Needs analysis in development of physics handout based on STEM approach for 11th grade of senior high school

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Abstract. Physics learning is part of natural science lessons to develop the ability to understand concepts, principles, and laws in solving problems related to natural events. STEM (science, technology, engineering, and mathematics) is a new approach in the development of the world of education that integrates more than one scientific discipline. Development of teaching materials physics handouts using the STEM approach developed are assumed by integrating the four components of Science, Technology, Engineering and Mathematics that are able to produce students' thinking activities that are useful to help raise students' critical thinking characterized by problem solving, decision making, analyzing assumptions, evaluating, and conducting investigations to overcome the problems of learning Physics of students. This research is a descriptive study conducted through direct observation at Senior High School (SMAN 4 Padang). The research sample was students of 11th grade. The instruments used were questionnaires and interview sheets. Needs analysis of physics handouts based on the STEM approach includes analysis of students, analysis of teaching materials and analysis of learning activities. Based on data analysis of material teaching using the Likert scale, the results obtained 62.83%. Therefore need to be developed in the form of STEM-based physics handouts for 11th grade of senior high school.

1. Introduction

The concept of 21st century learning requires students to play an active role in learning by finding their own concepts about the knowledge learned. Various 21st century skills must be explicitly taught. The ideal learning model for 21st century learning is project-based learning and problem-based learning because it involves 4C principles namely critical thinking, communication, collaboration and creativity [1] 21st century learning requires skills in terms of literacy. Literacy skills in the context of Science Natural Knowledge refers to scientific literacy [2].

The results of the 2015 Program for International Student Assessment (PISA) study show that the scientific abilities of Indonesian students are still low. In the 2015 PISA results report, the average science score of Indonesian students was 403. Occupying rank 62 out of 69 PISA participating countries (OECD, 2016). The low achievement results were seen in the results of The Trend in the International Mathematics and Science Study (TIMSS) in 2011 in the fields of mathematics and science[3]. The low quality of student learning outcomes shows that the learning process carried out by the teacher is still teacher centered, so that the teacher becomes the only source of learning for students. Teachers use the lecture method more in learning, and do not associate learning with problems in students' real life every day. Learning carried out lacks training in student skills [4].
Teachers generally rely more on teaching materials originating from publishers, whether in the form of textbooks or student activity sheets and the learning process is still mostly done conventionally with the lecture method [5]. One of the interactive teaching materials that teachers can use in the learning process is the Handout. Handouts are one example of the form of printed teaching materials. Handouts are written materials prepared by educators to enrich students' knowledge [6]. Handouts are intended to facilitate and provide assistance with information or learning material as a guide for students. This teaching material comes from several literature relevant to basic competencies and subject matter taught to students [7]. The function of the handout is to help students not need to take notes, as a companion to the educator's explanation, as a reference material for students, motivating students to be more active in learning, reminding the main points of the material being taught, giving feedback, and assessing learning outcomes.

In developing interactive handouts in learning is using the STEM approach (Science, Technology, Engineering, and Mathematics). An integrative approach is a learning approach that is carried out using several disciplines. STEM is an approach in the development of education that integrates more than one discipline. Learning with the STEM approach can shape students to reason, think critically, logically, and systematically, so that later they are able to face global challenges [8,9].

STEM learning is an integration of learning science, technology, engineering, and mathematics that is suggested to help the success of 21st century skills. STEM-based education can form human resources (HR) that are capable of reasoning and thinking critically, logically, and systematically, so that they will be able to face global challenges and be able to improve the country's economy. STEM can develop when it is associated with the environment, so that there is a learning that presents the real world experienced by students in everyday life. This means that through the STEM approach students are not just memorizing concepts, but rather how students understand and understand scientific concepts and their relationships in daily life [7].

Based on the explanation, learning by using STEM is an important question, because it provides training for students to be able to integrate each aspect of each. These aspects are called science, technology, engineering and mathematics. STEM in the process of learning Physics is expected to equip students with the various skills needed by students in the battle in the 21st century.

2. Research Method

This research is a qualitative descriptive study. The total subjects of this research was taken from 30 students of 11th grade at senior high school (SMA N 4 Padang). The instruments of data collection used were questionnaires and interview sheets. The questionnaire was filled out by students and the interview sheet was filled out by physics teachers in the school concerned. The questionnaire uses a Likert scale with four answer choices. The value of each indicator in the questionnaire is determined by equation (1) [10] and the analysis category is shown in Table 1.

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\text{Value} = \frac{\text{obtained score}}{\text{maximum score}} \times 100\% \quad (1)
\]

| No. | Observation Score | Category          |
|-----|-------------------|-------------------|
| 1.  | 90 > score ≤ 100  | Very Good (A)     |
| 2.  | 75 < B ≤ 90       | Good (B)          |
| 3.  | 60 < C ≤ 75       | Less (C)          |
| 4.  | ≤ 60              | Very Less (D)     |

Table 1. Categories of ability to think creatively [11]
3. Results and Discussion

The results of this study are the percentage of student analysis, analysis of teaching materials and analysis of learning activities of STEM approach that was carried out in 11\textsuperscript{th} grade senior high school (SMA N 4 Padang).

