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Implementation of Engineering Everywhere in Physics LKPD Based on STEM Approach to Improve Science Process Skills

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Abstract. High school students (MAN 3) Banda Aceh are experiencing problems related to science process skills, so they need to be improved. Efforts to improve KPS can be pursued through "Implementation of Engineering Everywhere in Physics worksheets based on the STEM approach with the aim of knowing the improvement of students' science process skills using Engineering Everywhere on physics worksheets based on the STEM approach. The Pre-Experimental Design One Group Pretest-Postest research, research subjects for class XI MIA 2 students as many as 27 people. The instruments used consisted of test instruments (scientific process skills test questions), and non-tests (RPP, LKS, teacher observation sheets, and student response questionnaires). Data analysis techniques quantitatively and qualitatively as well as the calculation of the N-Gain Score. The results of qualitative data analysis obtained validity, practicality of the instruments used and quantitative data analysis obtained the effectiveness of the science process skills instrument with an N-gain result of 0.69, and was supported by the results of the student response questionnaire which scored 940 in the effective category. **Keywords** : Engineering Everywhere, job sheet and Science Process Skills

Introduction

The industrial revolution 4.0 is a 21st-century industrial development, these developments result in changes in the world of education so that the learning process in this era must-have skills that are in accordance with the times. The implementation of the industrial revolution 4.0 in education is expected to meet the needs of a more effective and efficient teaching and learning process, the goal is to create the next generation of a nation that is superior and able to compete globally. (Rahmawati & Hardini, 2020). The 2013 curriculum emphasizes that knowledge is no longer the main goal. According to Ausubel, meaningful learning emphasizes the importance of students associating new experiences, phenomena, and facts with concepts that students already have (Habig & Gupta, 2021). The development of science process skills in learning physics needs to be done. The reason is that it is easier for students to understand complex and abstract concepts when

accompanied by practice/practicum, so students are expected to learn actively in developing skills (Kelley, et al., 2020).

Based on the results of observations and interviews with the physics teacher for class XI, it is known that the physics learning activities carried out have not been able to develop science process skills because in the learning process there are several problems faced by the teacher, which is 1). The learning process that takes place is teacher-centered; 2) The worksheets used have not been able to improve science process skills; 3) the practicum activities carried out are not effective. This shows that only 40% of students are able to achieve the minimum completeness Criteria and 60% of students have not achieved the minimum mastery criteria of 80. To overcome these problems, the use of science process skills worksheets can be applied.

According that students' science process skills can improve learning achievement because a quality learning process is able to support student learning achievement because it can improve science process skills and motivate students in carrying out learning. One of the worksheets that are interesting to (Kurniawati, et al., 2016). Innovative, and improve students' science process skills is a STEM-based worksheet, according to (Wahono, et al., 2020). The worksheet is effective because the observation of science process skills is included in the good category and is suitable for improving process skills. science, as well as student responses and, can be used in the learning process (Fithri, et al., 2021). STEM can also integrate four elements in learning, namely science, technology, engineering, and mathematics (Wang, et al., 2021). The relationship between science and technology cannot be separated, science requires mathematics as a tool in processing data, while technology and engineering are applications of science (Simarro & Couso 2021). Similarly, examples of using the STEM approach to project-based learning (Indriyana & Susilowati. 2020), Problem-Based Learning (Indriyana & Susilowati 2020), and Inquiry (Lia. 2018).

The problems that have been described underlie researchers to conduct research through Engineering Everywhere on physics worksheets based on the STEM approach to improve students' science process skills. The purpose of this study was to determine the improvement of science process skills through Engineering Everywhere on physics worksheets based on the STEM approach on the content of rigid body equilibrium in class XI MIA 2 MAN 3 Banda Aceh city. Material balance rigid objects is a material that is very close to everyday life. The benefit of this research is that the application of Engineering Everywhere in physics worksheets based on the STEM approach can help students to understand and experience the process of scientific inquiry so that students learn directly and develop skills to apply their knowledge.

