Development of Physics Learning Device Based Science Technology Society (STS) Learning Model to Improve Scientific Attitude and Students’ Understanding Concept of X Grade High School

I G A C K Dewi¹, I W Sadia¹, and I B N Sudria¹

¹ Departement of Science Education, Ganesha University of Education, Bali, Indonesia-81116
E-mail: chintyakusuma59@gmail.com

Abstract. This research is the development of physics learning device based on the learning model of Science Technology Society (STS) which is synthesized with a scientific approach. This research aimed to produce learning device in the form of lesson plans, student book, student worksheets, and teacher handbook on momentum and impulse material that fulfilled of valid, practical, and effective criteria. The development of this learning device used 4-D model consisting of four main stages, as follows: define, design, develop, and disseminate. The device development was only carried out until the develop stage. The results data included the result of requirement analysis, product planning, validity, practicality, and effectiveness of the device. The research results were obtained (1) the learning device developed presenting issues related to momentum and impulse material, (2) the validity of the student book is evaluated with very valid category and the validity of teacher handbook is evaluated with valid category, (3) the result of practicality was measured from the implementation of learning device, teachers’ response, and students’ response with very practical category, (4) developed device effectively improve scientific attitude and students’ understanding concept.

1. Introduction
The education system in a country can be a barometer of success for the country itself in managing its country. Education becomes a central aspect that is always given special attention to the national government, because the output of an education system is sufficient to predict the visualization of the nation’s future from the country itself. Education in Indonesia is organized systematically. All technical and non-technical aspects become an important family. The execution of an education system is generally seen in the learning process that occurs in the classroom. The learning process that is expected to occur is very complex, in the sense that it is not limited to the transformation of scientific concepts, but also the inculcation of character values and the development of students' life skills. All aspects must be realized in all types of subjects learned in class.

There are various disciplines which are continued to be various subjects taught in Indonesian schools. One of the subjects that is assumed to be a subject that has a fundamental role for the development of students' life skills is natural science or in foreign terms known as science. Science is essentially a collection of knowledge (a body of knowledge), a way of thinking, and a way of investigation. Science as a collection of knowledge is the results of the findings of various creative inquiry activities from scientists systematically compiled which are called products in the form of facts, concepts, principles, laws, formulas, theories, and models. Concepts are the building blocks...
of thinking. Basic concepts are learned to form higher mental processes to form principles and generalizations [1].

The achievement of Indonesian students' learning achievements in the field of Science is still relatively low. The results survey Program for International Student Achievement (PISA) show that Indonesia is ranked 69th out of the 75th participating countries [2]. The results of the TIMSS study (Trends in International Mathematics and Science Study) in 2011 showed Indonesian students ranked very low in (1) understanding complex information; (2) theory, analysis, and problem solving; (3) use of tools, procedures and solutions problems; and (4) conducting investigations [3]. The results of this study indicate the need for a change in curriculum orientation by not burdening students with learning content, but in the aspect of essential abilities needed by all citizens to participate in developing the country in the future. Therefore, the curriculum reform was carried out to become the 2013 curriculum by emphasizing the scientific approach by providing direct experience for students to develop competencies in learning the natural environment scientifically.

The application of the 2013 curriculum emphasizes the development of student character while demanding cognitive aspects. One of the character education that is emphasized in the 2013 curriculum is the scientific attitude. The applied scientific attitude includes curiosity when learning activities take place, honest attitude when conducting learning activities, the existence of cooperation between students in solving problems during learning activities and students' confidence when communicating the results of the experimental activities carried out. Therefore, schools should be able to play roles and responsibilities to instill and develop good values and help students shape and build character, especially in scientific attitudes. This paradigm also applies in learning science especially physics.

Based on the results of the researchers' initial observations, the researchers found gaps in SMA Negeri 8 Denpasar. Researchers find that students tend to be less enthusiastic in participating in learning physics. Students claimed to have difficulty understanding physics material even more so in answering physics questions. Many students complain about the benefits of studying Physics and assume that Physics is an abstract lesson. Students only know that Physics is only a lesson that contains formulas and theories, without knowing how to apply it in everyday life. Students are only given a direct understanding of the material without going through the process of forming conceptual understanding in students. This will have an impact on scientific attitudes and low understanding of the student concept. Therefore, it is felt very important to apply learning models that use more innovative methods and involve students in them, up-to-date, and be able to improve students' understanding concept.

Data on daily test scores for the previous topic on work and energy in the even semester in class X of SMA Negeri 8 Denpasar found that students' understanding of Physics concepts tends to be low than optimal. Of the total number of 10th grade students are 427 students, it was found that as many as 64% of the total 10th grade students received test scores below the minimal completeness criteria on work and energy material. Only as many as 36% of the total 10th grade students have completed the minimal completeness criteria value of 65. Based on information obtained from physics subject teachers, most students in the learning process are only able to remember and understand the material presented when the meeting is taking place. During the next meeting, only some students still remember or can repeat the material taught before. This shows that the thinking and elaboration activities of 10th students are less than optimal. It was stated that students appeared to be less active in the learning process, and initiative to explore the concepts being learned were not evenly found in each students.

