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Developing a textbook to support pharmacy students' mathematical problem-solving skills

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Abstract. Mathematics is a vital tool for solving problems in everyday life. For pharmacy students, it is the basis for formulating pharmaceutical preparations, calculating maximum doses, and performing dilutions. In calculations, students must understand the problem, plan the solution, carry out the steps, and ensure accuracy, which reflects problem-solving ability. There are four books with ISBNs, 3 discussing only mathematical concepts and one focusing on pharmaceutical calculations, but none combining both. Therefore, it is urgent to develop contextual, problem-solving-based textbooks to support pharmaceutical mathematics learning. This study aims to create a pharmaceutical mathematics textbook that strengthens problem-solving skills, particularly in measurement units and concentration statements. This study employed the ADDIE development model with 95 first-year pharmacy diploma students as respondents, and data were collected through a questionnaire. The results of the validity test, as evaluated by material and media experts, averaged 85.98% (considered very valid), while the feasibility test, conducted by lecturers and students, averaged 84.55% (also considered very feasible). It can be concluded that the developed textbook is valid, practical and effective for use in diploma and undergraduate pharmacy programs. The results can also guide the development of other chapters in pharmaceutical mathematics and help evaluate teaching materials to improve problem-solving skills at STIKes IKIFA.

Introduction

Mathematics is a subject taught from elementary to higher education as part of the curriculum (Alrabiah et al., 2022; Widana et al., 2024), where the main goal of learning mathematics is for students to be able to solve problems in everyday life (Umi et al., 2024). In addition, Cornelius proposed five benefits of studying mathematics, including logical and clear thinking, solving problems in everyday life, understanding patterns and relationships in various phenomena, developing creativity, and improving numeracy skills (Purnadewi & Widana, 2023; Cornelius, 1982). Research results found that mathematical ability in higher education is closely related to progress and achievement in learning, student satisfaction, and ultimately employment after graduation (Croft et al., 2022; Delaney & Devereux, 2020). Mathematics is included in the compulsory courses in the pharmacy department as a basis for formulating pharmaceutical preparations, calculating maximum doses, and calculating dilutions, which are accommodated through the pharmaceutical mathematics course (Alrabiah et al., 2022). The material on units of

measurement and concentration statements is one of the materials in pharmaceutical mathematics (Hegener, 2021; Mulac et al., 2022). The concept of measurement is used in pharmacy to quantify specific quantities. The basic units used are grams for mass, litres for volume, and moles for drug quantity. Therefore, understanding these concepts is crucial in pharmaceutical practice (Hartono & Kamaruddin, 2006).

The material on units of measurement and concentration statements is also closely related to dosage calculations, which is one of the competencies that pharmacy students must possess to avoid medication errors (Sugiarni, 2022). In calculating dosages, students must first understand the problem being asked, then plan a solution, carry out the calculation, and ensure its accuracy. These steps overlap with the problem-solving stages proposed by Polya, (2014). This indicates that developing students' mathematical abilities can be done through learning that prioritises problem-solving skills as one of the characteristics of mathematics learning (NCTM, 2000), which aims to build students' mathematical understanding (Son et al., 2020). This is because problem-solving enables students to understand better the problems they face and find new ways to solve them. In addition, they can also recall materials they have previously learned (Badger, 2012; Kibga et al., 2022).

According to Soedjadi (in Rendi), the material objectives of mathematics learning at every level emphasise problem-solving skills and their application in both mathematics and other disciplines (Murtikusuma, 2024). Problem-solving skills are just as important as the ability to understand the substance of the material. All problem-solving strategies in mathematics or other disciplines that require calculations involve quite complex mathematical calculations, so students need to practice them to develop mathematical problem-solving skills (Yayuk, 2019).