Methods

Sampling was done by purposive sampling, which used qualitative and quantitative approaches. Pre-experimental research design One group pretest-posttest design (sampling technique that meets the research methodology). The reason for selecting the sample was based on considerations of the time and budget required for the implementation of the research.

Data collection is carried out using instruments; (1) KPS test instruments, and (2) non-test instruments in the form of lesson plans, student worksheet, teacher observation sheets and student responses. These instruments were validated by exfert, then revised according to the corrections analyzed by considering the corrections and input from the

validator. After the revision is done according to the input of the validator. In line with the research results (Mahjatia, at al., 2021b) the instrument is declared suitable for use if it at least meets the valid criteria. Valid student learning assessment instruments will help teachers to conduct assessments in the learning process and improve student learning activities (Yusron and Sudiyatno 2021). The practicality of implementing Engineering Everywhere on STEM-based student worksheet in terms of teacher observation sheets measured by a Likert scale of four categories, namely Very Good (VG), Good (G), Less Good (LG) and Less Good (NG). The teacher's observation sheet assessment is calculated from the average score obtained and analyzed using the percentage formula. The assessment data obtained on the observer sheet is said to be practical if it at least meets the Good criteria (Darmaji, et al., 2019).

The effectiveness of the application of Engineering Everywhere is measured from the analysis of science process skills based on the test instrument indicators. N-gain score is calculated by using the N-Gain equation according to (Hake 1998). <g>= (S_post-S_pre)/(S_max-S_pre)

Description: <g>= Normalized gain value
S_post = Initial test scores
S_pre = Final test score
S_max = Maximum value

Furthermore, it is supported by the results of the analysis of student responses including the attractiveness, usefulness, discussion and ease of use of LKS science process skills.

Result and Discussion

Practicality of EE in STEM-based LKPD

The practicality of learning through the implementation of Engineering Everywhere in physics worksheets based on the STEM approach is seen from the implementation of learning with insignificant constraints, practicality is seen through the results of the teacher observation sheet in Table 1.

Table 1. Practicality of teacher observation sheets

Phase	Meeting I			Meeting II		
	Average	%	Information	Average	%	Information
1	2,67	67	G	3,5	88	VG
2	2,8	70	G	3,7	92	VG
3	3	75	G	3,5	88	VG

Information: 1 = Preliminary activities, 2 = Core activities (Identify, investigate & imagine,Create,Test & improve, communicate), 3 = Closing activity

At the first meeting each phase was categorized as good while at the second meeting there was an increase in each phase so that it became a very good category. At the first meeting there were obstacles due to insufficient time and the class conditions were not conducive during the practicum so that the observations were not very good. However, these obstacles can be overcome, so that at the next meeting there will be no obstacles. Overall, teachers the implementation of Engineering Everywhere in STEM-based student worksheet shows the results that teachers are able to carry out the steps of learning activities starting from preliminary activities, core activities and closing activities very well (Iswadi, et al., 2020).

Students have the opportunity to be creative and innovate on the projects they are working on because STEM requires students to produce products and make them motivated in learning, because they know the relationship between the material they learn and everyday life (Syukri, et al., 2021). This can be seen from the enthusiasm of students in completing activities in job sheet and when making and being creative with the products they do. According to (Lestari, et al., 2021), with members, students can learn actively and creatively, it can increase students' knowledge and understanding of the material provided.

Effectiveness of Engineering Everywhere in STEM-based worksheets

The effectiveness of the results of the implementation of Engineering Everywhere in physics worksheets based on the STEM approach is seen based on indicators of science process skills from pretest, posttest and N-gain scores. The indicators of science process skills in this research are observing, hypothesizing, applying concepts, communicating, interpreting data, planning experiments and conducting experiments. The average results of the scientific process skills indicators of students on the rigid body equilibrium material are presented in Figure 1. Meanwhile, the test results for increasing science process skills through the N-gain formula by (Putri, et al., 2021) obtained a score of 0.69 in the medium category. This is supported by the results of (Satriawan, et al., 2017) that the STEM approach can improve students' skills and the average N-gain value of students who use the STEM approach is higher than students who use the scientific approach (Mnguni, et al., 2020).

