Textbook Design on Temperature and Thermodynamic Based on Problem Solving Blended Learning Model

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Abstract. Research has been conducted to determine the validity of the development of textbook based on problem solving-blended learning model. The development method used in this research is refer to the 4D development step of Tiagarajan modified. Validation is conducted by 5 people, they are through the validation expert and appropriate field of study. Validation data was obtained by using a sheet validation then analysed by descriptive qualitative method. There are six components of validated used to validate the textbook, including: 1) design; 2) format; 3) materials (content); 4) language; 5) presentation; and 6) the innovation and quality of learning. The result of validity of textbook based on problem solving-blended learning model is 3.3 with a valid criteria. Therefore, the textbook developed are valid and appropriate to use.

1. Introduction
University became a strategy focus in improving the quality of human resources to enrich the life of a nation. One of the main components in higher education are students. Education today is in a period of knowledge (knowledge age) with accelerate in extraordinary speed. In the 21st century, education has a very important role in ensuring students to have the skills to learn and innovate, problem-solving skills, skills in using technology and media information, and be able to work and survive by using skills for life (life skills) [1].

In the UU RI number 12 of 2012 Article 41, paragraph 1 [2] states that the learning resources (one of them is textbook) on higher education must be provided, facilitated, or owned by the college according to the study program developed. Improving the quality of education must always be carried out, one of the efforts to improve the effectiveness of the learning process is the use of the textbook as a source of student learning [3].

Learning resources should be able to increase the student’s creativity so that their thinking skills are increasingly honed and ready to face the challenges of the 21st century. Partnership for 21st century skills formulate into three general skills, namely 1) the skills to think and solve problems, 2) related to information and communication skills, and 3) interpersonal skills and self-regulating [4].

Physics is a subject that requires understanding and rational thought in studying [5]. On the class, there is a lecturer use traditional lecturing and less involvement of students in the lecture. This is the cause of the students often wait every slide power point lecturer presentation without do anything. Students tend to use their thinking and reasoning skills very little. In fact, the physics material can be understood by thinking and reasoning in order to solve the problem.
The results of field observations in March 2019, showed that prospective of teacher physics candidate are less active during the discussion, monotonous and less interested. Presentation of the results discussion are presented in low understanding. Students are less trained in solving problems with various alternative solutions. In a presentation, students show minimum relevant images and videos. The use of technology is considered less than optimal. In addition, students also do not have a textbook as a learning resource which can be used to practice their thinking skills. Many of them are still using senior high school physics books as a source of learning. Another problem obtained during observation is physics teacher candidate less to read articles and scientific literature to increase their knowledge. This shows the lack of knowledge of physics teacher candidate especially on temperature and thermodynamics material.

Therefore, it is necessary to innovate the development of lecture devices such as student textbooks that is in line with 21st century skills characteristic. The problem-solving model is deemed in accordance with the nature of physics. Problem-solving model is defined as a series of learning activities, with emphasis on the process of resolving the problems facing the scientific basis [6]. Problem solving model based on cognitive learning theory and constructivism in which students are assumed to have the intellectual development of the individual when confronted with new and challenging experience when they try to solve the problem raised by this experience [7].

In the learning process by using the problem-solving model, there are several steps that will be performed, as described by [7] as follows:

a) Students listened to lectures objective, reading sheets issues given by lecturer, solve selected problems, and think about the answer while on the problem at hand.

b) Define and organize learning tasks related to the problems faced by working at group with the use of technology and communication.

c) Gathering information from learning resources (textbooks students and media information) as appropriate, carry out an experiment / observation / resolution of problems to get an explanation and problem solving.

d) Students plan and prepare appropriate work such as reports and solutions to problems.

e) Reflection or evaluation and expansion of the investigation results and the processes they use a variety of ways.

As for training 21st century skills, blended learning considered as appropriate method to teach students survival skills. Blended learning combines a variety of activities such as face to face meetings, Internet-based textbooks and virtual learning communities [8]. According to [9], blended learning is a concept that includes the learning process that combines teaching and face to face teaching supported by ICT. Blended learning combines direct instruction, indirect instruction, collaborative teaching, and computer assisted learning.

Problem solving-blended learning model developed in this research is use for students in learning process by lecturers as facilitators and tutors. Lecturer give students the opportunity to train the ability to solve problems (the science) involves hypothesizing with full responsibility, to design and conduct experiments, collect data, analyze the data, create tables of observations, and conclusion supported by ICT to solve the problem. This is in line with the research [5,10] which states that the problem-solving model improve high-level thinking skills, procedural skills, and solve problems.

