



Preliminary Study: Development of STEM-Based E-Students Worksheet to Improve Learners' Science Literacy Skills

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Abstract: The purpose of this study was to describe the results of the needs analysis for the development of e-Students Worksheet based on the STEM approach to improve the science literacy skills of students in several high schools in Padang City. This research design uses the R&D method by using the Plomp development model which consists of three steps, namely: 1) preliminary research; 2) prototyping phase, and 3) assessment phase. The instrument used in this research is a questionnaire validation sheet filled out by educators and students. Based on the analysis of the results of preliminary data observations conducted in several high schools in Padang City, the results obtained are in the analysis of graduate competency standards, assessment, learning activities have an average percentage with a very good category. However, in the analysis of students, the STEM approach, the use of electronic teaching materials, and science literacy generally have an average percentage that is in the sufficient category. To overcome the existing problems educators can develop STEM-based e-Students Worksheet to improve students' scientific literacy.

Keywords: Preliminary Study; STEM-based e-Students Worksheet; Science Literacy

Introduction

Physics is a science that is synonymous with observation and experiment (Novitra et al., 2021). The physics learning has to require students to engage and reflect on phenomena and the universe. The development of the world in the 21st century is characterized by the progress and demands of the times (Calmer, 2019). The 21st century, known as the century of technology, requires teachers to have teaching skills, one of which utilizes technology in the learning process. The 21st century has made the development of the world faster and more complex. The 21st century is the century of information, the century of knowledge economy, the century of information technology, globalization, industrial revolution 4.0 etc (Pratiwi et al., 2019). These changes are basically aimed at improving the quality of life of modern society (Pratiwi et al., 2019). Learning in the 21st century certainly requires educators to be more

creative in the learning process in order to keep up with the demands of the 21st century.

21st Century Skills, which recognized as competency standards that students need to be possessed by students to meet the demands of success in their future work and life (Asrizal et al., 2018). Education in this era of globalization is characterized by the application of sophisticated technology in the form of applications that can provide the needs and facilitate all information. According to (BNSP, 2010) there are several competencies or skills that must be possessed by Human Resources (HR) in the 21st century, namely the ability to think critically and solve problems, the ability to communicate and cooperate, the ability to create and renew, information and communication technology literacy, contextual learning skills, and information and media literacy skills.

In general, the problem that occurs in the learning process is that many students only focus on their

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respective gadgets to play games and social media, which can cause a decrease in student concentration. In this era of globalization, everything can be easier and more practical. This is indicated by the many applications of advanced technology in the form of applications that provide the needs to facilitate the learning process (Pratiwi et al., 2019). Of course, in this case educators and students are required to be proficient in using information and communication technology. The 21st century allows information and communication systems to copy the physical world into virtual form. This can be utilized by educators in developing teaching materials.

Teaching materials are all forms of materials used to assist teachers/instructors in carrying out teaching and learning activities (Depdiknas, 2010). Students Worksheet is an activity sheet in the learning process to find physics concepts, be it theory, demonstration, or investigation accompanied by clear instructions and procedures (Firdaus & Wilujeng, 2018). Student worksheets are worksheets that contain guidelines for students to carry out activities that reflect science process skills so that students gain the knowledge and skills they need to master (Rahmatillah et al., 2017). (Suyanto, 2011) said that one of the functions of using Students Worksheet is that it can be used to increase students' interest in learning if the learning activities guided through Students Worksheet are more systematic, colorful and illustrated and can attract the attention of students. In this era of globalization, everything can be easier and more practical. This is indicated by the many applications of advanced technology in the form of applications that provide the needs to facilitate the learning process (Pratiwi et al., 2019). According to (Razzaq et al., 2018), gadgets provide intrinsic motivation for students to learn outside the classroom actively. This can be utilized by educators in developing electronic Students Worksheet. Purnama & Suparman, 2020 said E-student worksheets are student work guides to make it easier for students to understand learning material in electronic form which is applied using a computer desktop, notebook, smartphone, or cellphone.

Answering the challenges of the 21st century, of course, in learning it is necessary to use an approach in order to produce quality human resources. One approach that can be used is the STEM (Science, Technology, Engineering, and Mathematics) approach. STEM learning is a blend of science, technology, engineering, and math lessons. STEM learning can develop if the learning process is associated with the real world experienced by students so that it can attract students' interest in understanding the process. STEM learning is an integration of science, technology, engineering, and math learning that are suggested to

help the success of 21st century skills (Tul'skaia et al., 2014).

