approach in a learning environment allows several topics to be effectively learned in a grade II elementary classroom. One STEM approach used '*Potatoes in My Head*', has learners learn about food ingredients, using measuring instruments, as well as basic techniques of engineering. This paper is the result of best practices carried out by the teacher in the second semester of the 2018/2019 academic year and involved 29 second grade students at a public elementary school in Bukittinggi, Indonesia. The aim is to see the improvement of students' learning outcomes and critical thinking skills. The knowledge was gathered through observation strategies and assessments of learning outcomes. The findings showed that the STEM approach in the *Potatoes in My Head* operation helped enhance learning outcomes and the students' critical thinking skills.

Keywords: *elementary school; learning outcomes; potatoes in my head; STEM approach*

1. INTRODUCTION

Twenty first century education directs students to have 4C skills (4C Skills) consisting of critical thinking, creativity, communication and collaboration which are expected to be able to help students adapt to the development of the Industrial Revolution 4.0 (Chittum et al., 2017). To achieve this, the concept of classroom learning must change and

requires innovation and creativity of all stakeholders involved in the learning process. Although school attainment is a cumulative process that combines the acquisition of academic skills and behavior, most studies only offer a view of the association between student capacity at high school age and final school examination results (Bell, 2016; Pertiwi, Abdurrahman & Rosidin, 2017).

At various levels of education, the problem of students' critical thinking skills is still the main concern of teachers; this ability is considered to have a more prominent role which will later be useful for student life after leaving school. So far, learning in the education system in Indonesia still presents separate and segmented learning even though the learning approach that is echoed is thematic integrative. Learning is still presented in the concept of subjects with a description of certain competencies that students must master. This raises a problem where students seem to get knowledge separately and not holistically. As well, some of the learning materials used don't seem to relate to the problems of their daily lives.

Several studies have found a positive association between comprehensive early childhood educational experiences and cognitive achievement for children who are vulnerable to change (Fantuzzo, Gadsden & McDermott, 2011; Florea & Hurjui, 2015; Rodzalan & Saat, 2015).

Several skills (including critical thinking), that are considered to be crucial to 21st-century abilities, unfortunately seem to have not received special attention in learning activities. The separation of learning in schools causes students to not be able to relate what they have learned with the new knowledge they will acquire (Altintas and Ozdemir, 2012); (Hürsen, Kaplan & Özdal, 2014).

This is believed to be one of the reasons why most learners today are less able to solve their problems and lack

imagination in doing schoolwork; their learning environment is more controlled by theories and principles that they do not necessarily need to properly develop themselves. In short, students have not been able to think outside the box when faced with problems that require creative solutions. In grade II SDN 09 Manggis Ganting itself, problems like this are not new and have always been a complaint by teachers for a long time. Students have not been able to work creatively in solving given problems and have not been able to link their initial abilities with the new subject matter they are learning. The epitome of all of these problems is the low student learning outcomes and the low critical thinking skills of students in everyday life.

One approach that is thought to be able to overcome the problems stated above is the Science, Technology, Engineering, and Mathematic (STEM) approach. The STEM approach is considered in accordance with the pattern of implementing the 2013 Curriculum which has become a compulsory curriculum in schools since it was first launched in 2013. The STEM approach combines multidisciplinary learning in one time and is in line with the thematic approach that is the soul of learning in the 2013 Curriculum (Anwar, 2017; Indriani, 2015; Putra, 2020).

STEM is an interdisciplinary learning approach which is a compatible partner between problems that occur in the real world and also problem-based learning in schools. This approach is capable of creating a cohesive learning system and

active learning because these four aspects are needed simultaneously to solve problems. The solution given shows that students are able to put together abstract concepts from every aspect (Feldon et al., 2016; Papadakis, Kalogiannakis & Zaranis, 2017).

In addition to improving students' ability to solve problems, the STEM approach is considered capable of improving students' critical thinking skills because every aspect of STEM has special characteristics that distinguish between these four aspects. Each of these aspects helps students think critically in solving problems that are much more comprehensive when integrated.

