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THE IMPACT OF ENGINEERING DESIGN PROCESS IN TEACHING AND LEARNING TO ENHANCE STUDENTS' SCIENCE PROBLEM-SOLVING SKILLS

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ABSTRACT

This study aimed to determine the impact of the integration of engineering design process (asking, imagining, planning, creating and improving) in an electrical & magnetism module to improve problem-solving skills in physics among secondary school students in Aceh, Indonesia. The quasi-experimental study was carried out with 82 form three (age 15 years old) students of a secondary school in Aceh Besar, Indonesia. The first author had randomly chosen two classes as the experimental group and two other classes as the control group. Independent samples t-test analysis was conducted to determine the difference between the physics teaching and learning module which integrated the five steps of engineering design process and the existing commonly used science "Pudak" teaching and learning module. The results of the independent samples t-test analysis showed that the use of the physics teaching and learning module which integrated the five steps of engineering design process was more effective compared to the use of the existing "Pudak" module in increasing the students' skills in solving physics problems. The findings of the study suggest that the science learning approach is appropriate to be applied in the teaching and learning of science to enhance science problem-solving skills among secondary school students. In addition, it can be used as a guide for teachers on how to implement the integration of the five steps of engineering design process in science teaching and learning practices.

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Keywords: Physics teaching and learning module, engineering design, science problem solving, magnetic field

INTRODUCTION

Science is an organized knowledge that is verifiable based on observations and experiments. It involves analyzing a phenomenon systematically and objectively for creating new knowledge that can be trusted (Johari et al., 2007; Maloney et al., 2001; Nikkhah, 2011). Science can also be interpreted as a way of thinking in solving a problem (Zurida et al., 2006). It involves the observation of an occurred phenomenon, predicting in a controlled manner what might happen, trying to construct meaning from observation, and sharing knowledge with others. Problem-solving skills in science teaching and learning is an objective of science learning that is expected to be acquired by students so that they can apply scientific knowledge to the real world meaningfully (Kirkley, 2003; Lim, 2000).

In the Indonesian curriculum, science education is used as a comprehensive effort to uplift the lives of the people by improving their quality of life to create a society that has knowledge and problem-solving skills so that they can develop themselves as useful citizens (Evi, 2010; Widowati et al., 2017). Similarly, in various studies on scientific creativity, problem-solving skills were

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also used as an aspect of scientific creativity of students in science teaching and learning (Hu & Adey, 2002). Scientific creativity in teaching and learning of science is a skill to understand science concepts and to use them to solve problems in creative ways (Hu & Adey, 2002; Laius & Rannikmae, 2011).

Students are generally aware that science is a difficult subject when they are asked to solve problems. Although many students say that they understand the science concepts, they face difficulties when asked to solve problems in science (Lim, 2000). Problem-solving involves various metacognitive strategies to enable students to understand how they think and explore the various methods to solve problems in science (Halim et al., 2016; Lee 2007; Seth et al., 2007). For students to solve various problems in science effectively, appropriate teaching approaches are needed. Teachers should not only implement teaching that is limited to remembering formulas and skills to carry out mathematical operations. The teachers should teach the science concepts by emphasising the right steps and familiarising the students by checking their work and understanding of the concept through a constructivist and contextual approach to enable students to learn and solve science problems (Heson, 2004; Seth et al., 2007).

In the implementation of science teaching and learning, teachers still emphasise memorisation of facts rather than focusing on scientific methods or scientific inquiry (Sopiah et al. 2009). Teachers need to use teaching methods which are aided by media and laboratory activities (Husin et al., 2015; Sulistyanto & Rusilawati, 2009). Some teachers were found to perform practical work when teaching science; however, it is not based on a constructivist and contextual approach in which the emphasis is to improve students' metacognition to facilitate their skills in problem-solving which may not be well developed yet (Seth et al., 2007).

Contextual and constructivist teaching such as practical work and hands-on activities can enhance students' problem-solving skills. Accordingly, this can be implemented through the application of engineering design process in science teaching and learning (Cantrell et al. 2006; Henson, 2004; Schnittka, 2009). Teaching and learning of science based on engineering design process is an approach that can better train the process of thinking. By following learning activities based on engineering design, students will learn how to analyse the situation and gather the relevant information, define the problems, evaluate and generate ideas creatively, develop ideas to solve problems effectively, as well as assess and make improvements to the solution. This is in line with the function and purpose of learning science itself, which is to develop scientific attitude through practical and scientific activities among students (Istikomah et al., 2016; Widowati et al., 2017).