The use of valid and effective learning tools in mathematics is necessary to achieve learning objectives (Sayudi et al., 2021). One of the learning objectives for units of measurement and concentration statements is to support students' mathematical problem-solving skills, so textbooks are needed to facilitate this goal. The use of textbooks in lectures has positive impacts for both lecturers and students, including facilitating effective learning and motivating students to engage in more varied, independent learning (Marisda et al., 2024). Previous research has shown an improvement in the quality of the learning process when using textbooks tailored to learning objectives (Jiang & Li, 2023; Prasetiyo & Perwiraningtyas, 2017), where mathematics learning assisted by the use of teaching materials can improve mathematical problem-solving skills (Isnaeni et al., 2021).

Printed teaching materials still have positive aspects, including the ability to be studied anytime and anywhere without special applications or tools, the ability to develop students' abilities in learning general principles, the relatively inexpensive production, and the ability to be reused (Sugiarni, 2022). Physical experiences can be gained through the use of printed teaching materials that other media cannot, such as touching and flipping through paper, and taking notes that can aid in understanding the information. Printed teaching materials also remain the primary choice in almost every educational institution for implementing the learning process (Susilawati et al., 2021).

Ideally, pharmaceutical mathematics learning should be supported by textbooks that systematically integrate fundamental mathematical concepts with their direct applications in pharmaceutical calculations. Such learning resources need to be presented with conceptual clarity, contextual examples, and problem-solving-oriented exercises, enabling students to bridge the gap between theory and practice. Learning materials need to be prepared not only for individual work but also to support problem-solving and solve problems systematically (Munandar, 2025; Widana et al., 2023). In this way, students are expected to strengthen their mathematical problem-solving abilities

while minimising potential risks of dosage miscalculations and formulation errors, ultimately fostering higher competency and readiness for professional practice in pharmacy.

Pharmacy students should have access to textbooks that integrate mathematical concepts with pharmaceutical calculations in a contextual manner, presented in clear language, supported by illustrative examples, and enriched with problem-solving-based exercises. Such resources will enable students to understand the material better, enhance their problem-solving abilities, and minimise errors in dosage calculations and formulations. Pharmacy students also need to understand how to convert measurement units and adjust doses according to age, body weight, and health condition (Efriani & Arifin, 2024). The availability of pharmaceutical mathematics textbooks remains limited. Most existing books emphasise only general mathematical concepts without linking them to pharmaceutical contexts, while others focus solely on pharmaceutical calculations without providing a strong foundation in mathematical concepts. As a result, students often struggle to connect theory with practice, which hampers the development of mathematical problem-solving skills and increases the risk of medication errors. The application of mathematical concepts in the context of pharmacy allows students to see direct relevance and enhances their understanding of problem-solving in the real world, preparing them to face future challenges (Efriani & Arifin, 2024).

Observations made on the availability of pharmaceutical mathematics textbooks on the market between 2018 and 2022 revealed that only four books had ISBNs, of which three still primarily discuss mathematical concepts, and the questions provided do not adequately train problem-solving skills in pharmaceutical calculations. Other books focus too much on pharmaceutical calculations alone, while the current need is for mathematical concepts that can later be applied in pharmaceutical calculations. However, there are no books that detail the connection between mathematical concepts and pharmaceutical calculations. Furthermore, it is found that not all mathematical problems found in textbooks are real problems (contextual) and only represent a transition from one solution step to problems with multiple solutions (Rahmawati, 2018).

The novelty of this research lies in the development of a pharmaceutical mathematics textbook that explicitly integrates fundamental mathematical concepts with real applications in pharmaceutical calculations, particularly in measurement units and concentration expressions. Unlike existing textbooks, this study emphasises a problem-solving-based approach, which not only focuses on mastering concepts or calculations but also enhances students' critical and systematic thinking skills. Furthermore, the use of the ADDIE development model ensures that the textbook meets the criteria of validity, practicality, and effectiveness, tailored to the needs of pharmacy students (Pratama et al., 2024). The measurement of effectiveness, validity, and practicality is carried out to determine how the developed teaching materials can be used in learning (Rahmi, 2023).