Based on the above explanation, it is necessary to develop valid and appropriate student textbook especially on temperature and thermodynamic with problem solving-blended learning model which can be used by the students to understand the material and actively engage students in the lecture. Therefore, the formulation of the problem in this research is how the validity of the student textbook-based problem solving-blended learning model developed for physics teacher candidate on temperature and thermodynamics?
2. Methodology
The method used in this research (development research) is the design development 4D model modified into 3 phases: define, design, and develop [11]. Define stage done by setting and define the needs of temperature and thermodynamic textbook by using model of problem solving-blended learning. Stage design is done by designing a draft of the textbook. Develop stage is the stage to revise the draft of the textbook from the previous phase to the final product. The final product has been revised based on feedback and suggestions from 3 validators until declared valid and appropriate to use.

The validation process performed by an expert or experts in accordance with the field of study. In this case there are 5 validators taken from three areas of study. They are 3 from physics expert, one person from language expert, and one person from educational technology expert. The final product is in the form of textbook based problem solving-blended learning model validated from six aspects: 1) the design of textbooks; 2) the format of the textbook; 3) material of textbooks; 4) language; 5) presentation; and 6) the innovation and improvement of the quality of learning.

Data generated from the process of validation by 5 validators are analyzed descriptively. In this study, the average score (P) of the expert assessment result is tailored to the student textbook assessment criteria as can be seen in Table 1 [12].

| Interval Score | Validation criteria | Information                  |
|----------------|---------------------|------------------------------|
| 3.6 ≤ P < 4    | very valid          | Can be used without revision |
| 2.6 ≤ P < 3.5  | valid               | Can be used with small revision |
| 1.6 ≤ P < 2.5  | less valid          | Can be used with major revisions |
| 1 ≤ P < 1.5    | Invalid             | Not to be used               |

3. Result and Discussion
At development and prototyping stage, the design and validation process is carried out by several experts. Here is described the design and validation of the textbook developed. Textbook developed containing components. According to [13] the components of the textbook is the title, the competence to be achieved, supporting information, training and assessment.

At the first page design, there is a textbook cover which designed in such a way to represent the content of this textbook. Therefore, a Figure of heated pan is shown as the cover. The title of the book, “Suhu dan Thermo Dinamika”, has also been validated, that was using font impact, font size 70, and should be coloured resembled as fire (the nature of heat). Moreover, at the cover, there is a problem solving based explanation and blended learning which express that the book was developed using problem solving model and blended learning-based font 30. The design of the cover can be seen at Figure 1.
At the next page, there is a competence indicator that will be achieved by the students. The learning material development must be in line with the indicator that would be developed. The indicator could give a Figure of the effective learning activity to achieve the competence. Therefore, the indicator competence needs to be arranged in the textbook as a guidance to plan, do, and evaluate the result of the learning process. The competence indicator design which needs to be achieved could be seen at Figure 2.

![Figure 2. The design of the competence](image)

Furthermore, in the textbook, there is a component talking about supporting information presented in the form of information and story which were related to the daily life. There is also a story of a figure or an inventor which is hoped to motivate the readers about how the way researchers think. Here is one of the example of the supporting information at Figure 3.

![Figure 3. The Cover Design of Supporting Information (Figure)](image)

Moreover, there is a part which implements blended learning, called as online discussion column. In this column, the students are asked to make a group consists of 3 students. Each groups will accomplish the problem by taking an advantage of internet access. The answer of the problem will be
sent through email and will be discussed at WhatsApp group at the specified time. The design of the online discussion could be seen at Figure 4.

**Figure 4.** The Design of Online Discussion Supporting Blended Learning

Furthermore, there is also a part which is used to train and develop scientific process skill that is mini laboratory. The skill which is trained is advanced process skill. Here is the design of mini laboratory shown at Figure 5.

**Figure 5.** The Design of Mini Lab Supporting Science Process Skills

Moreover, there is competence test which is used as an exercise for the students. This test contains problems that have to be solved. This component supports the problem solving model, since the students are trained to solve the problems in the form of questions. The competence test design can be seen at Figure 6.
Furthermore, there is an exercise question to facilitate the students’ skill in doing problem solving. The exercise question is used to assess students’ comprehension towards the lesson which is learned. The design of the exercise can be seen at Figure 7 as follow.

![Figure 6. The Design of Competency Indicator Supporting Problem Solving Skills](image1)

**Figure 6.** The Design of Competency Indicator Supporting Problem Solving Skills

After the design stage done, the next stage is validation by experts. There are six aspects were observed in the textbooks developed, namely, the design of textbooks, textbook format, content, language, presentation, innovation and improving the quality of teaching and learning. The validation result of design aspects of the textbook can be seen in Table 2.