Engineering design process has been reported by many studies to increase achievements in science teaching and learning, such as mastery of science concepts (Apedoe et al., 2008; Mehalik et al., 2008; Riskowski et al., 2009; Schnittka, 2009), interest and attitude towards science (Apedoe et al., 2008; Mehalik et al., 2008; Rogers & Portsmore, 2004), and to improve technical skills among students (Schnittka, 2009; Syukri et al., 2017). However, the skills of scientific problem-solving have not yet been reported in many studies. Thus, to demonstrate empirically how engineering design process can improve science problem-solving skills compared to existing teaching approaches, the researchers have integrated the steps of engineering design process into a science teaching and learning module. The impact of integrating the engineering design process in the module on students' science problem-solving skills was then compared to the existing "Pudak" science teaching and learning module.

Engineering design process as an approach to science teaching and learning in this study is a part of problem-based learning (Schnittka, 2009). Problem-based learning is an active learning strategy that is based on the theory of constructivism (Piaget, 1957; Vygotsky, 1978). The theory of constructivism and the engineering design process have the same goal, namely encouraging students to think and generate ideas or create innovative products based on existing knowledge and reasoning about everyday problems (Cunningham, 2007; Schittka, 2009). In this study, the theory of constructivism was used as the basis of integration of the five-steps engineering design process in the teaching and learning process in the classroom.

Problem-based learning and engineering design-based learning both begin with a science problem (Fortus et al., 2005; Schittka, 2009). The engineering design process approach is a problem-solving activity through the development of an idea or product that requires creative thinking in a systematic way, and assessment with the objective of arriving at the product itself (Eide et al., 2012; Haik, 2003; Hyman, 1998). Based on ABET (Accreditation Board for Engineering and Technology), engineering design processes activities can be divided into nine activities, namely: (1) recognising the need; (2) defining the problem; (3) planning the project; (4) gathering information; (5) conceptualising alternative approaches; (6) evaluating the alternatives; (7) selecting the best alternatives; (8) communicating the design; and (9) implementing the preferred approach (Hyman, 1998). However, these nine activities in the ABET model can change according to the purpose and context to be studied. Usually, the researchers will focus on some activities only in line with the goals and objectives of the study (Haik, 2003; Hyman, 1998). Various studies involving integration of engineering design process in teaching and learning activities have taken the nine steps of activities in the ABET model and modified it to become a five-step learning activity, involving asking, imagining, planning, creating, and improving (Cunningham, 2007; Mehalik et al., 2008; MoS, 2012; Schittka, 2009; Wendell, 2011).

In line with the theoretical basis of this study, Becker and Park (2011) through a meta-analysis study involving various engineering design process studies conducted in teaching and learning found that generally, the integration leads to the implementation of teaching and learning characterised by constructivism. To implement the learning in each step of the engineering design process, students would still need guidance from the teacher on how they can carry out each step of the engineering design process effectively. Following the philosophy that learning is an active process, students construct their own meaning from the experience provided by the teacher. To ensure that students can build their own understanding through the five steps of engineering design process, teachers were asked to carry out the teaching process in phases according to the theory of constructivism by Needham, namely: orientation phase, phase of inducing ideas, phase of restructuring ideas, phase of ideas usage, and reflection phase (Needham, 1987).

Needham (1987) describes that in constructivist learning, teachers have different objectives that are to be achieved for each phase. The orientation phase aims to stimulate interest and provide a meaningful context for learning. The inducing idea phase is aimed at enlightening students about their initial ideas on the studied phenomenon. The phase of restructuring ideas aims to make students aware of the views of the phenomenon that they are studying, and students can extend, modify or replace their initial views. The phase of idea usage aims to use new situations to reinforce the ideas that students have built. The phase of reflection aims to make students aware of changes in their initial ideas. The fifth phase is subsequently used as a guideline or approach in assisting teaching and ensuring that students apply each step of the learning activities according to the five-step engineering design process (ask, imagine, plan, create, & improve).