3.1. Analysis of students

Figure 1 shows the analysis of students in the learning process. It can be seen that the analysis of students on each indicator is different. The highest indicator is the learning approach used by the teacher with a percentage of 63.5\% categorized as less, while the indicator of learning interest in the lowest indicator is 59.33\% categorized as less. For the average aspect of the overall analysis of students, 61.89\% was categorized as poor. Based on these results of characteristics of students in physics learning are in the less category and need to be improved in each of these aspects.

![Figure 1. Graph of Student Analyze](image)

3.2. Teaching Material Analysis

The results of the analysis of teaching materials in the learning process are shown in Figure 2. It can be seen that the analysis of teaching materials on each indicator is different. The highest indicator is the ease of students understanding physics by using a handout with a percentage of 79.19\% categorized as good, while indicators of teaching materials used have integrated science, technology, engineering, and mathematics with a percentage of 51.67\% categorized as very bad. For the average aspect of overall teaching material analysis, it was found that 72.50\% was categorized as less. Based on these results it can be explained that the use of teaching materials in physics learning is in the less category and needs to be improved, especially in developing STEM integrated handout so that learning becomes more interesting, innovative, and can improve students thinking skills.
3.3 Analysis of Learning Activities

The analysis of learning activities can be seen in Figure 3. It can be seen that the analysis of learning activities on each indicator is different. The highest indicator is the element of teacher closing activities with a percentage of 63.3% categorized as less, while the physics material indicator with the STEM approach is in the lowest position with a percentage of 52.50% categorized as less. For the average aspect of overall student analysis, it was found that 58.95% was categorized as less.

Figure 2. Graph analysis of teaching materials

Figure 3. Graph analysis of learning activities
The several efforts must be made to improve students' thinking skills. In the implementation of learning, adequate facilities are needed to support teaching and learning activities independently, one of that is handout as teaching materials. Thus will create a more enjoyable learning process.

4. Conclusion
Based on the studies that have been conducted, it is concluded that the development of STEM-based physics handouts is effectively used to improve student learning competencies.

References
[1] Zubaidah, S. 2016. Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran. Seminar Nasional Pendidikan dengan tema “Isu-isu Strategis Pembelajaran MIPA Abad 21. STKIP Persada Khatulistiwa Sintang Kalimantan Barat.
[2] Triyanto, s. A., Susilo, H. Rohman. F & Lestari, E. S. 2016. Kecakapan Berpikir Kritis dan Literasi Ilmiah Siswa Kelas XI IPA7 SMAN 1 Karanganyar. Seminar Nasional Pendidikan dan Saintek. Isu-Isu Kontemporer Sains, Lingkungan, dan Inovasi Pembelajarannya
[3] Firman, H. 2007. Laporan Analisis Literasi Sains Berdasarkan Hasil PISA Nasional Tahun 2006. Pusat Penelitian Pendidikan Balitbang Depdiknas. Jakarta.
[4] Desianti, H., Budi, A., Nyoman, S. 2015. Pengembangan Perangkat Pembelajaran IPA Dengan Setting Sains Teknologi Masyarakat Untuk Meningkatkan Keterampilan Proses Sains dan Keterampilan Berpikir Kreatif Siswa SMP. e Journal Program Pasca Sarjana Pendidikan Ganesha Program Studi Pendidikan IPA 5
[5] Widyaningrum, R., Sarwanto, & Karyanto .2013. Pengembangan Modul Berorientasi POE (Predict, Observe, Explain) Berwawasan Lingkungan Pada Materi Pencemaran Untuk Meningkatkan hasil Belajar Siswa. Jurnal bioedukasi. 6 (1)
[6] Abdul Majid, Perencanaan Pembelajaran: Mengembangkan Standar Kompetensi Guru, PT Remaja Rosdakarya. 2007.
[7] Andi Prastowo, Panduan Kreatif Membuat Bahan Ajar Inovatif : Menciptakan Metode yang Menarik dan Menyenangkan, Diva Press. 2011.
[8] Breiner, J.M., Johnson, C.C., Harkness, S.S., & Koehler, C.M. 2012. What Is STEM? A discussion about conceptions of STEM in education and partnerships. School Science and Mathematics, 11, pp. 3-11
[9] Sari, Y.S., Selisne, M., and Ramli, R. 2019. Role of Students Worksheet in STEM Approach to Achieve Competence of Physics Learning. J. Phys.: Conf. Ser. 1185 012096.
[10] Arikunto, S. 2010. Prosedur Penelitian Suatu Pendekatan dan Praktik (Research Procedure An Approach and Practice). Jakarta: PT Rineka Cipta.
[11] Riduwan, 2010. Dasar-dasar Statistika (Basics of Statistics). Bandung : Alfabella.