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Development of Student Worksheets Based on Scientific Approach to Improve Concept Mastery and Problem Solving Skills of Students

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Abstract: Physics learning is learning related to natural phenomena, not only in the form of memorization but more demanding on understanding, applications and concepts that are scientifically integrated in mastering concepts and problem solving skills. The purpose of this research is to develop student worksheets based on scientific approach to improve students' mastery of concepts and problem solving skills. The method used in this research is research and development (R&D) which refers to the ADDIE development model. Student worksheets implementation design uses One Group Pretest-Posttest Design. The instruments used in this study were student worksheets assessment sheets, test questions for mastery of concepts and problem solving skills, student response questionnaires and teacher response questionnaires. Mastery of concepts and problem solving skills of students were analyzed using the N-Gain test to see the improvement before and after the implementation of student worksheets based on the Scientific approach. The results of the feasibility test in terms of the feasibility aspects of content, presentation and language obtained a percentage of 96.66% indicating that the student worksheets based on the Scientific approach to improve mastery of concepts and problem solving skills is very feasible to use. The results of the implementation of the student worksheets based on the Scientific approach can improve the mastery of concepts and problem solving skills of students which is marked by an increase in the pretest-posttest scores based on the results of the N-Gain test which shows the numbers 0.68 and 0.69 are in the medium categories. Teachers and students responded with a very positive category to SW based on a Scientific approach which was shown by figures of 3.31% for teacher responses and 105.38% for student responses.

Keywords: Student worksheets development; Scientific approach; Concept mastery; Problem solving skills

Introduction

Learning is a dynamic and continuous process that functions to meet the needs of students according to their respective interests, thus schools must have a learning system that emphasizes dynamic processes based on efforts to increase student curiosity (Huda, 2011). A dynamic process is an action taken during teaching, where in the learning process there is a reciprocal relationship to acquire knowledge and concepts from a theory.

In the learning process students need to have problem solving skills that must be developed, because through problem solving skills students are able to apply knowledge and understanding in everyday situations (Purfasari, 2016). The learning process in question is the existence of methods, strategies, approaches, models and teaching materials used that are very influential in achieving learning objectives.

Learning physics is a natural science that studies about phenomena that are often experienced in everyday life. In learning physics, it is not only memorizing formulas but requires mastery of concepts

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to understand theory, it also requires problem-solving skills in applying the formulas learned. Kulsum & Nugroho, (2014) stated that physics requires students to understand and understand these concepts not just knowing and memorizing and students are expected to be able to connect a concept with other concepts that are interrelated. .

Physics learning in Indonesia is currently more focused on how to help students improve cognitive knowledge, but does not help students learn how to apply scientific concepts that have been learned into real life outside of school (Koedinger et al., 2012). Another opinion was also expressed by Hoellwarth et al. (2005) which stated that physics learning in the classroom tends to emphasize mastery of concepts and override students' physics problem solving skills (Chiang and Lee, 2016; Ay et al, 2019).

Mastery of concepts and problem-solving skills can be grown and applied through scientific approach-based learning as stated by Rusman, (2015) and Nasrullah et al .(2018) that Scientific is an approach that designs the learning process so that students actively construct concepts, laws or principles through the 5M stages (observing, asking, collecting information, associating and communicating) is also referred to as a learner-centered scientific approach (Hallinger & Lu, 2013). Students in this scientific approach are encouraged to form the ability to solve a problem systematically (Hosman, 2014).

The teacher is only a facilitator in the learning process who plays a very important role in improving the quality of learning in the classroom. Teachers are expected to be able to create learning resources that can support the achievement of learning objectives. One form of learning resources that is an important part in supporting the learning process is teaching materials in the form of Student Worksheets (SW). SW is a printed teaching material in the form of sheets containing material, summaries and instructions that must be carried out by students (Prastowo, 2012; Asma et al, 2020).