Students tendencies arising from the low of scientific attitude in learning. The low attitude of students in learning is the cause of low understanding concept of students [4]. Curiosity of students who tend to be low, can be seen from the lack of participation in asking questions or opinions during the learning process. In addition, it was also mentioned that students tend to be more receptive to information provided by teachers without any effort to explore broader concepts by utilizing other learning resources.

The advantages of the STS learning model [5], namely: 1) students have higher creativity; 2) greater concern for society and the environment; 3) it is easier to apply the learning concepts to
community; and 4) have a tendency to air-participation in activities to resolve problems in the environment. Students who were given learning with a student-centered STS learning model could significantly increase positive attitudes towards science (scientific attitude) and be able to score high scores for understanding their concepts [6].

Departing from this explanation, the physics learning device that uses the STS learning model is an instrument that is considered capable of overcoming the problem of low scientific attitudes and students' understanding of concepts in physics learning.

2. Methods
This research is the development of a high school physics learning device product based on Science Technology Society (STS) learning model. The method used is research and development. The product developed for 10th grade students including lesson plans, student book, student worksheets, and teacher handbook. The learning device development model used in this study is 4-D model [7]. This model consists of four main stages, as follows, define, design, develop, and disseminate. The device development was only carried out until the develop stage.

Empirical test of this researcher was conducted in SMAN 8 Denpasar; besides, the study population as a subject of testing the learning tool is all 10th grade students of SMAN 8 Denpasar in even semester in academic year 2018/2019. The total of 10th grade is 427 students. Besides, one class was chosen randomly as a sample of limited field trials. 10th grade students of MIA 1 was the class selected which was given a treatment model in developing physics learning based on STS learning model.

The techniques of data collection used in this study were using several instruments such as: (1) the validation sheets of learning device, (2) the observation sheets of the learning implementation, (3) the questionnaire response of students and teachers to the learning components which include student textbook and teacher handbook, and (4) scientific attitude questionnaire and test of student’s understanding concepts on material of momentum and impulse.

The resulting of learning device product are said to have good quality if they complete three aspects, as follows: validity, practicality, and effectiveness. Therefore, to determine the quality of the learning tools developed are needed as follows: validity, practicality, and effectiveness. The criteria of the average validity [8] and the average practicality in learning device [9] are presented in Table 1 and Table 2.

| Range of scores | Category       |
|-----------------|----------------|
| 3.5 ≤ Sr ≤ 4.0  | Very valid     |
| 2.5 ≤ Sr ≤ 3.5  | Valid          |
| 1.5 ≤ Sr ≤ 2.5  | Invalid        |
| 1.0 ≤ Sr ≤ 1.5  | Very invalid   |

| Range of scores | Category      |
|-----------------|---------------|
| 3.5 ≤ Sr ≤ 4.0  | Very practical|
| 2.5 ≤ Sr ≤ 3.5  | Practical     |
| 1.5 ≤ Sr ≤ 2.5  | Impractical   |
| 1.0 ≤ Sr ≤ 1.5  | Very impractical|

The validity and practicality criteria used are if the average score (Sr) obtained is 2.5 ≤ Sr ≤ 3.5 with a valid or practical category.
Table 3. Conversion of Scientific Attitude Questionnaire Values

| Average Score Interval | Category       |
|------------------------|----------------|
| \( \bar{x} \geq 144 \) | Very high      |
| \( 120 \leq \bar{x} < 144 \) | High           |
| \( 96 \leq \bar{x} < 120 \) | Is             |
| \( 72 \leq \bar{x} < 96 \) | Low            |
| \( \bar{x} < 72 \) | Very low       |

3. Result and Discussion

The results of this research in the form of high school physics learning device based on STS learning models consisting of lesson plans, student book, student worksheets, and teacher handbook on momentum and impulse material that fulfilled of valid, practical, and effective criteria. The learning tool developed in this study used the STS learning model which was combined with a scientific approach. It can improve the positive values of students not only in cognitive abilities, but also in positive affective and psychomotor abilities. The results of the development of learning device are different from existing learning device. The lesson plans that have been successfully developed is by applying learning steps to the STS learning model which are synergized with the 5M scientific approach on the subject of momentum and impulse. Therefore, student activities become more directed and meaningful. Generally student textbooks used in schools are books published by printing. Of course, the development of student textbooks have differences, especially in the preparation of the material. Books developed by researchers covering science issues in the society, thus students can construct or build their own knowledge. In addition, the worksheets developed by researchers are also different from the worksheets that are commonly used in schools. The difference lies in the activities or activities of students. Student activities are adapted to the syntax of the STS learning model and the 5M stages of a scientific approach. So students can see a meaningful relationship between concepts and their application in society.