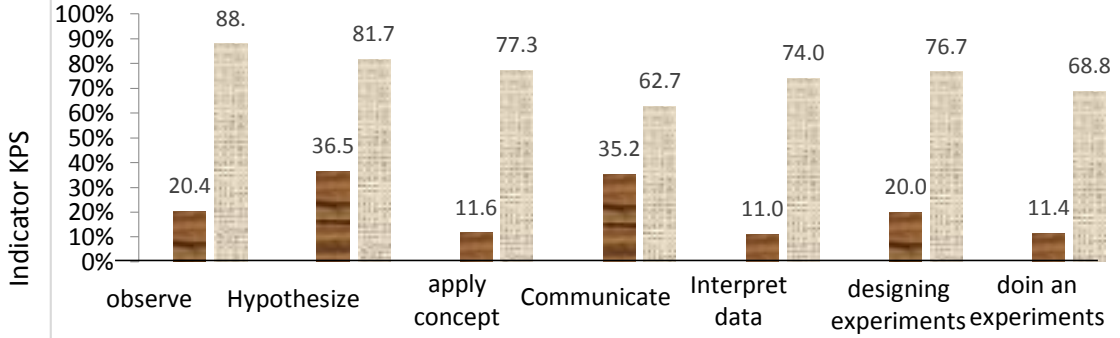

Figure 1. Graph of the results of the analysis of indicators KPS

Figure 1 shows that there is an increase in science process skills based on indicators seen from the pretest and posttest. In the beginning, the students' science process skills were obtained by percentages ranging from 11.0-36.5% which was in the low category. This is caused by students who are not used to expressing their ideas and are not accustomed to solving problems using scientific steps. Meanwhile, after being treated through the implementation of Engineering Everywhere in physics worksheets based on the STEM approach, the students' science process skills are in the percentage ranging from 62.70-88%. Through the products that have been developed, students are taught through identification and investigation activities as well as EE steps systematically so that students can

answer various questions in a variety of ways and are highly motivated in solving the problems given, so that all indicators of science process skills have increased. This is in line with the results of the (Cunningham, 2020) that the Engineering Everywhere process through the STEM approach makes students very motivated in learning.

Implementation of EE in STEM-based worksheets can grow indicators of observing science process skills, students can use as many senses as they have to collect relevant facts. This is in line with that the indicator of students' observing skills can interpret images or phenomena as initial hypotheses (Husna, et al., 2020). The indicator hypothesizes that there is an increase after being given treatment, this is seen from students answering questions from the Engineering Everywhere steps in the LKPD which are carried out systematically. This is in line with (Dewi, 2017) statement that formulating hypotheses is related to thinking skills to create or create.

Overall, the implementation of EE in physics worksheets based on the STEM approach can grow students' science process skills on each indicator. STEM-based learning is able to improve science process skills in a relatively short time and is able to provide convenience for students in understanding a learning material. This is in line with (Permanasari. 2016) that STEM-based learning can train students in applying their knowledge to make designs as a form of problem solving related to the environment and technology. The environmental context that shows STEM learning can build creativity, scientific literacy and problem-solving skills that are indispensable in facing the 21st century. This is because STEM learning can directly or indirectly train and demand students to be able to deal with it (Fithri. 2021).

The application of STEM-based student worksheet through the application of guided inquiry has increased KPS in every meeting, STEM-based student worksheet to train KPS is suitable for use in the learning process at the high school level (Mahjatia, et al., 2021). The development of STEM-based learning tools through guided inquiry is appropriate to use to improve students' science process skills in learning physics (Hikmah, et al., 2021).

N-gain analysis results Science Process Skills Indicator

The results of the analysis of the Gain pretest and posttest scores of students taught by applying EE in the physics student worksheet based on the STEM approach showed that the average value of the Science Process Skills Indicator of students increased significantly compared to the average value of the pretest. The interpretation of the values obtained shows that the posttest value is higher than the interpretation of the pretest value. The data on the improvement of science process skills that are reviewed are based on the indicators of Science Process Skills as shown in Table 2.