Teachers play different roles throughout the five phases of Needham's constructivism, and teachers need to provide help to ensure that students would be able to carry out the five steps of the engineering design process. In the asking step, teachers conduct the orientation phase, inducing the idea, and restructuring the idea. Teachers show students an everyday science phenomenon and direct them to make a connection with the science concepts that are being studied. The connection between new problems with students' existing knowledge will improve students' ability to synthesise the problem (Mehalik et al. 2008). In the imaging step, teachers go through the phase of restructuring the idea and provide active learning activities such as hands-on activities. Through existing and new knowledge of science concepts, students are directed to carry out some hands-on activities related to the previous asking step of the scientific phenomenon problem-solving. In order to solve the problem, students would certainly need skills based on knowledge and understanding of science concepts. In the planning step, teachers go through the phase of idea usage and direct students to the idea of designing a solution in the form of a graph that students imagined in the previous activity. In order to plan a solution according to the scientific concept, the student's knowledge and understanding of the science concept and problem must be strong. The plan produced in this activity can be applied in the form of a real science technical product design in the next creating step activity. In designing the product in the creating step, teachers also implement the idea usage phase which directs students to apply the science technical product design to the exact form of the plan they have designed. If the planned step was previously made only in the form of a graph or a diagram, then in the designing step activities, students run the application in the form of technical products to solve problems in science which are based on the science concept. In the improving step, teachers implement the reflection phase which directs students to assess the strengths and the weaknesses of the science technical products that have been produced. Although the evaluation is based on the various aspects of the activities such as form, function, and use, the main focus is on the assessment of the product's technical aspect and compliance with the scientific concept of the study. After the technical products' weaknesses have all been identified, students are required to make improvements to the weaknesses. Every student activity in each step of the engineering design process is expected to result in problem-solving skills among students (Cantrell et al., 2006; Haik, 2003).

The order of the steps in the application of the five steps approach of engineering design process is not rigid. The processes of the engineering design activities are cyclical; it can begin at any step and move forward or backward. However, to enable students to apply the five steps, such activities are carried out in sequence starting from the asking step; this is so that However, to enable students to apply the five steps, such activities are carried out in sequence starting from the ask step. This would enable the students to easily understand the steps and follow the steps according to the engineering design process model (Cunningham, 2007; MoS, 2012). From the descriptions of each step of the above activities and the findings of various studies, the integrated engineering design approach could be implemented in the teaching and learning of science. It can be concluded that the selection of engineering design process as an approach to the science teaching and learning module is appropriate.

In line with the purpose of the study, students are expected to acquire the science skills after they have implemented the five steps of the engineering design process. The science problem skills in this study are the dependent variable used to determine the impact of the science teaching and learning module that was built based on the five steps of engineering design process and was taught using Needham's five phases of constructivism. Science problem-solving skills refer to the ability of students to solve problems based on science concepts that are learned. In general, problem-solving is a thinking skill that combines critical and creative thinking skills to get the information and ideas to solve science problems using a creative and scientific method Therefore, this study, through a quasi-experimental method, was aimed at determining whether there are any significant differences in students' science problem-solving skills among students who used the treatment module and those who used the existing "Pudak" module.

METHODS

The effectiveness of the teaching and learning module of this study in relation to the existing teaching and learning module on students' science problem-solving skills was compared through a quasi-experimental design. The study was carried out in one junior high school in Aceh Besar. The school was selected from 47 schools which conduct science activities through purposive sampling method. In this selected school, two classes were randomly selected (simple random sampling) as the experimental group and two other classes as the control group. The experimental group practiced the electric & magnet module which was on electricity and magnetism, while the control group used the existing science teaching and learning module that are commonly utilised in Aceh on the same two topics.

The science teaching and learning module used in this study integrated the five steps of engineering design process. The five steps of engineering design process are the modified version of the nine steps of engineering design activities (Hyman 1998) that have been adopted in various studies in science education (Cunningham, 2007; Mehalik et al., 2008; MoS, 2012; Schittka, 2009; Wendell, 2011). The five steps of the engineering design activities are asking, imagining, planning, creating, and improving.

