



Developing A Textbook of Alternating Current Circuit Completed by Solving Problems Using Pythagoras Theorem

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Abstract

One of the most difficult chapters in physics is alternating current circuits. This material is also one of the materials tested in the university test. This is because the material requires a fairly complicated mathematical approach. Additionally, the alternating current circuit textbooks that have been used so far still use too high language. Therefore, the researchers need a simple way that can facilitate students in solving alternating current circuit problems and be packaged in a textbook. A simple way to solve alternating current problems can be done using the Pythagorean theorem. This is because the two are identical. Therefore, the purpose of this research is to develop a textbook on alternating current circuit material accompanied by a solution using a simpler method, namely the Pythagorean theorem. This study uses a research and development model with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) stages. There were five research instruments used: (1) validation sheets; (2) teacher interview sheets; (3) teacher and student needs sheets; (4) test sheets; and (5) student response questionnaire sheets. The developed textbook has been validated by two experts and one user with a percentage value of 89.13%, so it is in the very valid category. In addition, based on the results of field tests on 34 class XII students of Senior High School in Jember, it is known that the developed textbook obtained an effectiveness percentage of 83.46% with an N-Gain value of 83.46. The textbook is in the high category and has a response questionnaire percentage of 80.3, so the developed textbook received a very positive response from students. By using this textbook, students can solve alternating current circuit problems more effectively and efficiently.

Keywords: Alternating Current; Pythagoras; Solving Problems; Textbook

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INTRODUCTION

Learning is a learning activity carried out by educators and students equipped with materials/ tools and a series of interconnected procedures to achieve learning goals (Amini, 2017; Makki & Aflahah, 2019; Nuraini et al., 2022). In a learning process, the availability of teaching materials can support the learning process's success and improve students' understanding and learning outcomes; Permana *et al.*, 2018), especially if the teaching material is printed into a textbook that contains concepts or material supplemented with various sample questions and exercises to hone students' abilities (Maryamah et al., 2019; Permatasari & Trisnawati, 2021). Also, increasingly sophisticated technological advances are expected to produce better-quality textbooks (Koparan, 2017). However, until now, textbooks with complete material emphasizing the process of solving physics problems are still unavailable for senior high school students of the same level (Ariani, 2019).

Using textbooks in the classroom is an important component that cannot be separated from teaching and learning activities to achieve learning objectives. Research by Iswara *et al.* (2018) has proven that using teaching materials improves student learning outcomes. Furthermore, research by Yulia *et al.* (2018) also showed an increase in average knowledge between the control and experimental classes; the experimental class had an average of 84.04, while the control class had an average of 77.15. This research shows that using teaching materials has improved student learning outcomes.

The learning process that does not involve textbooks can cause the learning process to be less than optimal and not directed (Ramah & Rohman, 2018; Oktaviani et al., 2017). A textbook that can realize optimal learning and achieve learning goals is certainly good. A

textbook can be said to be a good textbook if it meets the four criteria for eligibility standards for a textbook based on the National Education Standards Agency regulations, namely content feasibility, presentation feasibility, linguistic feasibility, and graphic feasibility (BNSP, 2016). In addition, a textbook must follow the correct spelling, be not difficult to read, be attractive, and contain theory supplemented with illustrations to explain the meaning (Depdiknas, 2008).

One of the textbooks that is often used in learning is a printed textbook. Printed textbooks are textbooks that can help students understand and learn in order to achieve learning goals (Rohman, 2018). Printed textbooks have several advantages, including that students can more easily understand learning material because they can underline several important sentences, and they do not require new tools in the form of software or the like. They are easy to read anywhere and anytime without the influence of a signal.

One of the subjects that need to be supported by using teaching materials is physics because physics is difficult for high school students (Astalini et al., 2019; Diani et al., 2018). This statement is in line with the results of limited interviews with several physics subject teachers at Jember Regency High School, who stated that physics is a difficult subject and contains many similarities (Novelensia et al., 2021). Therefore, we need a printed textbook to help teachers and students learn physics more easily.

One of the physics materials considered difficult by students and used as material for the National Examination and state university entrance tests is alternating current material (Supriadi *et al.*, 2023). This is because its completion requires quite complicated mathematical calculations and approaches, so students experience

difficulties (Wahyuni & Handhika, 2019). In addition, in several printed books, the discussion of dynamic electrical material on alternating current circuits still uses language that is too high-level, and the discussion of the text has not been correlated with the questions, so students experience difficulties in solving questions (Sasmita et al., 2021; Hidayah et al., 2019). Therefore, a method of solving alternating current questions is needed, which is simpler and arranged in a printed textbook so that it can be understood optimally by students, is needed (Fitriah, 2019). This is because the textbooks used today still use more complicated conventional methods.