In the STEM-based science learning that was carried out for *Potato Learning in My Head*, the teacher begins the lesson by reviewing various kinds of fruits and vegetables and conducting questions and answers with students about the benefits of these fruits and vegetables for human life. Students are stimulated to mention the benefits of fruits and vegetables they eat every day. Students are also asked to identify the vitamins and minerals contained in the food. Students are then divided into several groups and given activity sheets that help them identify fruits and vegetables and then they are prompted to specifically discuss potatoes.

Students will weigh, measure, and find out the benefits of potatoes in their lives. Students use technology such as scales, calipers, rulers, knives, etc., to do their assignments. Students are also directed to examine the electrical content as an alternative energy in potatoes.

The four characteristics of STEM that are used in this project are based on the definition described by Torlakson, namely: (1) science which represents knowledge of laws and concepts that apply in nature, food served by nature; (2) technology is the skill used in managing society, organization, knowledge or designing and using an artificial tool that can facilitate work (scales, scissors, ruler, caliper, knife, Ampere meter); (3) engineering or engineering is the knowledge to operate or design a procedure to solve a problem (how students solve the problem); and (4) mathematics is the science that connects quantities, numbers and spaces which only requires logical arguments without or accompanied by empirical evidence (students measure and weigh vegetables, add or sum the amount of their food, etc.). All of these aspects can make knowledge more meaningful if integrated into the learning process (STEM Task Force, 2014; Feldon et al., 2016; Magnuson et al., 2016).

2. METHOD

This research is the qualitative research based on best practice teacher learning strategies in the classroom which is carried out according to the flow of classroom action research (Komara, Putra, & Hermita, 2020; Lestari, Hermita, & Kurniaman, 2019). Therefore, in accordance with classroom action research, the research problems that must be solved come from learning practice problems in the classroom conducted in a professional manner. The procedure for conducting this research

follows the basic principles of general action research. The subjects in this study were 29 students of class II SDN 09 Manggis Ganting, Mandiangin Koto Selayan District, Bukittinggi City.

There were 8 male students and 21 female students in the study. The researcher's consideration in taking the research subject is based on the researcher's observation of learning in class II which still uses conventional methods. The students come from various backgrounds of social conditions, and their critical thinking skills are still low.

The research was conducted in the second semester of the 2018/2019 academic year. Starting from the planning time to writing the research report it took 2 months, namely January to February 2019. The first cycle of the first meeting was held on Tuesday, January 14 2018, the second cycle of the second meeting was held on Tuesday, January 21, 2019. While the second cycle of the meeting was held on Wednesday, 22 February 2019 and the second cycle of the second meeting was held on Thursday, 23 February 2019.

The research procedure was carried out following classroom action research procedures, namely: planning, implementing, observing, and reflecting. Before research began, a research schedule had to be determined. Previously, researchers asked the principal's approval. After getting the time for the research, the next step is to study the 2013 Curriculum. In the curriculum there are Core Competencies

which are the general objectives of learning that students must achieve. Basic Competencies are the translation of Core Competencies. The next step is to make a learning implementation plan.

In addition, researchers also make worksheets that will be given to students. The implementation of this activity is carried out by researchers as practitioners and class II teachers as observers. Practitioners carry out learning activities in the classroom in the form of interaction activities between teachers and students, and students and students. Observation activities are carried out by peers as observers to observe student activities during the teaching and learning process, these student activities are recorded on the observation sheet by the observer. In reflection activities, researchers and teachers observe the observation sheets that have been made and conduct discussions about the advantages and disadvantages that exist in the learning that has been carried out.

If there are deficiencies, improvements are made to learning activities. The results of this joint reflection are used as input for further actions. In addition, the results of each action's reflection are used to formulate conclusions on the results of actions I and II.

The indicators of the success of this study are indicated by the following points, namely: (1) there is an increase in learning outcomes; measured by test (2) there is an increase in teacher performance in the learning process by

implementing learning; based on observation, (3) there is an increase in students' critical thinking skills; measured by the percentage technique based on the observation sheet. To process data on student learning outcomes, percentage techniques will be used and count on a scale of 1 - 100.