Before the students embarked on the first step which is asking, they were given a scenario about a student who wanted to make a science technical product that could generate electricity from a fan. In the process of designing the product, the student in the scenario needed help to make the science technical product that could produce electrical energy based on the concepts of electricity and magnetism. Briefly, in each step of the engineering design, the students in the experimental group had to carry out the learning activities as follows: (1) in the ask step, the students explored the problem and figured out how to create a product that does not use electricity or "free electricity energy" based on the knowledge of science concepts they had learned; (2) in the imagining step, the students had to think and imagine the science technical product to solve the science problem of "free electricity energy". Three hands-on activities on the science concepts were prepared for the students to assist them in thinking and imagining the possible solutions in creating the science technical product; (3) in the planning step, the students designed possible solutions in the form of diagrammatic solutions which they had imagined in the previous activity; (4) in the creating step, the students developed the science technical products to the exact form of the plan which they had created for solving the science problem of "free electrical energy"; and (5) in the improving step, the students made improvements to the science technical products which they had developed based on the weaknesses and shortcomings that were identified by the teachers and students in the other groups. Finally, after going through the steps, the students would be able to produce a science technical product that could change the rotation of the fan into electrical energy based on the scientific concepts of electrical & magnetic fields. Each step in the engineering design process which was integrated with the electric and magnetism module was validated by three experts; an expert in physics concepts, an expert in teaching and learning module development, and an expert in engineering design process. Changes were made accordingly based on the recommendations made by the experts.

The existing science teaching and learning module that is commonly used in Aceh is "Pudak". This module is a module of science teaching and learning that combines the information in the science textbooks with laboratory activities. The "Pudak" module is used in the process of teaching and learning either simultaneously or after students have been taught the theories and concepts from the science textbooks. The "Pudak" module derived its name from the name of the publisher or company that published the lab activity module. Generally, the "Pudak" module begins with the teaching of the science concept from the science textbook. After that, the students are directed to carry out the laboratory activities by following the steps provided in the module. Generally, the activities in the module are divided into three activities, namely, the explanation of the purpose and objectives, description of equipment/ materials, instruction on the steps of designing, and conclusions about the observations of the results.

The procedure of this quasi-experimental study i.e. to compare the teaching and learning of the science module was divided into four phases, namely: Phase 1: making a preliminary study and making plans for the construction of the module and the instrument; Phase 2: building the research module and instruments; Phase 3: determining the validity of the research module, conducting the pilot study, and improving the module and the instrument; Phase 4: conducting information dissemination and training sessions for the teachers to implement the module and carry out the actual study; Phase 5: carrying out the evaluation of the effectiveness of the module used by the quasi-experimental group and the control group.

To determine the effectiveness of both module in improving problem-solving skills in science, the first author used ten science problems in the form of objective questions related to the topic of electricity and magnetism. Each question tested the students' understanding and skills about the concepts of electricity and magnetism and application of these concepts to solve science problems in students' everyday lives. The ten science questions were formulated by adapting the problems of electrical & magnetic fields from various science textbooks into science problems in the students' everyday lives. One of the given science problems is as follows:

"During physics learning in school, Fatin and Fatan had been taught about the concept of electromagnetic induction. The teacher taught that the changes of magnetic force lines will be able to produce electric current. To prove the concept, Fatin and Fatan connected two magnets, electrical wires and a galvanometer, as shown in Figure 1".

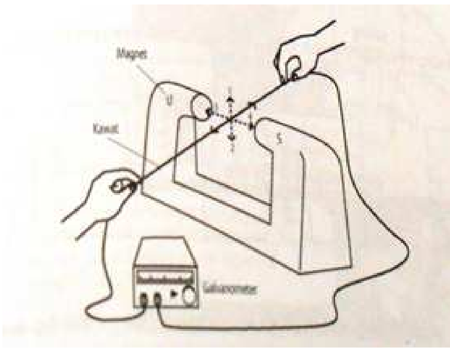

Figure 1. Connection of Two Magnets, Electrical Wires and a Galvanometer

However, Fatin and Fatan were still worried that their hand movements would induce an emf (electric current). According to your knowledge, the direction of the right hand to produce induction (electric current) is…"

To determine the validity and reliability of the instrument, the first author gave the instrument to two experts and also carried out a pilot study with 38 students. The results of the pilot study analysis by using the Kuder-Richardson 20 (K-R 20) formula showed that the reliability (r) was 0.73. The value of r showed that the science questions were acceptable and reliable (Ridwan, 2010).

The inferential statistical analysis of independent samples t-test was conducted before and after treatment to determine the effectiveness of the teaching and learning module on the science problem skills of the students in the experimental group and the control group. An independent samples t-test before treatment was conducted to determine whether the level of skills among the students in the quasi-experimental group and the control group were equivalent. An independent samples t-test was conducted after the treatment to determine the level of science problem-solving skills between the groups of students using the study's teaching and learning module and students who used the existing module. The before and after treatment independent samples t-test was also used to test the two null hypotheses (H0) in this study: $H_0$1: There are no significant differences in science problem skill level between the quasi-experimental group and the control group in the pre-test; and $H_0$2: There are no significant differences in science problem-solving skills level between the quasi-experimental group and the control group in the post-test.