One fast method that can be used to solve physics problems is to use the Pythagorean Theorem. The Pythagorean theorem is a quick trick to solve using Pythagorean triple values. In solving alternating current circuit problems, students do not need to calculate in a complicated and lengthy way. This is because fast tricks are usually associated with mathematics, and one of the links between physics and mathematics is the Pythagorean theory (Hasyim & Ramadhan, 2018). In addition, the reason for using the Pythagorean theorem in this study is because the equation in the RLC circuit is identical to the Pythagorean theorem equation.

Previous research on the Pythagorean Theorem in solving physics problems has been carried out by Okun (2008) regarding the transmission of Einstein's special relativity equations into a simpler form. This method was then applied by Korkmaz et al. (2016) to the world of education, and the result was that the Pythagorean Theorem could be used to solve physics problems. Furthermore, it was further developed by applying the Pythagorean theorem to Einstein's special reactivity material (Supriadi *et al.*, 2019). In addition, students' responses to the Pythagorean

Theorem also have a strong average criterion (Supriadi *et al.*, 2022).

Based on the problem description and previous research's success, the researcher wants to provide innovation for educators and students in the form of an alternating current textbook accompanied by problem-solving using a simpler method, namely using the Pythagorean theorem.

METHOD

The type of research used in this study is Designed Based Research (DBR) using the ADDIE model. DBR is a series of approaches intending to generate new theories and practices that explain and potentially impact the natural teaching and learning process (Akker, 2013).

The research was carried out in the odd semester of the 2022/ 2023 academic year with 34 class XII students at Senior High School in Jember. That school was chosen because, based on the teacher's needs questionnaire results, it was explained that the textbook currently used in class learning describes formulas that are too long, so teachers experience problems in explaining to students regarding problem-solving. Therefore, learning requires a textbook that is systematically arranged and equipped with examples of questions that are arranged from examples of easy-level questions to examples of difficult-level questions. The teacher also explained that at the school where the research was conducted, an alternating current textbook had never been prepared, which was equipped with various types of questions and accompanied by solutions in a simpler and faster way.

The ADDIE Model is named after the abbreviation of the process or its stages, namely Analysis, Design, Development, Implementation, and Evaluation (evaluation/ feedback) (Tegeh & Kirna, 2013; Ramadhanti et al., 2020). Using the ADDIE model in a

product development process is a method that is quite effective at this time (Defina, 2021). The five stages can be illustrated in Figure 1.

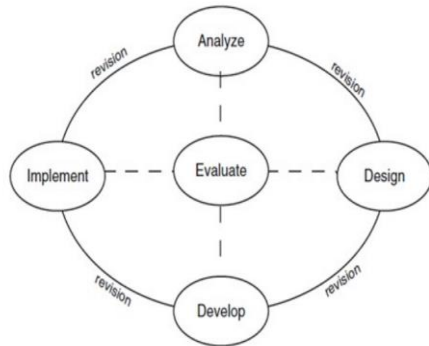


Figure 1 ADDIE development model stages
(Sumber: Cahyadi, 2019)

The detailed research stages are as follows.

Analysis

The data collection process was carried out at this stage by analyzing the necessary needs. The analysis phase was carried out in four stages: teacher needs analysis, student needs analysis, learning materials, and learning objectives (Tyas et al., 2020). Therefore, at this stage, several research instruments were needed, including (1) a validation sheet, (2) a teacher interview sheet, (3) a teacher and student needs sheet, (4) a test sheet, and (5) a student response questionnaire sheet. While the analysis section only uses instruments (2) and (3).

Design

Design is the process of making a product design. In this study, the product developed was a textbook on the Pythagorean Theorem on alternating current circuits. There are several steps taken in this stage, namely determining learning objectives (Wini et al., 2020), compiling learning materials, and designing the cover and layout of the textbook. The design phase was carried out with several design/ appearance

revisions before being developed and validated by the validator.

Development

The development stage is the stage where the textbook that has been compiled is reviewed by experts through a validity test; at the development stage, two activities were carried out: making product measurement instruments and testing product validity. The validators in this study were two material and media experts: a physics education lecturer at FKIP University of Jember and one user or field practitioner, a class XII physics teacher at Senior High School in Jember. The criteria for evaluating textbooks follow the Likert scale, which consists of five categories, as shown in Table 1.

Table 1 Validation sheet criteria

Criteria	Score
Very Valid	5
Valid	4
Quite Valid	3
Less valid	2
Invalid	1

(Modified from Hodiyanto et al., 2020)

The score data obtained is then converted into a percentage form and then the product validity value is searched. The percentage results obtained are then analyzed and converted into a predicate statement. The guidelines for converting percentages to predicate statements are shown in Table 2.