Mastery of concepts can be trained, one of which is through a learner-centered learning process by directing students to be active by using a scientific approach, this is in accordance with the results of research conducted by Fitriani (2016) and Susbiyanto et al (2019) who found that learning using a scientific approach can make students focused to be able to find concepts and apply concepts creatively through their activities or in work groups. Problem solving skills can also be trained through providing direct experience to students by giving work orders in the form of sheets contained in the SW, this is in accordance with the results of research conducted by Elwi et al. (2017) and Meutia et al. (2021) who found that learning using SW can make students motivated and active in learning physics which leads students to find concepts in understanding the material. Previous research on the Scientific approach has been carried out by several researchers, such as the research conducted by Suhendi, (2018) which found that the improvement of students' critical thinking skills after applying the scientific approach in the classroom showed positive and promising results.

Based on the results of initial observations made at SMA Negeri 2 Meulaboh, it was found that the physics learning process rarely conducted experiments and was still teacher-centered. Based on the results of the interview with the students' scores, it was found that only 48% of the total students whose scores met the predetermined minimum completion criteria. In addition, in the physics learning process, teachers have never used SW based on the Scientific approach to improve students' mastery of concepts and problem solving skills. The SW used by the teacher, especially on the material of Elasticity and Hooke's Law, is an SW which is only in the form of paper containing tables and practicums, only an ordinary demonstration without clear instructions, not an SW containing work steps to carry out an experiment,

Based on the description above, the researcher wants to conduct a study entitled the development of SW based on a Scientific approach to improve the mastery of concepts and problem solving skills of students.The purpose of this research is to develop SW based on scientific approach to improve students' mastery of concepts and problem solving skills.

Method

The method used in this research is the method Research and Development (R&D) using the ADDIE model development method (Analysis Design, Development, Implementation, Evaluation). The SW implementation design used is the One Group Pretest-Posttest design.As for designing something in this R&D research, one must look at the Figure 1.

This research was conducted at SMA Negeri 2 Meulaboh with the subject of SW implementation, namely students of class XI MIA 1, totaling 30 students. The instruments used in this study were SW feasibility assessment sheets, multiple choice test questions and essays related to elasticity and Hooke's law to measure mastery of concepts and problem solving skills, teacher response questionnaires and student response questionnaires to determine student and teacher responses related to SW based on the developed Scientific approach.

The data from the pretest-posttest results of students' mastery of concepts and problem solving skills were analyzed using the n-Gain test to determine the improvement obtained by students, then the normality of the data obtained using the Shapiro Wilk statistical test.

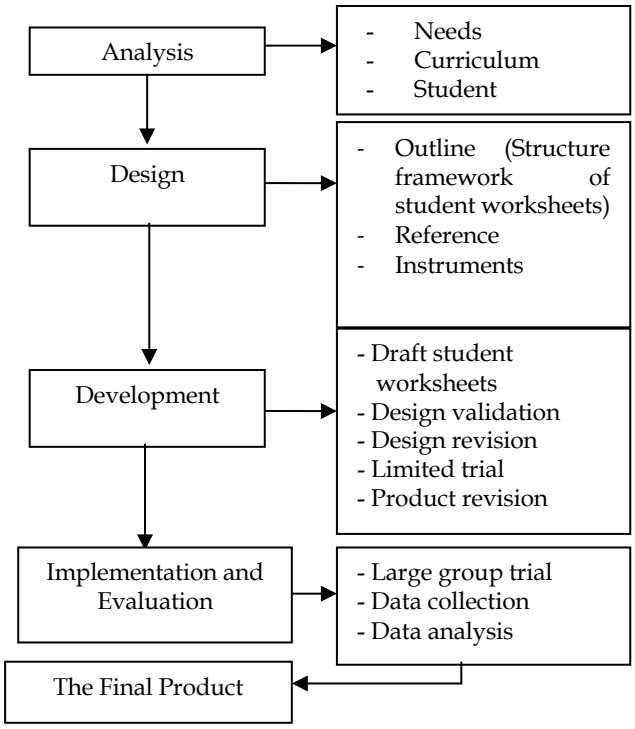

Figure 1. Research Flow Scheme

Result and Discussion

The procedure for developing SW based on the Scientific approach on elasticity and Hooke's law is carried out using the ADDIE development model consisting of the analysis, design, development, implementation and evaluation stages (Manalu et al, 2022; Wahyuni et al, 2021).