RESULTS AND DISCUSSION

A total of 82 students were involved in this study, of which 40 were in the experimental group and the other 42 in the control group. The profiles of students involved in the quasi-experimental group and the control group are shown in table 1.

Table 1. Student Profiles Based on Groups

Background	Experimental group	Control group
No. of students	40 students Class IXB : 22 Class IXD: 18	42 students Class IXA : 20 Class IXC : 22
Gender	24 males Class IXB : 12 Class IXD : 12 16 females Class IXB : 10 Class IXD : 6	22 males Class IXA : 10 Class IXC : 12 20 females Class IXA : 10 Class IXC : 10
Form	Three	Three
Teaching and learning	Using science teaching and learning module based on engineering design.	Using the commonly used "Pudak" module.

To identify the level of science problem solving skills in both groups of students and also to meet the assumption that students of both groups were equivalent, all students were asked to solve ten multiple-choice context-based science questions. The results of the descriptive analysis of the mean score, the students' responses, and the level of science problem solving skills of both groups are shown in table 2.

Table 2. Mean Score, Standard Deviation, and the Level of Science Problem Solving Skills for both Groups before the Treatment

Variable	Experimental group N = 40			Control group N = 42		
	M	S.D	Level	M	S.D	level
Science problem solving skills	3.00	1.41	26(62%) Low 14(35%)Medium	3.02	1.55	27(64%) Low 15(35.7%)Medium

Analysis of the independent samples t-test to identify the differences in the mean score of students' answers and level of science problem solving skills before the treatment for both groups are shown in table 3.

Table 3. Results of the Independent Samples T-test Analysis of Students' Science Problem Solving Skills' Pre-test Score for the Experimental Group and the Control Group

Variable	Group	No.	Mean	S.D	t-value	df	Sig.
Science problem solving skills	Experimental	40	3.00	1.41	- 0.072	80	0.942
	Control	42	3.02	1.55			

* Significance level p = 0.05

Based on table 3, the results of the independent samples t-test analysis showed that there was no significant difference in the mean score of science problem solving skills before the treatment was conducted among the students in the experimental group (mean = 3.00) and the students in the control group (mean = 3.02) with t (80) = - 0072, p = 0.942 (p > 0.05). These findings demonstrate that before the treatment was conducted, both groups of students had equivalent level of scientific problem solving skills.

After both groups were taught using the two module for twelve weeks, they were asked to answer the same problem solving questions again. The mean score of students' responses and level of science problem solving skills for the experimental group and the control group after treatment are shown in table 4.

Table 4. The Mean Scores, Standard Deviations, and Level of Science Problem Solving Skills for both Groups after Treatment

Variable	Experimental group N = 40			Control group N = 42		
	M	S.D	Level	M	S.D	level
Science problem solving skills	5.53	1.81	5(12.5%) Low 32(80%) Medium 3(7.3%) Excellent	4.23	1.80	18 (42.9%) Low 23 (54.8%) Medium 1 (2.4%) Excellent

Analysis of the independent samples t-test to identify differences in the mean score of students' answers and level of science problem solving skills after treatment in both groups are shown in table 5.

Table 5. Results of the Independent Samples T-test Analysis of Students' Science Problem Solving Skills' Post-test Score for the Experimental Group and the Control Group

Variable	Group	No.	M	S.D	t-value	df	Sig.
Science problem solving skills	Experiment	40	5.35	1.81	2.777	80	*0.007
	Control	42	4.23	1.80			

* Significance level p = 0.05

The results of the independent samples t-test analysis after treatment (Table 5) showed that there was a significant difference in the mean score of science problem solving skills between the students in the experimental group (mean = 5.35) and the students in the control group (mean = 4.23) with t (80) = 2,777, p = 0.007 (p< 0.05). The mean score of students in the experimental group was higher compared to the students in the control group. This shows that the science problem solving skills of the students in the experimental group which used the teaching and learning module that integrated the five steps of engineering design during science instruction was higher compared to that of the control group which used the "Pudak" module. In other words, it can be concluded that the integration of the five steps of engineering design process in the teaching and learning of science has managed to improve the science problem solving skills of the students.