Table 2 Criteria for percentage validity based on expert questionnaires

Percentage (%)	Interpretation
$80\% < p \leq 100\%$	Very Valid
$60\% < p \leq 80\%$	Valid
$40\% < p \leq 60\%$	Quite Valid
$20\% < p \leq 40\%$	Less valid
$0\% < p \leq 20\%$	Invalid

(Modified from Hodiyanto, 2020)

Implementation

The implementation stage is carried out after the textbook is declared valid by

the validator. After the textbook was declared valid, the textbook was tested in the field on Class XII students of the senior high school in Jember, which is determined by the random sampling technique recommended by Sugino (2017). Trials in this study were conducted to determine the effectiveness and practicality of the textbook that had been compiled. In this study, two types of tests were carried out.

Effectiveness test

Test the effectiveness of textbooks on a limited basis. Testing the effectiveness of this study was carried out by measuring student learning outcomes before and after using the compiled textbooks. The research was conducted in 2 meetings (the meeting in question was not the whole chapter, but specifically the last chapter, namely the application of the Pythagorean theorem in a simple AC circuit) where the first meeting gave a pretest while the second meeting taught the Pythagorean theorem and gave a posttest. The Pretest and Posttest scores were then analyzed using the N-Gain score developed by Hake & Richard (2002) to determine the effectiveness of developing textbooks.

Meanwhile, to find out the magnitude of the increased value of student learning outcomes seen from the difference between pretest and posttest scores obtained by students. Data on students' cognitive learning outcomes were then analyzed using the N-Gain score. The results were analyzed using the Normalized Gain criteria (g) in Table 3.

Table 3 Normalized gain criteria

N-Gain Criteria	Criteria
$g \geq 70\%$	High
$30\% \leq g < 70\%$	Medium
$g < 30\%$	Low

Student Response Test

Student response test regarding how positive the textbook was developed with a limited test. This trial was

obtained from student responses to a questionnaire that had been distributed. Score data obtained from a Likert scale questionnaire is in the form of a percentage. So, the results can be analyzed using the following equation. The percentage results were categorized into provisions of the Student response value category according to the provisions of the Student response value category can be seen in Table 4.

Table 4 Category of student practicality

Score Range	Criteria
$80\% < p \leq 100\%$	Very Positive
$60\% < p \leq 80\%$	Positive
$40\% < p \leq 60\%$	Pretty Positive
$20\% < p \leq 40\%$	Less Positive
$0\% < p \leq 20\%$	Very Less Positive

(Modified from Riduwan, 2015)

Evaluation

This stage is the improvement stage based on the suggestions and input provided by the validation team and users regarding the shortcomings of the textbooks. The revision stage is in every step of the ADDIE model, starting from Analysis, Design, Development, and Implementation. At this stage, it would also be discussed regarding the level of validity, effectiveness, and student responses to the textbooks prepared. The evaluation stages in the ADDIE model are carried out as a thorough evaluation from start to finish, and the evaluation activities aim to determine student competencies obtained from learning outcomes. The evaluation carried out can be obtained from the student response rates and the N-Gain results from the respondents' test results.

RESULT AND DISCUSSION

The development product produced in this study is a textbook on alternating current circuits accompanied by problem-solving using the Pythagorean theorem. The development product produced in this study aims to provide a simpler way of solving alternating current circuit problems using the

Pythagorean Theorem. Thus, from the resulting product development, it is hoped that students can solve alternating current circuit questions more easily and simply. In accordance with the development model used, the results of the data obtained in this study include the following five stages:

Analysis

The analysis phase was carried out in three stages: needs analysis, student character analysis, and curriculum analysis (Benny, 2019). At the needs analysis stage, it is known what problems are experienced by teachers and students in learning, so researchers can find solutions to the problems they face. The teacher's needs questionnaire results explained that the textbook currently used in class learning describes formulas that are too long, so teachers experience problems explaining problem-solving to students. Therefore, learning requires a textbook that is systematically arranged and equipped with examples of questions arranged from examples of easy-level questions to examples of difficult-level questions. The teacher also explained that at the school where the research was conducted, an alternating current textbook had never been prepared, which was equipped with various types of questions and accompanied by solutions in a simpler and faster way. But apart from this, students' learning outcomes on physics material by solving questions that require long mathematical formulations are considered quite good.

The second stage of analysis is the analysis of the characteristics of students. An analysis of student characteristics was carried out to determine the characteristics of students from cognitive, affective, and psychomotor aspects. These three aspects were obtained in detail from the results of the interviews, where the results showed that in terms of cognitive

aspects, it was considered quite good. However, sometimes some students were not careful in working on the questions and had difficulty applying the formulas in the questions. From an affective perspective, some tend to be active in learning. In terms of psychomotor skills, students are quite skilled at learning.