Table 2. The results of the N-gain analysis of students implementing EE in the physics student worksheets based on the STEM approach

Student Code	Score			
	Pretest	*Posttest*	*N-Gain*	Category
S-1	25	73	0.64	Medium
S-2	13	67	0.62	Medium
S-3	19	80	0.75	High
S-4	19	72	0.65	Medium
S-5	19	73	0.67	Medium
S-6	38	86	0.77	High
S-7	19	71	0.64	Medium
S-8	25	65	0.53	Medium
S-9	25	86	0.81	High
S-10	26	66	0.54	Medium
S-11	19	79	0.74	High
S-12	33	100	1.00	High
S-13	20	66	0.58	Medium
S-14	26	80	0.73	High

Student Code	Score			
	Pretest	*Posttest*	*N-Gain*	Category
S-15	19	79	0.74	High
S-16	25	73	0.64	Medium
S-17	25	78	0.71	High
S-18	1	75	0.75	High
S-19	26	87	0.82	High
S-20	7	73	0.71	High
S-21	26	65	0.53	Medium
S-22	5	73	0.72	High
S-23	25	79	0.72	High
S-24	19	73	0.67	Medium
S-25	12	72	0.68	Medium
S-26	24	72	0.63	Medium
S-27	19	79	0.74	High
Total	**559**	**2042**	**18.74**	
Average	**20.70**	**75.63**	**0.7**	**High**

The results of the analysis of the average N-gain of students based on the implementation of Engineering Everywhere in the physics student worksheet based on the STEM approach showed that 14 out of 27 students were in the high category or overall it could be said that the average N-gain of students in class XI mia 2 was 0.7 high category. The use of learning with the STEM approach makes it easier for students to understand and master the material, as the study results (Halim, et al., 2021). This is supported by the results of (Prayogi, et al., 2021) that the STEM approach can improve students' skills and the average N-Gain value of students who use the STEM approach is higher than students who use a scientific approach.

Overall, the implementation of EE in physics worksheets based on the STEM approach can grow students' science process skills on each indicator. STEM-based learning is able to improve science process skills in a relatively short time and is able to provide convenience for students in understanding a learning material. This is in line with (Prayogi, et al., 2017) that STEM-based learning can train students in applying their knowledge to make designs as a form of problem solving related to the environment and technology (Irwandi, et al., 2020). The environmental context that shows STEM learning can build creativity, scientific literacy and problem-solving skills that are indispensable in facing the 21st century. This is because STEM learning directly or indirectly can train and demand students to be able to deal with it (Dewi, et al., 2017)

Student response questionnaire

The effectiveness of the implementation of EE in STEM-based physics worksheets is obtained through the answers from students when answering the response questionnaire distributed at the end of the meeting. The results of the practicality of the student response questionnaire were calculated using the Likert't summeted Rating formula by (Susanna, et al., 2020) which obtained a score of 942 out of 1188 in the effective category. This is indicated by the total score of respondents which lies between 742.5 (median) with a score of 965.25 (quartile 3) which is the limit score in the effective category (Indrawan, et al., 2020).

Based on 4 indicators of student response questionnaires, namely attractiveness, usefulness, language and use, easy for students to understand and effectively used in the learning process as evidenced by students being active and enthusiastic in answering questions in the student worksheet well. This is in accordance with the results of (Jatmika, et al., 2020) study that a teaching material can be said to be effective if the average student is active in learning activities and the average student is active in doing assignments and the student's response to learning is carried out well/positively. According to (Onsee and

Nuangchalerm, 2019) that STEM-based student worksheet development is practical if the response from students after using job sheet in learning makes it easier for students to learn.

Conclusion

The results of the analysis of research research data can be concluded that the implementation of the Engineering Everywhere process in physics worksheets based on the STEM approach is categorized as very good, and the science process skills of MAN 3 students. Banda Aceh experienced a significant increase in students' KPS. The pree-test mean value of 20.70 increased to 75.63 and students' N-Gain was 0.7, belonging to the high category, as well as enthusiastic and positive student responses in participating in the Engineering Everywhere process on physics worksheets based on the STEM approach.

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