How to train problem-solving skills in physics using authentic learning

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Abstract. Based on early observation, it is known that student's problem-solving skills in one of SMAN Banjarmasin are still low. Research and development to produce a module of dynamic fluid with authentic learning to train student's problem-solving skills were conducted. The objectives of this study were to describe the validity of module. This research used 4D models (Define, Design, Develop, and Disseminate). The data was collected and analyzed from the validation sheet that was rated by the practitioner and expert in physics education. The results showed that the validity of the module is 3.28 and categorized as valid. It can be concluded that the dynamic fluid module with authentic learning is suitable to be integrated within physics learning to train student's problem-solving skills.

1. Introduction
One of the efforts to improve the quality of education through the most basic sciences, one of which is physics which is the basis of all engineering sciences and technology [1]. Learning physics requires problem-solving skills [2], following the objectives expressed by Walsh [3], namely creating humans who can solve complex problems by applying the understanding and knowledge of participants students in everyday life. Students are required to try on their own to find solutions to problems and the knowledge that accompanies them, resulting in truly meaningful knowledge [4]. Students will better master the concepts contained in their cognitive structure and train thinking skills by enhancing problem-solving skills so that they will get better learning outcomes [5–8]. Low learning outcomes can occur due to the lack of problem-solving skills of students [9–12]. So problem-solving skills are one of the determinants of student learning outcomes.

Problem-solving skills can be trained through authentic learning [13–15]. According to Rule [16], authentic learning is learning that focuses on real-life, more complex problems and solutions to solve these problems using role-playing exercises, problem-based activities, case studies and participation in real practice communities. Heath and McLaughlin [17] consider authentic learning activities as "learning from experience". So it can be said that through authentic learning, students are invited to learn from their daily experiences in the real world to practice problem-solving skills.

Based on a preliminary study using a test instrument on students of class XI IPA at a SMAN Banjarmasin city, problem-solving skills have not been trained optimally. Based on the solving indicators used by students who were able to understand the problem by 67%, planning a solution by 46%, solving problems according to the plan by 3.5% and 0% of students who checked back on all steps. Several other facts were found based on the results of interviews with students including (1) learning
physics in class only used teaching materials in the form of student work sheet; (2) the unavailability of a physics module with authentic learning that is related to the problems of everyday life.

One effort that can be made to link physics subjects with authentic learning is module development. Authentic learning is a learning strategy designed by linking problems and applications taught to students in school to real-life [18]. Authentic learning can make it easier for students to analyze a physical phenomenon which can later be explained mathematically [19]. The application of authentic learning makes students not only gain knowledge but also be able to relate the knowledge gained to their daily lives [20]. In line with Triutami & Ruwanto’s [21] research, the development of modules containing authentic learning can increase students’ motivation and understanding of physics concepts. Wornyo, Klu, & Mokhaka [22] reveal that authentic learning provides students with the opportunity to achieve three learning objectives, namely the acquisition of skills, understanding concepts and application of knowledge because authentic learning reflects cognitive experiences that occur in real life [23]. The development of a dynamic fluid module with authentic learning in this study is aimed at practising the problem-solving skills of students. The purpose of this study is to describe the validity of the module being developed.

2. Method
This research is a research and development (R&D) which develops a dynamic fluid physics module with authentic learning. The development steps in this study used the 4D model (Define, Design, Develop, Disseminate) Thiagarajan which was modified into 3D only, namely until the development stage to determine the validity of the module. The stages of module development using a 3D model can be seen in Figure 1.

![Figure 1. Stages of the modified 4D development model being the 3D model](image)

The instrument used was a module validation sheet filled in by three raters from academics (lecturers) and practitioners (teachers). The data obtained from the module validation results were then analyzed to obtain a mean score and compared with Table 1 to determine the criteria for the assessment aspects [24].

| Interval Determination | Interval | Category |
|------------------------|----------|----------|
| $X > \bar{X}_i + 1,8\text{xb}_i$ | $X > 3,4$ | Very Valid |
| $\bar{X}_i + 0,6\text{xb}_i < X \leq \bar{X}_i + 1,8\text{xb}_i$ | $2,8 < X \leq 3,4$ | Valid |
| $\bar{X}_i - 0,6\text{xb}_i < X \leq \bar{X}_i + 0,6\text{xb}_i$ | $2,2 < X \leq 2,8$ | Fair Valid |
| $\bar{X}_i - 1,8\text{xb}_i < X \leq \bar{X}_i - 0,6\text{xb}_i$ | $1,6 < X \leq 2,2$ | Less Valid |
| $X \leq \bar{X}_i - 1,8\text{xb}_i$ | $X \leq 1,6$ | Very Less Valid |

Information:

$X_i$= ideal average = $\frac{1}{2}$ ( max score + min score)

$\text{xb}_i$= ideal standard deviation = $\frac{1}{6}$ (max score – min score)
3. Result and Discussion

This study produced a fluid module with authentic learning to practice problem-solving skills of students. The research and development carried out adapted the research model from Sivasailam Thiagarajan, Dorothy S. Semmel and Melvyn Semeel [25] is a 4D model that is modified into 3D with the stages of define, design and develop.

At the design stage, researchers analyzed the curriculum used in the high school, namely the 2013 revised curriculum, which emphasizes the activeness of students during the learning process. Learning is delivered using a scientific approach, and students are expected to have 4C abilities (Creative, Critical Thinking, Communicative and Collaborative). Besides, learning also applies higher-order thinking skills or HOTS (Higher Order Thinking Skills). Furthermore, analyzing the characteristics of students in class XI IPA who have 17-18 years of age means that they are in the formal operational stage. Based on the results of preliminary data analysis, problem-solving skills will be emphasized at the planning completion stage, solving problems as planned and checking again on all steps. The learning outcomes of students obtained are still low. Also, to analyze the material that will be taught in the development of this module, namely dynamic fluid material with sub materials including ideal fluid, the principle of continuity, the Bernoulli principle and its application in everyday life. This material is suitable to be associated with authentic learning because the application of physics is easy to find in everyday life.