In addition to interview data, an analysis of the characteristics of students was also obtained from the results of a questionnaire, which revealed that students have different habits in terms of their learning styles. Nine students stated that they learned materials by studying the material and understanding the content of the material, 14 students stated that they studied material by reading repeatedly, ten students learned material by memorizing formulas, nine students learned material by solving questions, and only one student learned material by listening to explanations Teacher.

Next is the curriculum analysis stage. The purpose of curriculum analysis is to find relevant material so that the development of textbooks can encourage students to increase their ability to process alternating current problems in various cases. Curriculum analysis is carried out by identifying the characteristics of the material and learning objectives. An analysis of material characteristics is carried out to determine the material used in product development. Material characteristics were obtained from literature studies in journals and textbooks.

The researcher chose an alternating current circuit in this study because the alternating current is a material with many complicated mathematical equations, so teachers must be able to provide examples of questions with different cases and their applications in life. However, sometimes the teacher only gives questions limited to concepts which are still limited to a few cases.

This makes students less able to solve problems and practice more in-depth questions. Therefore, a textbook on alternating current was compiled, which was equipped with various examples of problem applications, especially series RL, RC, and RLC circuits and combinations.

Design

This stage is the initial planning stage for making teaching materials which consist of outlines, namely determining learning objectives, selecting types of teaching materials, and designing product concepts (Suhadirman et al., 2022). This stage is the initial planning stage for making teaching materials which consist of determining learning objectives, choosing the types of teaching materials, and designing product concepts. The learning objectives are determined based on Core Competency, Basic Competence, and alternating current circuit material indicators. Next is the stage of selecting the types of teaching materials according to the characteristics of students, material characteristics, and the school environment. Based on the analysis results, the textbook was chosen as the teaching materials developed in this research. At the product design

stage, several activities were carried out, namely conducting work analysis and needs analysis and analyzing indicators and learning objectives based on KI and KD. In addition, at the design stage, a design plan was also made on the manuscript layout and textbook design layout (Simarmata, 2022). The textbook development design layout can be seen in Figure 2.



Figure 2 Cover design and textbook layout

The results of the design of an alternating current textbook accompanied by problem-solving using the Pythagorean theorem are divided into three main parts: introduction, content, and closing. Each of these parts can be seen in Table 5.

Table 5 The design of a textbook for alternating current circuits is accompanied by problem-solving using the Pythagorean theorem

No	Textbook Components	Textbook Design	Page
1	Introduction	a. Textbook Cover	-
		b. Foreword	ii
		c. Table of Content	v
		d. List of Table	vii
		e. List of Figure	viii
2	Content	a. The material in each chapter	1-10
		1. Chapter 1 : Alternating Current Voltage	11-20
		2. Chapter 2 : Alternating electric current	21-34
		3. Chapter 3 : Resistance in alternating current circuit	35-44
		4. Chapter 4 : Alternating current power	45-104
		5. Chapter 5 : Alternating Current Circuit	
6. Chapter 6 : The Pythagoras Theorem in			

No	Textbook Components	Textbook Design	Page
		Simple RLC Circuit	
		b. Sections in Chapter	
		1. Learning Instruction	105-124
		2. Learning Outcomes	
		3. Fill in the material	
		4. Summary	
		5. Examples of question and discussion	
		6. Practice question	
3	Closing	a. Competency test 1	131-142
.		b. Competency test 2	143-154
		c. Bibliography	155-158
		d. Glossary	159-162
		e. Index	163-164
		f. Writer Biography	165-166

The following differences in solving the old method and Pythagoras are shown in Figure

3.

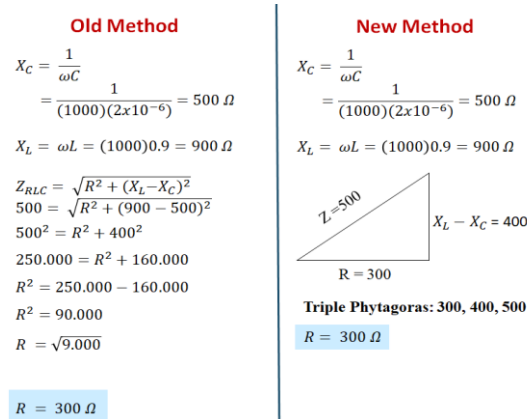


Figure 3 The differences between solving the old method and Pythagoras

Development

The development stage is the stage where the realization of the textbook design is carried out. One of the important stages in this stage is the validity testing stage by experts regarding the teaching materials being developed (Defina, 2021). At the Development research stage, validation activities were carried out for three validators. These included two expert validations by Physics Education lecturers at the University of Jember and one user validation by a physics teacher at a Senior High School in Jember. The validation results for the textbook on alternating current circuits accompanied by problem-solving using the Pythagorean theorem are shown in Table 6.

