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Feasibility Test of STEM Learning Devices Assisted by Learning Videos to Improve Students' Concept Understanding of Dynamic Fluids

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Abstract: This development research aims to test the feasibility of STEM learning tools assisted by learning videos to improve students' understanding of the concept of dynamic fluid dynamics. This research is included in Research and Development (R&D) with a 4D model consisting of Define, Design, Develop, and Disseminate. The products developed are syllabus, Learning Implementation Plan, Student Worksheets, concept understanding test instruments, and learning videos. The technique of collecting feasibility data uses a validation questionnaire that is assessed by six validators, namely three lecturers and three practicing teachers. The results of data analysis using a Likert scale show that the overall average of the device reaches 3.45 with the category of 86.65% (valid). From the results of these data, it can be concluded that the product developed is suitable for use in the learning process.

Keywords: Device development; STEM; Concept understanding

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Introduction

The quality of a nation's generation can be improved through education. Education is a process in order to influence students to be able to adapt as best as possible to the environment thereby causing changes in students that allow them to function strongly in social life. Research conducted by Wijaya (2016) states that students must also have competencies, including having the ability to think critically in overcoming a problem, communicating, collaborating, creativity, and innovating. In addition to students, the educational process involves educators. The task of educators plays an important role in preparing human qualities in the country to be able to compete and struggle to face challenges in the 21st century (Mayasari, et al, 2015). The challenge of the 21st century is technological advances that have both positive and negative impacts on modern life.

Advances in technology can support the world of education so that learning can run easily (Wijaya, et al, 2016). The selection of the right media and teaching materials by utilizing science and technology can support the learning process smoothly. Advances in science and technology have created many applications that can assist teachers in providing an overview of a problem virtually (Sutarno, 2017). In addition, advances in science and technology can assist teachers in overcoming problems, both in learning and in the practicum process by implementing a virtual lab. Educators can also innovate to take advantage of science and technology so as not to create monotonous teaching and learning activities in the classroom.

The use of inappropriate learning models can lead to the boredom of students in following the learning process, materials that are not understood, and make learning monotonous (Sari, 2017). Problems that often arise in schools are usually because students feel bored, bored, and less motivated to learn the material taught by the teacher. The use of the lecture method causes teachers to dominate learning and students are not responsive during teaching and learning activities. This

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student inactivity makes students feel unable to apply a concept to everyday problems (Arifin, 2017). Understanding concepts in physics has become a concern because physics is considered one of the most difficult subjects for students (Azizah & Yuliati, 2015). Understanding the concept of physics can be proven directly by everyone. Therefore, learning physics requires the activeness of students.

Learning physics requires an activity that involves students in problem-solving processes or experiments that can produce a product (Erlinda, 2016). The teacher should act as a facilitator, who only directs students to find ways to solve a problem. In the 2013 curriculum, it is hoped that each educational unit can carry out a process of teaching and learning activities that are creative, independent, challenging, interactive, and inspiring (Permendiknas RI No. 41, 2007). Regarding process standards that require a scientific approach, a learning approach such as the STEM approach can be used. STEM is an approach that in its activities collaborates Science, Technology, Engineering, and mathematics (Milaturrahmah, et al., 2017).

STEM (Science Technology Engineering Mathematics) is an interdisciplinary approach that requires active students through the discussion process in class. Students are required to actively use technology products in learning with a STEM approach (Kaniawati, 2016). STEM learning connects material with life, involves students in practice, guides students in practice, utilizes technology, uses active student learning strategies, communicates actively with students, and gives assignments in groups. The integration of STEM learning with simple technology can help in understanding material and improve high-order thinking skills (Yusuf & Widyaningsih, 2019).

Students who take part in STEM learning are able to improve their understanding and learning experience and can apply concepts from the subject being studied. Active learning can support STEM learning so that it can increase students' creativity (Siswanto, 2018). The STEM approach in Indonesia has not been widely applied in schools. Therefore, researchers raised STEM learning assisted by learning videos in the hope of increasing students' conceptual understanding skills as well as resources and learning to apply STEM learning.

Method

This research uses the type of research and development to produce certain products and test the feasibility of these products. This study uses a 4D development model consisting of Define, Design, Develop, and Disseminate (Thiagarajan, 1974). In the define stage, an analysis of physics learning activities in schools is carried out, in order to obtain information about the problems encountered during learning. The information was obtained through observation sheets and teacher interview sheets. The design stage aims to produce an initial draft of the developed learning device. Learning tools developed in the form of syllabus, lesson plans, student worksheets, videos, and concept understanding test instruments. Furthermore, at the development stage, validation of learning devices is carried out by the validator.