There are three types of analysis (analysis) stages in this study, namely needs analysis, curriculum analysis and student character analysis. At this stage, information was obtained that the learning media in the form of SW used did not meet the criteria of a good SW. The SW used in school practical learning does not have an aspect of problem-solving skills. The use of SW is not accompanied by questions that can stimulate students' problem solving skills and is not accompanied by application in everyday life. Students said that they actually liked physics lessons, but they said they were bored because in the learning process that took place they rarely did practicum or activities that involved the activeness of students. As a result,

The design stage, at this stage the SW designed is the SW based on the Scientific approach. The worksheets based on the Scientific approach are designed using Microsoft Word, A4 paper size, Times New Roman and Comic Sans MS fonts with varying sizes of 12-20. The preparation of the SW assessment instrument is also carried out at this stage. The SW that has been compiled is evaluated using the SW assessment instrument in the form of a questionnaire. The questionnaire was prepared to measure several aspects of the SW assessment, namely aspects of presentation feasibility, content feasibility and language and writing feasibility. In addition to the SW assessment questionnaire, a teacher and student response questionnaire was prepared to determine the responses of teachers and students to the developed SW.

The development stage, at this stage the development of the SW begins with a validation process given to two expert lecturers. The assessment of the quality of the SW is based on the feasibility of presenting the SW, the feasibility of the content, and the feasibility of language and writing. The SW assessment based on the Scientific approach that has been carried out can be seen in the Table 1.

Table 1: Results of SW feasibility test analysis

Eligibility Aspect	Percentage Value (%)	Criteria
Presentation	93.75	Very Worthy
Contents	96.25	Very Worthy
Language and Writing	100	Very Worthy
Average value	96.66	Very Worthy

Based on Table 1 above, the average percentage assessment of all aspects obtained is 96.66%, indicating that the SW products compiled are classified in the very feasible category. After going through the validation process by experts consisting of two expert lecturers as validators and the results were very feasible, then the SW based on the Scientific approach was tested on class XII students of MIA 2 SMAN 2 Meulaboh. The assessment of the test class students on the SW based on the Scientific approach is seen through the response questionnaires given to students. The response of students to the SW based on the Scientific approach showed a very positive attitude, this was shown based on the results of the questionnaire analysis of student responses in the trial class which showed the number 105.38 and was in the very positive category.

The implementation stage of SW based on the Scientific approach was applied to students of class XI MIA 1 at SMAN 2 Meulaboh which aims to see whether there is an increase in mastery of concepts and an increase in problem solving skills after applying the SW based on the Scientific approach. At this stage, it begins with the implementation process in the form of giving pretest questions of concept mastery to determine the students' initial conceptual mastery of the elasticity and Hooke's law material after completing the pretest, then distributing problem-solving skills pretest questions in order to determine the initial problem-solving skills of each. students to the material elasticity and Hooke's law.

Based on the data that has been analyzed, the results show that there is an increase in the mastery of concepts and problem solving skills of students in terms of before and after the implementation of the SW based

on the Scientific approach. The pretest-posttest data obtained were analyzed using the n-Gain test to determine the category of increasing mastery of concepts and problem solving skills obtained by students. The results of the average values obtained can be seen in Table 2 and 3.