Table 6 Validation results of the textbook pythagorean theorem in simple AC circuits theory and its applications

No	Aspect	Average score (Max score = 5)	Score
1.	Content Eligibility	4.36	90.40%
2.	Language Eligibility	4.47	89.33%
3.	Eligibility of Presentation	4.30	87.60%
4.	Graphic Eligibility	4.43	89.70%
Value average Criteria			89.13%
			Very Valid

The assessment aspects of validator 1 consist of four assessment aspects, namely content feasibility, language feasibility, presentation feasibility, and

graphic feasibility, with a total of 48 questions. Table 6 shows that obtaining a value from validator 1 is in the content aspect of 90, language feasibility of 88,

presentation feasibility of 89.2, and graphic feasibility of 89.2. Thus, the average value of validation by validator 1 is 89.1. The average value is $80\% < p \leq 100\%$, so according to the validity criterion, it is in very valid criteria (Desyandri et al., 2019).

The assessment aspects of Validator 2 consist of four assessment aspects, namely content feasibility, language feasibility, presentation feasibility, and graphic feasibility, with a total of 48 questions. Table 6 shows that obtaining a value from validator 2 is on the content aspect of 86.6, language eligibility 88, presentation feasibility 80, and graphic feasibility 89.2. So that the average value of validation by validator 2 is 85.95. The average value is $80\% < p \leq 100\%$, so according to the validity criterion, it is in very valid criteria.

The assessment aspects of validator three (users) consist of four assessment aspects, namely content feasibility, language feasibility, presentation feasibility, and graphic feasibility, with a total of 48 questions. From Table 6, it can be seen that obtaining a value from validator 3 (user) is 92.75. The average value is $80\% < p \leq 100\%$, so according to the validity criterion, it is in the very valid criteria. Based on the validation results from the three validators on the four aspects that have met the eligibility standards, it can be concluded that the textbook of alternating current circuits accompanied by problem-solving using the Pythagorean theorem is very valid and can be applied in the learning process.

The results of the revision of the textbook are (1) Completion in chapter 6 related to the quick way in the sample questions section is too long and seems complicated, (2) In each chapter, the learning objectives and learning outcomes have not been included. In addition, the design at the head of the chapter is still not attractive, (3) In the discussion section on resistors, the

image still does not explain how to read the correct resistor. It is better if the drawing is specified, and (4) The phasor drawing still has errors, namely that the direction of the phasor e should be counterclockwise, and besides that, in the picture, it is still not written what components are on the x-axis and y-axis.

Implementation

The implementation stage is the stage where researchers apply the learning system that is being developed. The main objectives of this stage include:

- 1) Directing learners in order to achieve goals or competencies.
- 2) Ensure there is a way out of problems/ solutions so that they can overcome gaps in learning outcomes for students.
- 3) Ensuring the achievement of the competencies, knowledge, skills, and attitudes students need (Simarmata, 2022).

The implementation stage of the textbook is carried out with two tests, namely the effectiveness test and the practicality test, as follows:

Effectiveness Test

After the textbook is validated by three validators and declared valid, the next step is to carry out the implementation phase of the textbook in learning. The implementation phase was carried out on a limited basis at the senior high school in Jember, precisely in class XII MIPA 6. The implementation phase was carried out using textbooks in the learning process, then giving pretest and posttest to students (N=33) to find out the increase in pretest and posttest results so that the level of effectiveness of the book was known. Teach alternating current circuits accompanied by problem-solving using the Pythagorean theorem in learning. In the pretest questions, students are directed to work on questions using the conventional method, while in the posttest questions, students are directed

to solve problems using the Pythagorean theorem. The results of the pretest and

posttest values can be seen in Table 7.

Table 7 Pretest and posttest results in limited trials

Number of Students	Average Pretest	Average Posttest	Difference in Average	Average N-Gain (%)	Category
33	47.58	90.61	43.03	83.46	High

Based on the results in Table 7, using N-Gain shows the average pretest result (using conventional solutions) is 47.58, while the average posttest score (using the Pythagorean theorem) is 90.61, with a difference of 43.03. Referring to the Normalized gain criteria shows that students' learning outcomes are 83.46%, so they are in the high category. This value indicates that the developed book can be effective in improving student learning outcomes because the textbook is equipped with easier problem-solving, so it does not require a long mathematical method in its completion. This can also be seen from the way

students work on the pretest and posttest: the working paper needed by students during the pretest tends to be more complicated and lengthy because it uses a complicated and lengthy method, while in the posttest it only requires a maximum of one paper in the process.