The data analysis technique used to measure the feasibility of STEM learning devices is to use a Likert scale. The Likert scale equation is shown in equation 1.

$$P = \frac{f}{N} \times 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Description:
P = Percentage Number
f = Score obtained
N = Maximum score

Based on the results obtained using the Likert scale, the device eligibility categories are grouped according to Table 1.

Table. 1. Eligibility of Learning Devices

Percentage (%)	Eligibility Criteria
85 -100	Valid
70-85	Quite Valid
50 -70	Less Valid
0-50	Invalid

Result and Discussion

Define stage

At this stage, a preliminary analysis was carried out in the form of observations and interviews with physics teachers at SMA Negeri 2 Praya in order to get an overview of the characteristics of students and learning activities and methods used in class. Based on the results of observations made at SMA Negeri 2 Praya, there are various problems found in physics learning, namely students who tend to be passive, and learning that is still teacher-centered. Meanwhile, based on interviews conducted with physics teachers at SMA Negeri 2 Praya, students did not have enthusiasm in learning and the improvement in learning was still relatively low due to errors or ignorance of basic concepts brought from the previous class. The use of media is rarely used in the classroom due to the teacher's lack of mastery of technology, and learning in the midst of the COVID-19 pandemic has caused educators to have very little time to evaluate the understanding of students' concepts as a whole.

Based on the initial analysis, then a task analysis is carried out that is adjusted to the Basic Competencies and indicators of competency achievement in dynamic fluid materials. The following are the results of the task analysis as outlined in Table 2.

Table 2. Task Analysis with STEM approach

Analysis section	Results of Analysis
Core Competencies	**Core Competencies 1** (Spiritual attitude) Living and practicing the teachings of the religion he embraces. **Core Competencies 2** (Attitude) Living and practicing honest behavior, discipline, responsibility, caring (working together, cooperation, tolerance, peace), politeness, responsiveness, and pro-active and showing attitudes as part of the solution to various problems in interacting effectively with the social and natural environment and in placing themselves as a reflection of the nation in the world association. **Core Competencies 3** (Knowledge) Understand, apply, analyze factual, conceptual, procedural knowledge based on his curiosity about science, technology, cultural arts, and humanities with insights into humanity, nationality, statehood, and civilization related to the causes of phenomena and events, and apply procedural knowledge to specific fields of study in accordance with his talents and interests to solve problems. **Core Competencies 4** (Skills) Processing, reasoning, and praying in the concrete and abstract realms related to the development of what he learned in school independently, and able to use methods in accordance with scientific rules.
Basic competence	3.4 Apply the principle of dynamic fluid in technology. 4.4 Create and test simple projects that apply the principle of fluid dynamics, and their physical meaning.
Indicator	3.4.1 Describes the notion of an ideal fluid, the equation of continuity, and Bernoulli's law. 3.4.2 Describes the physical quantities of dynamic fluids. 3.4.3 Identify the concept of dynamic fluid in everyday life. 3.4.4 Observe a demonstration of the principle of dynamic fluid. 3.4.5 Applying the continuity equation and Bernoulli's law to dynamic fluids. 4.4.1. Gather information on the application of continuity equations and Bernoulli's law. 4.4.2. Create a simple project that applies the same continuity or Bernoulli's law. 4.4.3. Processing and presenting data from simple project experiments that apply continuity equations or Bernoulli's law. 4.4.4. resenting the results of a simple project experiment that applies continuity equations or Bernoulli's law.

Furthermore, concept analysis is carried out on dynamic fluid material. The purpose of this analysis is to find out the main concepts that will be described on the concept map. The concept map for dynamic fluid materials can be seen in Figure 1.

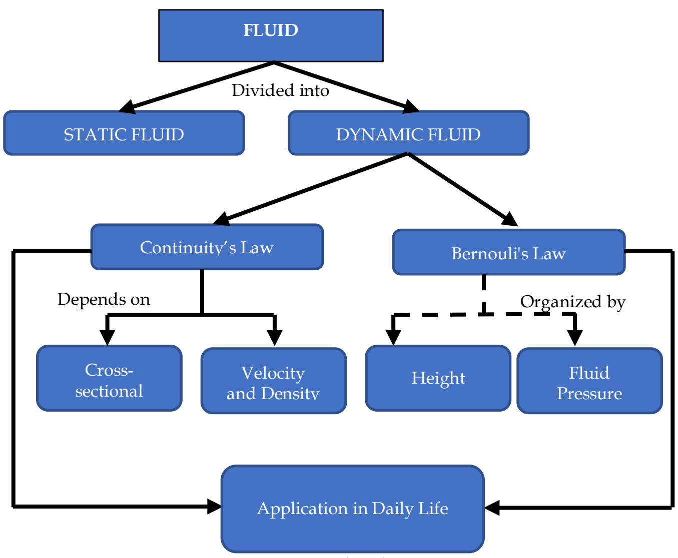

Figure 1. Dynamic Fluid Concept Map.