Integrating the five steps of engineering design process (asking, imagining, planning, creating, and improving) in the science teaching and learning module on the topic of electrical & magnetic fields appears to have increased the students' proficiency in science problem solving skills. The positive increase in the students' problem solving skills is the result/outcome of the integration of the five steps of engineering design process, namely asking, imagining, planning, creating, and improving which were prepared systematically in this electrical & magnetic module.

The asking step that presents the contextual narrative or story of problems in science, in this case "free electricity", gives an overview of the educational activities to the students in terms of the goals and objectives of the learning itself (Hyman, 1998; Rockland et al., 2010). The science problem on "free electricity" was given to the students in the form of a science story describing the happenings of students' real life everyday experiences to enable them to understand the scientific issues well and deeply. Through good understanding of the problems, students will understand the science concepts more easily such that they will be able to explain and resolve the problems (Apedoe et al., 2008; Fortus et al., 2005; Syukri et al., 2012). Thus, it is not surprising if the "free electricity" science problem and the concept of electrical & magnetic fields which was developed in the asking step of the activity managed to improve the students' skills and knowledge of science

Next, the imagining step in this science teaching and learning module also contributed to students' problem solving skills in science. In this step, the students were given instructions by the teachers to implement the application of concepts of electricity and magnetism through three hands-on activities. According to Rockland et al. (2010), the use of practical approaches such as the application of science concepts through hands-on activities in the engineering design process will help students to find relationships between concepts they learn with technology and problems in their daily lives. The ability of students to find relationships between scientific concepts and real life will allow them to apply science concepts to solve problems in their everyday lives (Apedoe et al., 2008; Syukri et al., 2012).

After carrying out the three hands-on activities in the imagining step, the students were then asked in the planning and creating steps to apply the concepts of electricity and magnetism to come up with a science technical product to solve the problem of "free electricity energy" as described in the asking step. Through understanding of the concept of electrical & magnetic fields that they have learned, students in these two steps are required to solve the problem of science "free electricity" in the form of a science technical product. The ability to apply the understanding of science concepts in everyday life such as planning and designing a science technical product to solve a problem may help improve the students' skills in understanding and solving science problems (Apedoe et al., 2008; Fortus et al., 2005).

The effectiveness of the five steps of engineering design process in the science teaching and learning module on students' skills development in solving science problems depended on the sequence of steps of learning planned by the first author. It began with a context-based science problem and ended with the technical product to solve the problem, and these steps encouraged the students to show their ability to solve problems. This finding is consistent with the views of the science teachers who implemented the science teaching and learning by using the scientific creativity module developed for this study, as exemplified by the statement made by one of the teachers: *"Even before I actually performed an active learning activity involving engineering design, I did not manage the learning flow step by step like in this module. I rarely did the ask step, but this is important to stimulate students to think on how to solve the given problem so that they can create a product to solve the problem".*

The asking and designing steps are two activities which provided more stimuli to students' problem solving skills. In the asking step, the students learned about the science concept and connected it to the "free electricity energy" context-based science problem. Through the three hands-on activities in the imagining step the students attempted to think of how the implementation of the application of the science concepts can be used in a science technical product to solve the problem of "free electricity". This finding corresponds with one of the statements made by a student: *"The ask step in this module was good because we were given a good scientific problem in* *a real-life situation so it made it easy for us to imagine. In addition, the concepts of electricity and magnetism that taught us to solve problems in science through such concepts. The imagining step in this module included hands-on activities that are helpful in imagining about what we should do to solve the science problem of "free electricity energy".*

The honest and positive views of the teachers and students on the five steps engineering design process also reinforced the effectiveness of engineering design process in teaching science. The numerous positive effects of the integration of the engineering design process in the teaching and learning of science can lead to better and increased science problem solving skills among students. Thus, it should be integrated in the science curriculum to improve students' achievements and skills, especially in science problem solving skills.

CONCLUSION

The well-planned and systematic development of the module which was based on an appropriate teaching model gave very positive impact on various achievements and skills among the students. This study integrated the five steps of engineering design process as an approach in students' learning of science to improve students' science problem solving skills. Using independent samples t-test analysis, the results showed that there were significant differences between the science problem solving skills of the students in the experimental group compared to those in the control group. It was found that the mean scores of science problem solving skills in the experimental group that used the science teaching and learning module based on the five steps of engineering design process were higher than the mean score of the control group that used the existing "Pudak" module. The findings of this study led to the conclusion that the five steps of engineering design process implemented in the science teaching and learning module which included the steps of asking, imagining, planning, creating, and improving could improve students' science problem solving skills as reported by various previous studies.

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