The application of STEM which initially only aims to increase students' interest in the field of STEM becomes wider (Gann & Carpenter, 2019). Learning by using STEM approach is very important, because it provides training to learners to be able to integrate each aspect at once. These aspects include science, technology, engineering and mathematics. By applying the STEM approach in the learning process physics is expected to equip students with the various skills required by students in the face of competition in the 21st century (Sari et al., 2019)

STEM is needed in learning. STEM literacy refers to: a). Knowledge, attitudes, and skills of an individual to overcome the problems in real life, explains a natural and design world, and describes the conclusions of different facts on the subject of STEM (Farwati et al., 2018), An individual's understanding of the characteristics of the STEM discipline as a form of knowledge, and inquiry. c). An individual's sensitivity about how STEM shapes material, intellectual and environmental cultures d. The desire of an individual to be tied to the STEM issue and tied to the ideas of STEM as a constructive, caring and reflective citizen (Bartholomew, 2017). STEM-based learning can be applied to physics subjects, where physics is part of science. Physics is a field of science that studies natural phenomena so that it can be applied in everyday life (Roberts, 2012). In line with the opinion of (Becker & Park, 2011) STEM education is an approach to the learning process that can combine two disciplines in it. This means that using the STEM approach is expected to help students in fostering curiosity about scientific inquiry and help foster the ability to solve problems.

One of the skills of learners expected in the industrial era 4.0 is science literacy. science literacy is the ability to use scientific knowledge to identify questions, obtain new knowledge, explain scientific phenomena and conclude based on scientific evidence. Science literacy certainly requires not only knowledge of concepts and theories but also requires knowledge of procedures related to scientific investigations.

Method

This research design uses the R&D method with the Plomp development model. Plomp's development model consists of three steps, namely: 1) preliminary research; 2) prototyping phase, and 3) assessment phase (Plomp & Nieveen, 2013). The preliminary research phase requires information about the problems that exist in the field of education. In the first stage, a needs analysis was carried out including the analysis of

graduate competency standards assessment, learning activities, students, the use of electronic teaching materials, the STEM approach, and students' science literacy skills. The results of the preliminary analysis were obtained based on the distribution of questionnaires conducted.

Furthermore, in the second stage of the prototyping phase. This stage is conducted after the preliminary research phase is conducted. At this stage the prototype is developed, evaluated, revised iteratively (cycles). The design results at this stage produce a prototype. Then a formative evaluation of the prototype is carried out. Formative evaluation is an evaluation aimed at improvement, found in all phases and iterative cycles of design research. Formative evaluation has several stages as illustrated in Figure 1.

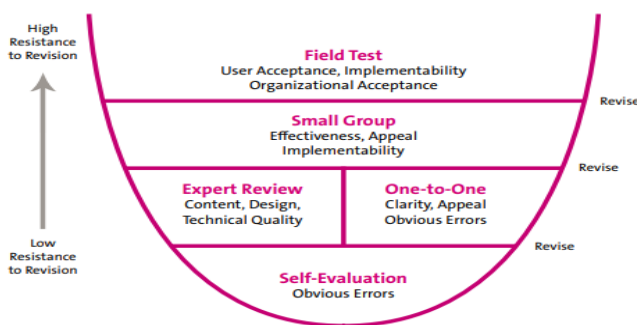


Figure 1. Formative Evaluation of the Plomp Development Model (Source: Plomp & Nieveen, 2013)

Based on Figure 1 above, the following is an explanation of the formative evaluation of the Plomp development model: a) Self-Evaluation, namely by making improvements to the STEM-based e-Students Worksheet that has been designed. This self-evaluation aims to re-examine some possible errors that are still contained in the STEM-based e-Students Worksheet developed before being validated by the validator. b) Expert Review is the result of the design in prototype I which has been evaluated then given to the expert to be validated. This validation is done to assess the extent to which the STEM-based e-Students Worksheet design is feasible to use or not. c) One-to-One Evaluation aims to see the level of practicality of the STEM-based e-Students Worksheet that has been designed. Products that have been developed are tested on each learner who has a level of ability that includes high, medium, low. The three learners were separately asked for their comments on the STEM-based e-Students Worksheet developed such as content, presentation, benefits and matters related to the indicators of the practicality of STEM-based e-Students Worksheet. d) Small Group (small group evaluation) The revised results of the one-on-one evaluation were then tested in a limited trial on this STEM-based e-Students

Worksheet on a group of learners who had different ability levels. Then the learners were asked to assess the STEM-based e-Students Worksheet that had been developed through the practicality sheet. Then the results of the assessment are also analyzed to correct any errors in the STEM-based e-Students Worksheet before being used for field testing. e) Field Test (field test) This research activity is carried out to assess STEM-based e-Students Worksheet on a larger scale. The purpose of this evaluation is to see the level of practicality of the STEM-based e-Students Worksheet that has been designed into several meetings. The practicality test continues until a valid and practical STEM-based e-Students Worksheet is obtained.

Finally, the assessment phase, at this stage, the development of STEM-based e-Students Worksheet is tested to see the extent of the effectiveness of the STEM-based e-Students Worksheet developed. Product effectiveness means a measure that states whether or not there is an effect or influence of the product developed on users, namely on students. Research design and method should be clearly defined.