Furthermore, the formulation of learning objectives is carried out based on the observation stage of the initial analysis. The objectives of the resulting learning are; (1) Through videos used by teachers, students can identify events related to dynamic fluid principles in everyday life; (2) Through the problems given by the teacher, students can mention the properties of ideal fluids; (3) Through group discussions, students can explain physical quantities in dynamic fluids; (4) Through group discussions, students can use the continuity equation in solving problems related to the dynamic fluid principle; (5) Through the presentation of the material, students can use Bernoulli's law equation in solving the problem of tank leakage; (6) Through demonstration activities, students can explain the principle of Bernoulli's law on aircraft lift; (7) Through group discussions, students can gather information to solve problems related to the dynamic fluid principle; (8) hrough teacher explanations and project-making activities, students can create simple projects using dynamic fluid principles; (9) Through experiments using simple projects that have been made, students can process data from the experimental application of Bernoulli's law; (10) Through experiments using simple projects that have been made, students can present experimental data on the application of Bernoulli's law; (11) Through the teacher's direction, students can present the results of the experiment using a simple project that has been made.

Design Stage

At this stage, the design of the product to be developed is carried out. The syllabus developed is a modification of the existing syllabus and adapted to STEM learning. The preparation of the STEM Teaching Program Plan is adjusted to the Core Competencies and Basic Competencies contained in the syllabus. Meanwhile, the Student Worksheet is prepared to support the success of the learning process. so that the student worksheet is given questions that can be solved by searching for information or doing simple experiments. Furthermore, the question of understanding ability consists of 5 items in the form of a description, where each question represents several indicators of conceptual understanding. The ability to understand concepts based on Bloom's revised taxonomy (Anderson et al., 2001) are interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

Development Stage

The development stage is the stage to produce product development which is carried out in two stages, namely: product validation tests by validators and limited trials. The first stage, namely product validation, aims to determine the feasibility of the device developed and assessed by an expert validator consisting of three lecturers. Validator 1, Validator 2, validator 3, and three practicing teachers as Validator 4, Validator 5, Validator 6. The data obtained at this stage is the feasibility data for STEM learning devices can be seen in Table 3.

Table 3. Feasibility of STEM Learning Devices.

Validator	Syllabus	Lesson Plans	Student Worksheet	Instrument	Videos
Expert	3.40	3.36	3.33	3.38	3.50
Practitioner	3.66	3.46	3.46	3.47	3.66
Total average score	3.53	3.41	3.39	3.42	3.58
Validation Criteria (%)	88.25	85.25	84.75	85.50	89.50
Description	Valid	Valid	Quite Valid	Valid	Valid

Table 3. shows the feasibility of learning devices in which the STEM syllabus has an average value of 3.53 with the criteria of 88.25% (valid), for the STEM learning program plan, the average score is 3.41 with the category of 85.25% (valid), for The student worksheet containing the average score of 3.39 with the category of 84.75% (quite valid), for the instrument, the average score was 3.42 with the category of 85.5% (valid), for Video it was obtained an average score of 3.58 with the category of 89.5% (valid). The improvement of STEM learning tools based on input from validators can be seen in Table 4.

Table 4. Validator comments and improvements

Learning Media	Suggestions	Repair
Syllabus	Adding information about STEM learning steps in learning activities	Adding a description of the STEM learning steps in learning activities
Lesson Plans	Fix image on material analysis and Complete how to get the equation	Added dynamic fluid general concept map and added interesting images
Student Worksheet	Add dynamic fluid general concept map and add interesting pictures	Added dynamic fluid general concept map and added interesting images
Concept Understanding Test Instrument	Correct writing according to EYD	Correct writing according to EYD
Tutorial video	Improved sound-to-display compatibility	Improved sound match with the display
	Symbols must be italicized	Fixed formula writing symbols (italics)
	Add the size of the height of the bottle in the experiment	Added height measure to bottle in the experiment
	Explain the image of the arrow in the Bernoulli equation application	Adding an arrow line explanation to Bernoulli's equation

Table 4. shows the improvements needed to improve the feasibility of STEM learning tools assisted by learning videos to improve students' understanding of the concept of dynamic fluid dynamics. The learning tools have been revised based on the validator's comments.

Conclusion

STEM learning tools assisted by learning videos to improve understanding of dynamic fluid dynamics are suitable for use in the learning process.

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