This material was chosen to practice problem-solving skills because the cognitive domain in the Basic Competence of this material is the application level (C3), where students are expected to apply information to real situations easily. In formulating learning objectives, referring to the physics content standards in the 2013 revised curriculum. The basic competence in dynamic fluid material is applying dynamic fluid principles in technology in everyday life. Learning objectives are formulated by adjusting basic competency in a dynamic fluid material.

The preparation of tests based on the learning objectives to be achieved carried out at the define stage. Based on the test indicators made, then the media that can practice problem-solving skills are selected. The media developed in the form of visual media, namely modules containing authentic learning. The final step at this stage is the preparation of the module format. The format developed in the module contains authentic learning on the subject of dynamic fluids, namely cover, foreword, table of contents, instructions for using modules, concept maps, keywords, teaching materials, authentic learning corners, authentic learning skills, physics figures, student worksheets, guided exercises, advanced exercises, group exercises, independent exercises, bibliography, glossary, and answer keys.

At the developmental stage, a dynamic fluid module with authentic learning is arranged according to what has been planned in the define stage. After all of the aspects are met, the developed module is distributed to three validators. Expert validation aims to obtain suggestions for improvement and improvement of the module. Validation was carried out by two academic validators and one practitioner validator using a module validation assessment sheet by ticking the marking scale column for the assessment of each aspect. The results of the validators' assessment were then analyzed to determine the validity of the module and then revised according to the assessors' suggestions so that draft II was produced. The physics module before and after being validated can be seen in Figure 2 to Figure 7 below.

\[ X = \text{empirical score} \]
Figure 2. Arrangement of shapes before validation

Figure 3. Arrangement of shapes after validation

Figure 4. Example questions before validation

Figure 5. Example questions after validation
Based on the results of the validation, a physics module with authentic learning is produced, which can be implemented in the learning process. The results of module validation calculations can be seen in Table 2.

| Aspects of assessment     | Average score | Category |
|---------------------------|---------------|----------|
| Module Format             | 3.36          | Valid    |
| Language                  | 3.31          | Valid    |
| Module Contents           | 3.48          | Very valid |
| Presentation of the module| 3.17          | Valid    |
| Benefits of the Module    | 3.00          | Valid    |
| Average score of aspect   | 3.28          | Valid    |

The results of the module validation from all aspects assessed by the validator obtained an average score of 3.28 in the valid category. The score is reviewed from several aspects including module format, module content, module presentation and module benefits. The format aspect of the module validity has a valid category. It shows that the module cover is attractive, there is a formulation of learning objectives, module components are met, clear numbering, appropriate font types and sizes, design and layout suitability are good, text and image illustrations are appropriate, column format is following paper format, the suitability of material summary With the material, the physical size of the module provides easy storage and is suitable for high school students and the module print quality is good. The language aspect of the module validity has a valid category with aspect criteria including according to the development of students, communicative, straightforward, dialogical, interactive, coherence, coherence of thought flow, consistency, conformity to correct Indonesian language rules, use of terms and symbols. The content aspect of the module gets a very valid category with aspect criteria, namely material coverage, material accuracy and up-to-date. The module presentation aspect has a valid category. It has
several criteria including presentation techniques, supporting material presentation, presentation of learning in modules, characteristics of the module, presenting authentic learning in modules and presenting sample questions and practice questions to practice problem-solving skills. The beneficial aspects of the module are categorized as valid so that teachers and students can use them.

The results of the module validity analysis indicate that the module has been developed based on proper rules and standards so that the module has been able to meet the criteria for good teaching materials. High school students can use good teaching materials as a learning resource [26]. Supported by Arimadona's [27] statement as one of the learning resources, the modules that are developed and have a valid category have good quality. In line with Triutami & Ruwanto's [21] research that modules containing authentic learning that get a good category, are worthy of being tested in physics learning. It shows that the module with authentic learning can be implemented in the learning process in the classroom. Sudiyono [28] states that a valid instrument will also produce valid data or if the resulting data is valid, then the instrument is also valid. It means that the instrument is said to be good, where the material in the module contains authentic learning in good categories. It can be seen from the examples and applications raised in the module relating to the daily lives of students so that students are expected to learn and understand them more easily. Also, the modules developed in this study are expected to increase the motivation of students by learning, according to the statement [29] that the module can increase learning motivation by including pictures and examples of daily life in the module. According to Daryanto [30], a module in which subject matter is written in such a way that the reader can absorb the material on their own or can learn independently. Daryanto & Dwicahyono [31] stated that by studying module material, students are directed to finding a goal through certain learning steps. In this case, the developed module is adjusted based on the objectives in learning, namely to practice problem-solving skills of students. It is supported by the statement [32] that by loading authentic learning, students have more skills in terms of analyzing problems in real life Problem-solving skills that are trained through physics material containing authentic learning provide benefits to students to achieve success in his life [14].

4. Conclusion

Based on the results of the research, it is concluded that the physics module of dynamic fluid material contains authentic learning to practice the developed problem-solving skills that can be implemented in physics learning. It is supported by the validity of the module developed according to the validator, which is valid and fit for use. Through this module, it is hoped that it can increase students' learning motivation because the knowledge learned can be applied in students' daily lives. Besides, with the problems that are presented in this learning which is related to the real world, the students' problem-solving skills are increasingly practised.

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