Student Response Test

Student response test was carried out by giving questionnaires to students' responses to a textbook on alternating current circuits accompanied by problem-solving using the Pythagorean theorem in limited tests, and can be seen in Table 8.

Table 8 Results of student practicality of alternating current coursebooks accompanied by problem-solving using the pythagorean theorem

Aspect	Percentage Aspect	Average Percentage (%)	Category
Ease of Use	83	80.3	Very Positive
Attractiveness	75		

The results of the student response questionnaire on the aspect of ease of use obtained a score of 83, and this shows that the developed textbook has been able to help students understand alternating current circuit material because it describes easier completion steps, uses simple language, and contains structured material systematically. Furthermore, in the aspect of attractiveness, a score of 75 is obtained; this means that the developed textbook uses an appropriate color composition and clear presentation of pictures and illustrations to increase student interest. The last aspect is the aspect of textbook efficiency, and this aspect gets a score of 83. This shows

that the developed textbook allows for independent study use, is easy to carry anywhere at any time, and is in good condition even for a long period. From these three aspects, the results of the student response questionnaire obtained an average of 80.3%. The results of the average percentage of response aspects are then adjusted according to indicators according to Riduwan (2015). Indicators with an average percentage of 80.3% are in the range, so it can be concluded that the textbook on alternating current circuits accompanied by problem-solving using the Pythagorean theorem is categorized as very positive (Mujizah et al., 2020).

Evaluation

The evaluation stages are carried out formatively at each stage in the completed ADDIE procedure, namely Analysis, Design, Development, and Implementation. At the analysis stage, an evaluation was carried out because there was still a lack of data regarding teacher needs, so the results of interviews complemented the analysis. Through the interview stage, it can be known what problems are experienced by teachers and students in learning, so the researchers can obtain solutions to the problems they face, according to a class XII physics teacher at Jember High School. An evaluation/improvement is carried out at the design stage, namely the cover design and textbook layout, as shown in Figure 4.

Rancangan Buku Ajar Teorema Pythagoras dalam Rangkaian AC Sederhana Teori dan Aplikasinya		
No	Draft	Outline
1.		
2.		

Figure 4 Revised Cover and Layout

At the development stage, an evaluation was carried out on the suggestions and comments of the validators for improving the textbook.

Evaluation at the implementation stage is at the stage of using textbooks in the field. At the implementation stage, there is an evaluation, namely that not all students get textbooks because they are still being printed in limited numbers. This can also cause students to be less than optimal in assessing the textbook.

CONCLUSION

The following conclusions can be drawn based on the data obtained from the research results and the discussion regarding the development of a textbook on alternating current circuits accompanied by problem-solving using the Pythagorean theorem described in the previous chapter.

The alternating current textbooks accompanied by problem-solving using the Pythagorean theorem are categorized as very valid by expert and user validators with an average score of 4.39 and a validity percentage of 87.8% so that the product can be implemented in the learning process.

Alternating current circuit textbook accompanied by problem-solving using the Pythagorean theorem obtained data on the improvement of the N-Gain test, which was categorized as high with an average score of 83.46%, so the alternating current circuit textbook accompanied by problem-solving using the Pythagorean theorem can be effectively used in learning.

The textbook for alternating current circuits, accompanied by problem-solving using the Pythagorean theorem, obtained practicum data with an average value of 80.3, so it received a very positive response from students. This makes students motivated to learn because this book contains simpler problem-solving.

REFERENCES

Akker, J. V. D., B. Bannan., A. E. Kelly., N. Nieveen, & T. Plomp. (2013). *Educational design research*. Enschede: Netherlands institute for curriculum development.

Amini, R. (2017). The development of integrated learning based students' Book to improve elementary school students' competence. *Unnes Science Education Journal*, 6 (2): 1586-1592.