Before a limited field trial, the validity of learning device is tested by experts and practitioners consisting of professional physics teachers with a minimum 5 years of teaching experience and have made a learning device. FGD activities attended by practitioners were also carried out to produce equipment products that completed valid criteria (suitable for use).

The scientific attitude questionnaire test and the student’s understanding concept test were carried out in two classes of 10th grade of SMA Negeri 3 Denpasar. The results analysis of the validity of the scientific attitude questionnaire used product moment correlation technique of Carl Pearson; besides the reliability by using Alpha Cronbach technique. Based on the result analysis, the questionnaire instrument that was declared valid between \( r_{xy} > r_{table} \) and reliable with a reliability \( \geq 0.70 \). The reliability value obtained for the scientific attitude questionnaire was 0.924 which showed the reliability of the questionnaire was very high. The validity of the understanding concept test was measured by using the formula of point-biserial correlation technique and the reliability of the understanding concept test using the Kuder-Richardson 20 (KR 20). The real instrument used in the testing activities concept understanding test has been declared valid because \( r_{pbi} > r_{table} \). Therefore, the score of the relevant item correlates significantly with the total score. The reliability coefficient of the understanding concept test was 0.85, which was classified as a very high category.

3.1. Validation of Experts and Practitioners

Validated products are physics learning device, including lesson plans, student book, student worksheets, and teacher handbook. The validation of the learning device was carried out by 13 practitioners (physics teachers). The validators provide quantitative and qualitative product validation on the validation sheet. The average score of validity for student book is 3.52; syllabus 3.47; lesson
plans 3.41; student worksheets 3.50; teacher handbook 3.51; and evaluation tools 3.50. All the validity of the devices were successfully developed with valid category and feasible to use. The empirical validation of the limited field trial activities carried out at SMA Negeri 8 Denpasar. The practicality of the learning device can be known from: 1) the implementation of the learning device, 2) the teacher's response, and 3) the student's response.

From the results of the study of the feasibility of learning tools obtained a score of 3.52 with very practical criteria, the teacher's response to learning obtained a score of 3.72 with very practical criteria, and student responses to student books obtained a score of 3.52 with very practical criteria. This means that the results of the study indicate that the learning device developed has fulfilled the practical requirements. Practicality of the device is caused by the teacher and students easily utilize the devices that are developed and can utilize in accordance with a predetermined time allocation, as well as the tools, materials, and media used in learning are easy to obtain and easy to use, so students and teachers give positive responses to learning that has been done. Learning activities by using a model of the STS makes students to be active who on activities with the use of scientific knowledge, technology understanding to solve problems and make decisions creating scientific knowledge [10]. STS learning model uses technology as a link between science and society [11]. The STS learning model links science and technology and the benefits to society [5]. The purpose of this learning is to form individuals who have scientific and technological literacy and who are concerned about community and environmental issues. Based on the above it can be concluded that the physics learning device developed have complied with the practicality of learning tools. Therefore, teacher handbook which is developed fit to be used by teachers and student book is also fit to students.

3.2. Effectiveness of Learning Devices

The effectiveness of learning devices is measured by providing a scientific attitude questionnaire and tests of understanding physical concepts on the topic of momentum and impulse. Posttest was given to students of 10th grade students of MIA 1. At this stage pre-experimental design is used in the form of one-shot case study. The effectiveness of the learning device developed can be seen from the results of the scientific attitude questionnaire of students during the learning process and the score of concept understanding tests.

The scientific attitude of 10th grade students of SMA Negeri 8 Denpasar is described based on the average percentage score obtained using the scientific attitude questionnaire. From the results of the study, it was found that the scientific attitude of students was in the high category. The STS learning model has a significant positive effect on students' scientific attitudes [12].

In addition to scientific attitudes, the effectiveness of learning devices is also known by providing a concept understanding test. In this study as many as 20 items were made with details for BC 3.10. Applying the concept of momentum and impulse, as well as the law of conservation of momentum in everyday life. In this study, the average value of the students' understanding of concept tests was 75 with high qualifications. So it can be concluded that the devices are arranged effectively to increase students' understanding of concepts. The learning tools with the STS learning model can improve students' understanding of concepts [13]. The STS learning model is very well applied in science learning, especially in the field of physics because it can provide positive views and changes to science, so as to enhance students' understanding of science concepts and attitudes [14].

Based on the acquisition of the average value of scientific attitudes and the value of understanding the concept, it can be said that the physics learning tool based on the STS learning model is effective in increasing scientific attitudes and students' understanding of concepts.

4. Conclusion

Based on the findings of research and discussion, it can be concluded that the characteristic of learning device developed was presenting issues related to momentum and impulse materials. The validity of the student book is evaluated with very valid category and the validity of teacher handbook is evaluated with valid category. The result of practicality was measured from the implementation of learning device, teachers' response, and students' response with very practical category. Developed
device effectively improve scientific attitude and students’ understanding concept. Based on the finding of this study, that learning device fulfilled valid criteria, practical, and effective in improving scientific attitude and students’ understanding concept, so it can be used in wider scope.

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