Table 2. Analysis of increasing students' conceptual mastery

Average Value		N-Gain	Category
Pretest	Posttest		
41.33	81.33	0.68	Moderate

Table 3. Analysis of improving students' problem solving skills

Average Value		N-Gain	Category
Pretest	Posttest		
56.5	87.16	0.69	Moderate

Based on Table 2 above, the acquisition of the pretest value of students' concept mastery before applying the SW based on the Scientific approach shows the number 41.33, this shows that students' knowledge of elasticity and Hooke's law is still low. The posttest is given at the end of the lesson to see the increase in students' mastery of concepts after applying the SW based on the Scientific approach. Posttest results obtained an average percentage of 81.33. This is indicated by the N-gain increase test score which shows the number 0.68 in the medium category. The scores obtained showed a significant increase after the implementation of the SW based on the Scientific approach. This increase occurs because by using the SW based on the Scientific approach, students can easily understand the material being studied and when the learning process takes place, students play an active role so that they can develop mastery of concepts through the steps of activities that exist in the SW based on the Scientific approach. This can be seen in the Figure 2.

Figure 2. The teaching and learning process by applying SW based on a scientific approach.

In accordance with the results of research conducted by Rahmayani (2019) found that problem-based worksheets are very helpful and make it easier for students to understand the material.

Furthermore, based on Table 3, the acquisition of the pretest score for students' problem solving skills before applying the SW based on the Scientific approach shows the number 56.5, this shows that the problem solving skills of students on elasticity and Hooke's law are also still low. The posttest is given after learning to see the improvement of students' problem solving skills after applying the SW based on the Scientific approach. Posttest results obtained an average percentage of 87.16. This is indicated by the N-gain increase test score which shows the number 0.69 in the medium category. The scores obtained showed a significant increase after the implementation of the SW based on the Scientific approach. This increase occurred because of the treatment using SW based on a Scientific approach, students can easily understand the material being studied and when the learning process takes place, students can socialize and work together in groups so that they can develop problem solving skills through the steps of the activities in the SW based on scientific approach.

Figure 3. Cooperation between students in the teaching and learning process

This is in accordance with the results of research conducted by Kristyowati (2018) which found that learning using SW based on a scientific approach can improve the scientific attitude and activeness of students in learning. The following is a bar chart of the values of the pretest and posttest of students' mastery of concepts (Figure 4).

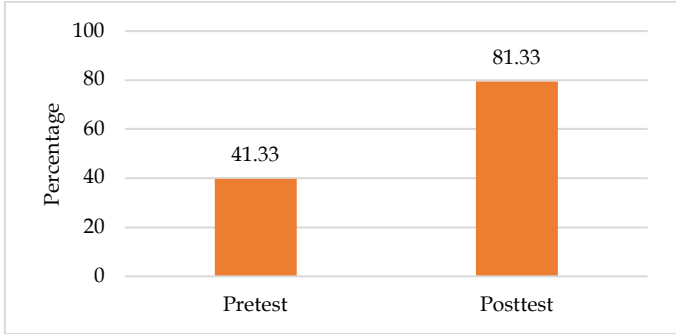

Figure 4. Comparison of pretest-posttest scores on students' mastery of concepts

Based on Figure 4 can be seen that the resulting pretest value is 41.33 with the resulting posttest value of 81.33. This shows that the posttest value of students' concept mastery is higher than the resulting pretest score. This proves that the application of SW based on the Scientific approach that has been developed is very effective in increasing students' mastery of concepts. This is in accordance with the results of research conducted by Saregar, (2016) and Doyan et al (2021) that the scientific approach can improve students' conceptual mastery skills through experiments that can be carried out to develop and build physics learning concepts in students. Here are also diagrams of the pretest and posttest of students' problem-solving skills (Figure 5).

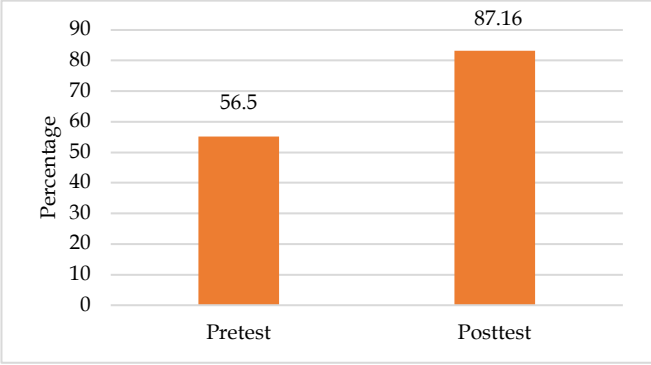

Figure 5. Comparison of pretest-posttest scores on students' problem-solving skills