Based on the background and research urgency, the research questions are formulated as follows: How can a pharmaceutical mathematics textbook on measurement units and concentration expressions be developed to be valid, practical, and effective in supporting students' mathematical problem-solving skills, and what are the levels of validity, practicality, and effectiveness of the developed pharmaceutical mathematics textbook in supporting student learning? This study aims to develop a pharmaceutical mathematics textbook on measurement units and concentration expressions that is valid, practical, and effective in supporting students' mathematical problem-solving skills. Examine the levels of validity, practicality, and effectiveness of the developed pharmaceutical mathematics textbook in enhancing student learning.

Method

Research Method and Design

This study employed a qualitative descriptive method for textbook development, utilising the Analyse, Design, Develop, Implement, and Evaluate (ADDIE) model. The Analysis stage is conducted to identify the needs for developing teaching materials and to address the issues in existing teaching materials. The Design stage involves designing the concept of the teaching materials to be developed, as well as the actual design of the teaching materials. The Development stage is the stage of developing the teaching materials that have been planned. The Implementation stage involves conducting trials with a small group to obtain initial feedback on the product that has been created. The Evaluation stage is the process of evaluating whether the teaching materials meet the needs and development objectives (Judijanto et al., 2024). Several previous studies have used the ADDIE model to develop problem-solving-based teaching materials (Aditya & Hiltrimartin, 2024; Lah et al., 2024; Zhafira et al., 2025). The ADDIE method has advantages such as being simple and organised, consisting of 5 systematic and interconnected stages, being needs-analysis oriented, emphasising periodic evaluation, and being widely applicable in educational settings (Siahaan, 2025). This makes it more systematic and structured for use in developing pharmaceutical mathematics textbooks (Murtikusuma, 2024).

Participants and Sampling Technique

The research was conducted at STIKes IKIFA from September 2024 to July 2025, involving one pharmacy lecturer and one mathematics lecturer as content experts, as well as one language lecturer and one pharmacy lecturer serving as media experts and validators. For the small group trial sample, 2 pharmacy lecturers and 10 students were used. For the final evaluation, 35 students and 2 lecturers were selected as the sample. This study involved all 95 active students from the first year of the Diploma in Pharmacy program as the research population and sample, selected using a total sampling approach.

Research Procedures and Timeline

Textbook development refers to the ADDIE model, as illustrated in Image 1.