Ariani, T. (2019). Efektivitas bahan ajar

- fisika berbasis scientific materi termodinamika, *Jurnal Inovasi dan Pembelajaran Fisika*, 6(1), pp. 45–55.
- Astalini, Kurniawan, D. A., Perdana, R., & Pathoni, H. (2019). Identifikasi sikap peserta didik terhadap mata pelajaran fisika di sekolah menengah atas negeri 5 Kota Jambi, *Unnes Physics Education Journal*, 8(1), 34–43.
- Defina, D. (2021). *BIPA dan MKWK Bahasa Indonesia: Penelitian dan Pengembangan Materi Ajar di IPB*. Bogor: IPB Press.
- Depdiknas. (2008). *Panduan pengembangan bahan ajar*. Jakarta: Depdiknas.
- Desyandri, D., Muhammadi, M., Mansurdin, M., & Fahmi, R. (2019). Development of integrated thematic teaching material used discovery learning model in grade V elementary school. *Jurnal Konseling Dan Pendidikan*, 7(1), pp. 16-22.
- Diani, R., & Syarlisjisman, M. R. (2018). Web-enhanced course based on problem-based learning (PBL): Development of interactive learning media for basic physics II. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 7(1), pp. 105-116.
- Fitriah, L. (2019). Efektivitas buku ajar fisika dasar I berintegrasi imtak dan kearifan lokal melalui model pengajaran langsung. *Berkala Ilmiah Pendidikan Fisika*, 7(2), pp. 82–96.
- Hake, H., & Richard, R. (2002). Relationship of individual student normalized learning gains in mechanics with gender, high-school physics, and pretest scores on mathematics and spatial visualization. *IUB Physics Education research*, 1(1).
- Hasyim, F., & Ramadhan, A. (2018). Kecukupan kemampuan matematika bagi calon guru fisika, *Jurnal Inovasi Pendidikan Fisika dan Integrasinya*, 1(2), pp. 1–6.
- Hendriani, N. (2021). *Bahan Ajar Sosiologi SMA Berbasis Nilai-nilai Keimanan dan Ketakwaan*. Banten: Pascal Books.
- Hodiyanto. (2020). Pengembangan media pembelajaran berbasis micromedia flash bermuatan problem posing terhadap kemampuan pemecahan masalah matematis, *Jurnal Pendidikan Matematika*, 9(2), pp. 323–334.
- Hidayah, D. N., & Priscylio, G. (2019). Pengembangan bahan ajar mandiri pokok bahasan suhu dan kalor menggunakan software Camtasia. *Journal of Teaching and Learning Physics*, 4(1), pp. 50-64.
- Iswara, W, Gunawan, A, & D. (2018) . Pengaruh bahan ajar muatan lokal mengenal potensi bengkulu terhadap hasil belajar peserta didik, *Jurnal Pendidikan Guru Sekolah Dasar*, 1(1), pp. 1–7.
- Koparan, T. (2017). Analysis of Teaching Materials Developed by Prospective Mathematics Teachers and Their Views on Material Development, *Malaysian Online Journal of Educational Technology*, 5(4), pp. 8–28.
- Korkmaz, S. D, Aybek, E. C, & Orucu, M. (2016). Special relativity theorem and Pythagoras magic, *Journal IOPscience*, 51(2).
- Mahendra, Z. E., Purwana, U., & Simulation, I. (2022). Pengembangan lkpd digital berorientasi nature of science dan berbantuan phet interactive simulation pada materi gerak harmonik sederhana. *Jurnal Ilmiah Pendidikan Fisika*, 6(3), 557.
- Makki, I, & A. (2019) *Konsep dasar belajar dan pembelajaran*. Pamekasan: Duta Media Publishing.
- Maryamah, I, Anriani, N, & Fathurrohman, M. (2019). Pengembangan bahan ajar materi pythagoras yang berorientasi pada kompetensi abad 21 untuk guru SMP. *Supremum Journal of Mathematics*