3. RESULTS AND DISCUSSION

In STEM-based learning which is carried out for this research, the first cycle begins by explaining the benefits of food and drinks eaten for human life. The teacher begins the lesson by demonstrating various kinds of fruits and vegetables and by conducting questions and answers with students about the benefits of these fruits and vegetables for human life. Students are stimulated to mention the benefits of the fruits and vegetables they eat every day. Students are also asked to identify the vitamins and minerals contained in these foods. Students are divided into groups and given student activity sheets that help students identify fruits and vegetables and their benefits.

Student activities in the first cycle were still in the form of an explanation of fruits and students were asked to group various kinds of fruits and vegetables, then asked to explain their reasoning or their basis for grouping these fruits and vegetables into the same group. Students grouped them based on their content in general, for example rice, potatoes, sago, and sweet potatoes were grouped as staple foods. Tomatoes, oranges, lemons, mangosteen, and

rambutan are classified as fruits. Eggplant, chickpeas, and string beans are classified as vegetables.

The first cycle activity was carried out with a pattern of two meetings. At the second meeting, the teacher asked students to write down their experiences when they went to the market, buying fruit and vegetables that they had done with their parents. The writing sample that students write must be written with due regard to the correct use of punctuation and capital letters. Students are also asked to count the sum of their purchases and are given several prices for fruits and vegetables. Students are asked to explain what vegetables and fruit they would buy if they had a certain amount of money. For example, for twenty thousand rupiahs, what vegetables can you buy? Or for the same amount of money, what fruit can you get? How heavy?

Students are asked to design a fruit and vegetable composition that they will eat every day of the week and present a list of their fruit choices to the class. Then, students are asked to explain the reasons why they chose these fruits and vegetables. When the teacher scaffolds students with questions that require them to explore by relating their experiences to the lessons they get in school, students are also trained in their critical thinking skills when it comes to solving the given problem. This is in line with Taylor's opinion that students should be stimulated by questions that link the schemata they already have with the new knowledge they are learning

(Taylor & Hochuli, 2017; Allen, Webb & Matthews, 2016).

The results of the Cycle I study based on the improvement of student learning

outcomes and the increase in critical thinking skills observed by the observer can be explained in the following table.

Table 1. The Average Value of Each Type of Student Learning Activities on 1st Cycle

No	Type of Activity	Meeting		
		1 st	2 nd	Improvement
1	Learning Outcomes	72	78	6%
2	Critical Thinking	50	62	12%

In general, grade II students seem happy in learning with the STEM approach. So far, students have not been stimulated by activities that involve multidisciplinary (science, mathematics, language, and engineering) in one lesson. During the activity classifying fruits and vegetables, students looked enthusiastic and scrambled to come to the front of the class to express their opinions. The atmosphere in the class, which was usually quiet, became bustling and boisterous with student voices. Even the students who are usually quiet also raised their hands to come to the front of the class. Student activities during the first cycle took a lot of time when students worked in groups.

The teacher does provide more opportunities for students to discuss in their groups. This is in accordance with Daly's opinion which states that when students are fully involved with directed tasks from the teacher, students will not realize that they are being involved in interdisciplinary learning and they get two or three knowledges at once (Daly et al., 2016; English, 2017; Aldemir & Kermani,

2017). Learning with the STEM approach is proven to improve students' critical thinking skills because they are able to critique and be actively involved in learning (Mustafa et al., 2016; Shahali et al., 2017). When viewed from the learning outcomes, the average student learning outcomes have indeed increased; However, there are still lesson outcomes that have not been achieved and there are still steps in the STEM approach that must be taken by the teacher according to the plan, therefore learning continues to cycle II.

In the second cycle, the activity was continued by investigating potatoes. The teacher deliberately chose potatoes for investigation because around the school environment, parents planted lots of potato plants, and students could easily pick potatoes in their yard. Students brought potatoes of various sizes and conditions for the activity. Some were fresh and some were almost rotten. However, the teacher made the variety of potatoes that students brought as observation material for students to compare sizes.

The activity begins with a general explanation of the activity steps that will be carried out by the students during learning. Then the teacher divided the students into groups. Each group consisted of 5 to 6 people. Each group was given an activity sheet that must be completed with the potatoes they have brought. With this worksheet, students work in groups to identify their potatoes. The following is a series of activities carried out by students during the *Potatoes in My Head* lesson.