![Figure 7. The Design of Assessment](image2)

**Figure 7.** The Design of Assessment
Table 2. Validation Result of Design Aspect by Expert

| No. | Aspects of Observations                  | Average | Assessment criteria |
|-----|-----------------------------------------|---------|---------------------|
| 1   | Cover                                   | 3.6     | very valid          |
| 2   | Foreword                                | 3.4     | Valid               |
| 3   | Table of contents                       | 3.8     | very valid          |
| 4   | Learning Objectives / Indicators        | 3.4     | Valid               |
| 5   | The order of the content of the material | 3.2     | Valid               |
| 6   | Design images, tables, and staining     | 3.0     | Valid               |
| 7   | Examples of solving problems            | 3.4     | Valid               |
| 8   | Evaluation (competency test)            | 3.2     | Valid               |
| 9   | Summary                                 | 3.0     | Valid               |
| 10  | References                              | 3.6     | very valid          |

The average score 3.4 Valid

Table 2 states that the score of each indicator on design aspects ranging from 3.0 to 3.8 with a valid and very valid criteria. Overall, the average score of design aspects validation is 3.4 with a valid criteria. This means that the design of textbooks in accordance with the characteristics of the user who in this case are the student in average age of about 19-21 years. The average age 19-21 years is taken from the average age of students taking a basic physics course. Further validation results indicated textbook for format aspect in Table 3.

Table 3. Validation Results of Format Aspect by Expert

| No. | Aspects of Observations                                                                 | Average | Assessment criteria |
|-----|----------------------------------------------------------------------------------------|---------|---------------------|
| 1   | Each section is clearly identifiable.                                                   | 3.4     | Valid               |
| 2   | Material relevant to the purpose of each activity.                                     | 3.2     | Valid               |
| 3   | The numbering system is clear and attractive.                                          | 3.0     | Valid               |
| 4   | Balanced text and illustrations.                                                        | 2.6     | Valid               |
| 5   | Writing (arial font type, font 11, and spaced 1.15) can be read clearly.               | 3.4     | Valid               |
| 6   | Appropriateness physical size for the student.                                         | 3.6     | Valid               |
| 7   | The level of attractiveness of the student textbook visually.                          | 4.0     | very valid          |

The average score 3.3 valid

Table 3 shows that the score of each indicator in format aspect ranges from 2.6 to 4.0 with a valid and very valid criteria. Overall, the average score of the validity of the textbook on the format aspect is 3.3 with a valid criteria. The format of this text adapted from the Glencoe book [14]. Students usually use high school physics book as a source of learning. These books are not optimal on its visually aspect in appropriate with characteristics of the students in their age. Further validation results indicated textbook for the content aspects in Table 4.

Table 4. Validation Result of Content Aspect by Expert

| No. | Aspects of Observations                                                                 | Average | Assessment criteria |
|-----|----------------------------------------------------------------------------------------|---------|---------------------|
| 1   | The material uses a standard reference book                                           | 2.6     | Valid               |
| 2   | Truth content (facts, principles, concepts, laws, theories, and scientific process).  | 3.0     | Valid               |
| 3   | Content update                                                                         | 3.2     | Valid               |
| 4   | Maintaining the relationship between content and implementation in education.         | 3.0     | Valid               |
| 5   | Systematic appropriate with scientific structure                                      | 3.0     | Valid               |
| 6   | Relevant to the curriculum of university and the school.                               | 2.8     | Valid               |

The average score 2.9 Valid

Table 4 shows that the score of each indicator on content aspects ranging from 2.8 to 3.6 with a valid and very valid criteria. Overall, the average score of the validity of the textbook on the content aspect is 2.9 with a valid criteria.
Table 4 indicated that the score of each indicator in the content aspect ranged from 2.6 to 3.2 with a valid criteria. Overall, the average score on the content aspect is 2.9 with a valid criteria. This means that the textbook has been write according to the components criteria of [13], they are the title, the competence to be achieved, supporting information, task and assessment. Content of textbook using a reference from the book physics for scientists and engineer with modern physics [15], Physics Fifth Edition Vol 1 [16], and Fundamentals of Physics [17]. The problems found in the textbook are also based on daily life - today. There is a mini laboratory to train a problem solving skills (science process skills). Images presented also helps the understanding of students and there is a link to access the website for a more complete explanation. Further validation results indicated textbook for language aspect in Table 5.

| No. | Aspects of Observations                                      | Average | Assessment criteria |
|-----|-------------------------------------------------------------|---------|---------------------|
| 1   | Readability in accordance with students and professors      | 3.2     | Valid               |
| 2   | Using good and right Indonesian.                            | 3.2     | Valid               |
| 3   | The term is used appropriately and easily understood.       | 3.4     | Valid               |
| 4   | Using the steady state.                                     | 3.6     | very valid          |
| 5   | Using English communicative and effective.                  | 3.6     | very valid          |
|     | **The average score**                                       | **3.4** | **Valid**           |