Result and Discussion

Based on the research, initial data observations were made through distributing questionnaires in three high schools in Padang City. Then the questionnaire was filled in by all Physics educators in grade XI in three high schools in Padang City. There are several analyses conducted in this study, namely the analysis of graduate competency standards, assessment, learning activities, students, STEM approach, the use of electronic teaching materials, and science literacy.

The first needs analysis is the graduate competency standards analysis, where the graduate competency standards analysis consists of aspects, namely the attitude aspect, knowledge aspect, and skill aspect. In the attitude aspect, the average percentage for the three schools observed was 92.3% with a very good category. Furthermore, the knowledge aspects include factual, conceptual, procedural, and metacognitive. The average percentage value in this knowledge aspect is 86.3% with a very good category. Third, in the skills aspect, the average percentage is 55% with a poor category, so it can be seen that among these three aspects, the skills aspect has the lowest percentage value.

The second needs analysis is an assessment analysis, where this analysis can describe the assessment carried out by educators on students. In this assessment analysis, there are three aspects, namely assessment planning, assessment implementation, and reporting. In the aspect of assessment planning, the average percentage is 94.6% with a very good category. Furthermore, in the aspect of implementing the

assessment, the average percentage is 91.6% with a very good category. Third, namely in the aspect of reporting, the average percentage is 91.6% with a very good category. So, it can be seen that the assessment carried out by educators is very good.

The third analysis is the analysis of learning activities, where in this analysis there are three learning activities, namely in the introduction, core activities, and closing activities. In the preliminary activities, the average percentage is 96% with a very good category. Furthermore, in the core activities, the average percentage is 92% with a very good category. Finally, the closing activity obtained an average percentage of 94% with a very good category.

The fourth analysis is the analysis of students. In this learner analysis, there are several aspects that are assessed, namely learning styles (visual, auditory, kinesthetic), interest and motivation. Learning style is a habit shown by individuals in processing information and knowledge and learning a skill (Khuluqo, 2017). Then interest in learning is the tendency or interest of students in learning (Charli et al., 2019). Furthermore, motivation is the driving force for students to carry out learning activities that come from within students so that there is a desire to make efforts to achieve learning goals (Andriani & Rasto, 2019).

In the analysis of students in the aspect of learning style, the average percentage is 66.3% with a sufficient category. Furthermore, in the aspect of students' interest, the average percentage is 74% with a good category. Third, namely in the aspect of student motivation, an average percentage of 72% is obtained in the good category. We can see that in the analysis of students, all aspects are in the sufficient category, but the aspect of learning style is the lowest among other aspects. So, it is necessary to make innovations or strategies in the learning process that can improve the learning style of students which later if the learning style of students suits them, it will help increase students' interest and motivation in learning physics. According to (Ghufro, M Nur., 2014) there are reasons for the importance of knowing the learning style of students by educators, namely communicating through messages, when educators know the tendency of students' interests and learning styles, educators try to realize it and adjust the knowledge base of students.

The fifth analysis is the analysis of the STEM approach, where the analysis of the STEM approach obtained an average percentage of 72% in the good category. Based on the questionnaire that has been given to students, there are still many students who have not been able to apply what has been learned in everyday life. Second, there are many students who have not been able to solve problems or problems given by educators, in general, students are able to solve problems given in

the form of groups or discussions. (Hannover, 2017) said the purpose of learning using the STEM approach is suitable for school learning where the subject in learning requires complex knowledge.

The sixth analysis is the use of electronic teaching materials. In this analysis, an average percentage of 69% was obtained in the sufficient category. So it can be seen that it is necessary to develop electronic teaching materials in order to increase interest, motivation, learning styles, and learning outcomes to answer the challenges of the 21st century. One of the electronic teaching materials that can be developed is electronic student worksheets or what is called e-Students Worksheet. Purnama & Suparman (2020) said that the use of e-Students Worksheet can make it easier for students to understand learning materials because the application can use cellphones so that students can understand the subject matter anywhere and anytime.

The last analysis is the analysis of science literacy. In this science literacy analysis, an average percentage of 68.3% was obtained in the sufficient category. It can be seen that there are still students who do not understand the concept of physics so that it causes students to be less able to understand the meaning and principles of the laws of physics itself. So, it can be seen that students have not been able to use scientific knowledge to identify questions, gain new knowledge, explain scientific phenomena and conclude based on scientific evidence.

Conclusion

Based on preliminary data observations conducted in three high schools in Padang City, it can be concluded that the analysis of the the analysis of graduate competency standards, assessment, and learning activities has gone well. However, in the analysis of students, the STEM approach, the use of electronic teaching materials, and science literacy generally have an average percentage in the sufficient category. To overcome the existing problems, educators can develop STEM-based e-Students Worksheet to improve students' science literacy in order to help students with various skills in facing competition in the industrial 4.0 era.

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