- Education (SJME)*, 3(1), pp. 67–77.
- Muzijah, R., Wati, M., & Mahtari, S. (2020). Pengembangan e-modul menggunakan aplikasi Exe-Learning untuk melatih literasi sains. *Jurnal Ilmiah Pendidikan Fisika*, 4(2), pp. 89-98.
- Novelensia, N., Bektiarso, S. & Maryani, M. (2021). Penerapan Pembelajaran kooperatif tipe numbered heads together (nht) disertai metode eksperimen dalam pembelajaran fisika di sma. *Jurnal Pembelajaran Fisika*, 3(3), 242–247.
- Nuraini, L., Anggraeni, F. K. A., Harijanto, A., Prastowo, S. H. B., Subiki, S., Supriadi, B., & Wahyu, R. (2022). Development of al-qur'an-based physics learning media applications to improve higher order thinking skills and spiritual attitudes for preservice physics teacher. *Indonesian Review of Physics*, 5(1), 32-39.
- Okun, L. B. (2008). *The theory of relativity and the Pythagoras theorem*. Uspheki.
- Oktaviani, W., Gunawan, G., & Sutrio, S. (2017). Pengembangan bahan ajar fisika kontekstual untuk meningkatkan penguasaan konsep siswa. *Jurnal Pendidikan Fisika dan Teknologi*, 3(1), 1-7.
- Pabri, M., Medriati, R. & Risdianto, E. (2022). Uji kelayakan e-lkpd berbasis kontekstual berbantuan liveworksheet untuk melatih kemampuan berpikir kritis di sma, *Jurnal Ilmiah Pendidikan Fisika*, 6(3), 642.
- Pendidikan, B. S. N. (2016). *Lembar Pedoman Penilaian Ujian Praktik Kejuruan Keahlian Teknik Pemesinan Tahun Pelajaran 2016/2017*. Jakarta: BSNP.
- Permana, A. H., Mulyati, D., Bakri, F., Dewi, B. P., & Ambarwulan, D. (2018). The development of an electricity book based on augmented reality technologies. *International Conference on Mathematics and Science Education*, 1157.
- Permatasari, O. I., & Trisnawati, D. (2021). Pengembangan bahan ajar fisika berbasis way of investigating untuk meningkatkan keterampilan proses siswa smk. *Physics Education Research Journal*, 3(2), pp. 103-112.
- Prabowo, A., Rahmawati, U. and Anggoro, R. P. (2019). Android-based teaching material for statistics integrated with social media whatsapp. *International Journal on Emerging Mathematics Education*, 3(1), p. 93.
- Ramadhanti, R., Mastuang, M., & Mahardika, A. I. (2020). Pengembangan bahan ajar fisika topik elastistas menggunakan model pengajaran langsung untuk melatih kemampuan pemecahan masalah peserta didik. *Jurnal Ilmiah Pendidikan Fisika*, 4(2), pp. 65-75.
- Ramah, S., & Rohman, M. (2018). Analisis buku ajar bahasa arab madrasah aliyah kurikulum 2013, *Arabiyatuna: Jurnal bahasa Arab*, 2(2), 141–159.
- Riduwan. (2015). *Dasar-dasar statistik*. Bandung: CV. Alfabeta.
- Sasmita, S., Medriati, R. & Hamdani, D. (2021). Pengembangan e-modul berbasis process oriented guided inquiry learning materi rangkaian arus bolak-balik (ac) untuk melatih kemampuan berfikir kritis siswa sma. *DIKSAINS : Jurnal Ilmiah Pendidikan Sains*, 2(1), 1–14. doi: 10.33369/diksains.2.1.1-14.
- Simarmata, R. K. (2022). *Pengembangan bahan ajar dan media pendidikan sd*. Tasikmalaya: Perkumpulan Rumah Cemerlang Indonesia.
- Suhadirman, S., Damayanti, A., & Syamsudduha, S. (2022). Pengembangan lkpd konsep fluida statis berbasis problem solving polya peserta didik kelas xi ipa SMAN 2 Bulukumba, *Jurnal Ilmiah*

- Pendidikan Fisika*, 6(3), p. 616.
- Supriadi, B. *et al.* (2023). Pythagorean theorem for solving simple rlc circuit problems. *Proceeding International ICCGANT*, 133-145.
- Supriadi, B. *et al.* (2019). Pythagoras method to complete einstein special relativity issues. *Journal of Physics: Conference Series*, 1211(1).
doi: 10.1088/1742-6596/1211/1/012050.
- Supriadi, B. *et al.* (2022). Respon siswa terhadap metode pythagoras sebagai alternatif. *ORBITA: Jurnal Kajian, Inovasi dan Aplikasi Pendidikan Fisika*, 8(2019), 128–133.
- Tegeh, I. M. & Kirna, I. M. (2013). Pengembangan bahan ajar metode penelitian pendidikan dengan ADDIE model. *Jurnal IKA*, 11(1), 16.
- Tyas, L., Harjana, H., & Wahyuningsih, D. (2020). Identification the need of electronic-based physics teaching materials for increasing problem Solving Ability in the 21st Century. *Prosiding SNFA (Seminar Nasional Fisika Dan Aplikasinya)*, 5, 129-133
- Wahyuni, S., & Handhika, J. (2019). Profil kesuliatan belajar pokok bahasan listrik dinamis siswa smk. *Makalah Nasional Pendidikan Fisika IV 2018*, 7(1), 286–289.
- Wini, M. K. M., Laksana, D. N. L., & Awe, E. Y. (2020). Pengembangan bahan ajar multilingual berbasis konten dan konteks budaya lokal etnis ngada pada tema diriku untuk siswa kelas I sekolah dasar. *Jurnal Pendidikan Dasar Flobamorata*, 1(2), pp. 73-80.
- Yulia, E., Asrizal, A., & Ramli (2018). Pengaruh bahan ajar ipa terpadu tema gelombang dalam kehidupan bermuatan literasi era digital terhadap hasil belajar siswa kelas viii smp negeri 8 padang. *Pillar of Physics Education*, 11(2), 113–120.