Based on Figure 5, it can be seen that the pretest value produced is 56.5 with the resulting posttest value of 87.16. This shows that the posttest value of students' problem solving skills is higher than the resulting pretest score. This proves that the application of SW based on the Scientific approach that has been developed is very effective in improving students' problem solving skills. This is in accordance with the results of research conducted by Saregar, (2016) that the scientific approach can improve students' conceptual mastery skills through experiments that can be carried out to develop and build physics learning concepts in students.

The difference in the value of the pretest and posttest of students' problem solving skills is caused by the enthusiasm of students' learning when the SW is applied based on the Scientific approach. SW which contains steps for conducting experiments in accordance with the syntax of the Scientific approach, namely 5 M which makes students more enthusiastic in the learning process. Based on the results of research conducted by Suhendi, (2018), it was found that students' critical thinking skills can be developed through learning using worksheets based on a scientific approach.

When learning activities take place, students explore everything they get during the practicum process so that they can easily understand elasticity and Hooke's law based on the concepts they find in practical activities, so that their problem solving skills will also increase. This statement is in accordance with that given by Chutami, (2021) that the scientific method can be used to improve students' problem solving skills through practicums carried out to build and develop concepts in physics learning so as to improve learning outcomes obtained by students. This statement is in accordance with the results of research conducted by Sanggara (2018) which states that students' problem-solving abilities can be significantly improved by practical learning. The results of other research regarding problem solving skills were also found by Wahyuni, (2020) stating that students' problem solving skills can be developed by learning using worksheets so that they are practical and effective in learning well.

The improvement of students' problem solving skills on each indicator was also analyzed using the N-Gain test. The details of improving students' problem solving skills on each indicator based on the N-Gain test scores can be seen in Table 4.

Table 4. Indicator Troubleshooting

Indicator	N-Gain
Focusing the Problem	0.78
Describing the Problem	0.48
Planning Solutions	0.71
Implementing Solutions	0.84
Evaluating Solutions	0.66
Average	0.70

Based on the analysis of the n-gain test, there was an increase in problem solving skills on indicators of focusing on problems, describing problems, planning problems, implementing solutions, and evaluating solutions. It can be seen in Table 4 above that the highest increase occurred in the indicator describing the problem, namely describing solving skills. Describing is assessed based on the ability of students to describe logical problems and implies understanding, not just remembering what has been learned (Irfana, 2019). Efforts to improve problem solving skills using SW based on the Scientific approach in this study were able to develop describing indicators. This is supported by the average value of the pretest-posttest which has increased by 0.69 with moderate criteria.

Based on the results of the response questionnaire analysis that has been carried out, the students gave a very positive attitude towards the SW based on the Scientific approach on elasticity and Hooke's law material. This is indicated by the student response questionnaire score which shows the number 105.38 and is in the very positive category. In addition to students, physics subject teachers also give a very positive attitude towards SW based on the Scientific approach that has been developed. The results of the analysis of the response questionnaire given to the teacher with a score of 3.31 so that the attitude is categorized as very positive.

Therefore, SW based on the Scientific approach developed can be used as an educator as a tool that can help improve students' problem-solving skills and can help students to more easily understand or master a concept by being directly involved in the discovery of the concept.

Conclusion

Based on the results of the research that has been done, it can be concluded that the student whorksheet (SW) based on the scientific approach that was developed obtains very feasible criteria based on the feasibility test that has been carried out with a percentage of 96.66%. Then the SW based on the Scientific approach can improve the mastery of concepts and problem solving skills of students which is indicated by the average value of n-gain mastery of the concept of 0.68 in the medium category and in each indicator of problem solving skills which shows the number 0.69 is in the category currently. As well as teachers and students gave a positive response to the development of SW results based on a scientific approach.

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