The activity begins with measuring the dimensions of the potatoes with measuring instruments (ruler, calipers, and scales). Students measure the length of a potato, using a caliper to measure its diameter, and using a scale to measure its weight. The teacher supervises students in terms of accuracy while using measuring instruments, and reading measuring instruments, and writing down the results on the worksheets.

During the lesson, it was seen that the students were enthusiastic about doing their assignments. The activity begins with determining the size of potatoes into large and small categories. Students select one of the categories and circle the appropriate category for their potato. Then they measure the length of the potato using a ruler and write it down in centimeters (cm). Then the students were asked to weigh their respective potatoes and then assign their potatoes a group. The results are written on the observation sheet that has been distributed by the teacher. In these activities, the concepts of science and mathematics learning were

emphasized more in the activity, but students did not feel the separation between learning materials.

The use of technology such as Ammeters and scales is also seen as a trigger for the emergence of students' critical thinking skills. Then they modified the amount of salt they put in the water so that their potatoes can float, which is a simple engineering technique that can be done by second graders of elementary school.

This is consistent with Chiu's opinion about STEM, stating that the basis of STEM education involves the integration of these subjects by breaking down discipline-independent teaching "silos" that students often encounter throughout the day, and making connections to real-world contexts (Chiu et al., 2015; Allen, Webb & Matthews, 2016).

The next student activity is to describe the shape of their potato. In this activity the teacher expects students to be able to describe the potatoes according to their actual potatoes. The pictures of potatoes made by the students were colored and creatively created so that they resembled the potatoes they had. The students were seen trying to imitate their potatoes as closely as possible. This activity was also carried out by students with enthusiasm. From the results of the teacher's observations and discussions with the observers, the students seemed to be giving their best efforts so that the pictures they made were as similar as possible to the original potatoes.

The next student activity is to write down the uses of the potatoes and write

down their potato flavors. Students' answers varied, some made it sweet, sour, bitter, salty, and others. Then the students also wrote down other benefits of potatoes as a source of electricity that they had never known before, even though they had learned about the benefits of potatoes in general in cycle I, successfully done, what obstacles were felt, and how they felt).

Based on the analysis of student work sheets, it can be analyzed that the students' ability to take *Potatoes in My Head* learning experience has stimulated

them to think critically and involves science, mathematics, engineering, technology, cultural arts, and Indonesian, as well as learning. Students get not only one knowledge at a time, but multiple knowledges at once. Students' ability in critical thinking increases according to the observations of teachers and observers. Student learning outcomes during learning also increase and the percentage of students' critical thinking skills has increased. Student learning outcomes can be seen in the table 2 below.

Table 2. The Average Value of Each Type of Student Learning Activities on 2nd Cycle

No	Type of Activity	Meeting		
		1 st	2 nd	Improvement
1	Learning Outcomes	76	88	12%
2	Critical Thinking	70	78	8%

Table 2 shows the increase in student learning outcomes from cycle I. An increase in students' critical thinking skills also occurred by 8%. Learning with the STEM approach is proven to be able to trigger the achievement of several learning objectives at one time. This is in accordance with Mangunson's opinion which states that although school achievement is a cumulative process that combines the mastery of academic skills and behavior, most of the results of research by experts on the application of the STEM approach show a view of the association between students' self-development capacity during learning and school outcomes (Magnuson et al., 2016). Based on the research results obtained, it can be concluded that the STEM approach

is proven to improve student learning outcomes as well as improve students' critical thinking skills in schools. The knowledge that students get at school can be applied in their environment and their daily lives.

4. CONCLUSION

Based on the results of the research and discussion above, it can be concluded from this activity that the STEM approach is proven to improve learning outcomes and critical thinking of students in class II SDN 09 Manggis Ganting, Bukittinggi City.

The STEM approach allows students to study several subjects at a time and gain diverse knowledge without students realizing that they are studying several

subjects because there is no separation between the subjects being studied.

For this research, it can be generally suggested to teachers that they should be able to use the STEM approach for subject matter that can be combined to be studied in one lesson. An analysis of the subject matter is required before starting the lesson. The author cautions that they have not taken into account other processes in the school that can increase or decrease the predictive power of the skills and behavioral actions that the author takes.

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