Table 5 shows that the average score on each indicator in language aspect ranges from 3.2 to 3.6 with a valid and very valid criteria. Overall, the average score on language aspect is 3.4 with a valid criteria. This means that the sentences used in the textbooks are good and right in accordance with the rules of Indonesian Spelling (EBI). In the textbooks also use a steady state, such as temperature, heat, and expansion. There is also a discussion column and look for alternative solutions utilizing ICT so the textbook is communicative and effective in helping students understand the content. Further validation results indicated textbook for presentation aspect in Table 6.

| No. | Aspects of Observations                                      | Average | Assessment criteria |
|-----|-------------------------------------------------------------|---------|---------------------|
| 1   | Teaching science process skills.                            | 3.8     | very valid          |
| 2   | In accordance with the level of thinking and reading skills of students and lecturers. | 3.6     | very valid          |
| 3   | Encouraging students to actively participate.               | 3.4     | Valid               |
| 4   | Interesting and fun.                                        | 3.8     | very valid          |
|     | **The average score**                                       | **3.6** | **very valid**      |

Table 6 shows that the score of each indicator on aspects of presentation ranged from 3.4 to 3.8 with a very valid criteria. Overall, the average score of the presentation aspect is 3.6 with a very valid criteria. In the textbook, there is a special column for science process skills in the form of mini laboratory that can be practiced easily. Textbooks are also encouraging students to be actively involved because they can seek clarification through website links that has been provided. Further validation results indicated textbook for innovation and quality aspect in Table 7.

| No. | aspects Observations                                      | Average | Assessment criteria |
|-----|-----------------------------------------------------------|---------|---------------------|
| 1   | Compliance with the curriculum of LPTK                   | 3.6     | Very valid          |
| 2   | Stressing on the implementation of real-world education. | 3.4     | Valid               |
| 3   | Support the active learning process.                      | 3.2     | Valid               |
| 4   | Facilitate the development of problem-solving.            | 3.2     | Valid               |
| 5   | Facilitate the development of science process skills.     | 3.6     | Very valid          |
| 6   | Utilizing the media usage of ICT in the learning process. | 3.2     | Valid               |
Table 7 shows that the average score for each indicator on the innovation and learning quality aspect ranged from 3.2 to 3.6 with a valid and very valid criteria. Overall, the average score of the innovation and learning quality aspect is 3.4 with a valid criteria. This means that there is conformity between LPTK curriculums with the curriculum in schools. The content present on textbook is material relating to physics lessons at school and emphasizes the application of real-world education. Textbooks are also utilizing ICT media in the process of solving the problem. This suggests that the textbook based on problem solving-blended learning model are in accordance with the process steps to solve the problem stated by [7]. Therefore, the textbook developed on temperature and thermodynamic declared valid and worthy use of innovation and the quality of learning aspect.

Based on the criteria for the validity results of textbooks, design aspect, format aspect, content aspect, language aspect, presentation and innovation as well as the quality of learning aspect that has been described above, the overall validity of the textbook developed can be seen in Table 8.

| No. | Aspects Observations                                                                 | Average | Assessment criteria |
|-----|--------------------------------------------------------------------------------------|---------|---------------------|
| 7   | Supporting teaching learning process by learning to know, learning to do, learning to be yourself, and learning to live in unity. | 3.2     | Valid               |

The average score 3.4 Valid

Table 8 shows that the average overall validation score of the textbook is 3.3 with a valid criteria. The average score of the validity of the textbook can be presented easily in Figure 8.

Table 8. Validation Result of Textbook with Model-Problem Based Blended Learning

| No. | Aspect                  | Average | Assessment criteria |
|-----|-------------------------|---------|---------------------|
| 1   | Design                  | 3.4     | Valid               |
| 2   | Format                  | 3.3     | Valid               |
| 3   | Content                 | 2.9     | Valid               |
| 4   | Language                | 3.4     | Valid               |
| 5   | Presentation            | 3.6     | Very valid          |
| 6   | Innovation and Quality Learning | 3.4 | Valid               |

The average score 3.3 Valid

Figure 8 shows that presentation aspect has highest validation score that is 3.6 with a very valid criteria. While the content aspects has the lowest score that is 2.9 with a valid criteria. It is alleged that material especially on temperature and thermodynamics are still not comprehensive between curriculum of LPTK and school.

Figure 8. Validation Result of Textbook in Each Aspect
4. Conclusion
Based on result and discussion above, the textbook based on problem solving-blended learning model is valid and worthy to be used. The validity result show that overall aspects has valid result with score 3.3. Recommendation for the next research is to develop textbook by concerning to students characteristic and finish till disseminate stage in order to get better quality of textbook.

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