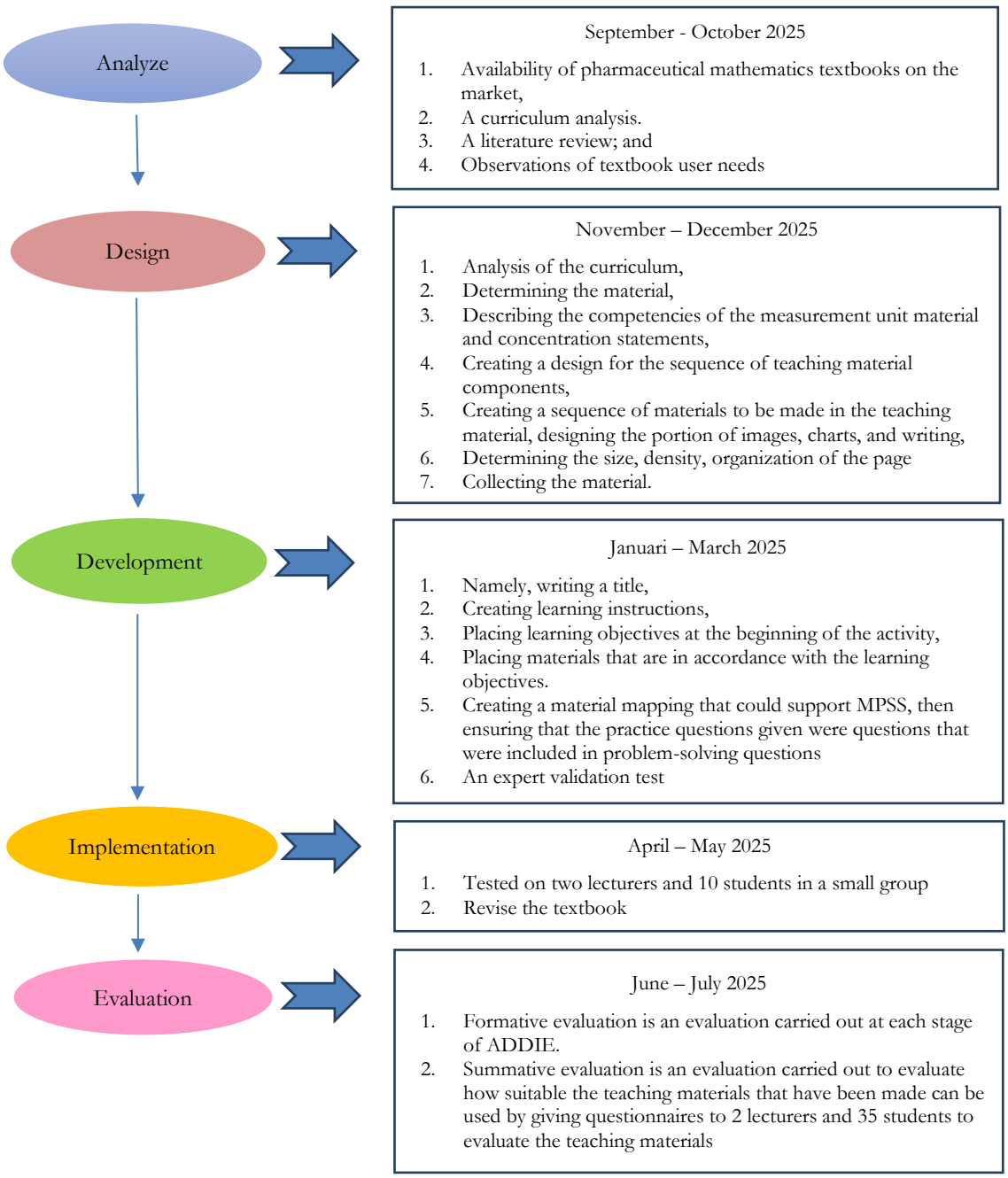

Image 1. ADDIE Model to develop the textbook

Data Collection Techniques and Research Instruments

Data were collected through a questionnaire. The assessment instrument given to the sample was a questionnaire with a Likert scale with four answer options, namely very poor, poor, good, and very good (Kurniawan, 2021). The textbook assessment indicators, as presented by media experts and material experts, are shown in Table 1. Meanwhile, the textbook assessment indicators for lecturer and student users are presented in Table 2.

Table 1. Textbook Assessment Indicators for Media Experts and Material Experts

Textbook Assessment Indicators for Media Experts	Indicator	Sub Indicator
	Presentation Aspects	The teaching material display is clear and attractive; there are study instructions, the use of appropriate and meaningful illustrations and images, readability, and easy-to-use
	Substantial aspects	The existence of learning achievements; The existence of practice questions; The relationship between learning materials and the topic; The benefits or importance of teaching materials
	Media Organisation Aspects	Page size conformity; Image/table size conformity; Page density
	Language aspects	Using simple language, using clear sentence structure, and using standard and interesting language.
Textbook Assessment Indicators for Subject Matter Experts	Indicator	Sub Indicator
	Relevance Aspect	Relevance of the material to the achievement of learning objectives; Adequacy of the material; Integrated with other fields; Easy to use
	Aspects of material accuracy	Accuracy of facts and concepts; Accuracy of terms and symbols; Clarity of description/explanation of material
	Assessment aspects	Can measure learning outcomes; There are practice questions.
	Conceptual Breadth Aspect	Suitability of material with scientific developments; Suitability of concepts with the student level
	Aspects of mathematical problem solving	Examples and practice questions according to problems in pharmaceutical calculations; Practice questions are made according to problem-based questions; Material can help solve problems in pharmaceutical calculations; Can support mathematical problem-solving skills

Table 2. Textbook Assessment Indicators by Users (Lecturers and Students)

Textbook Assessment Indicators for Users (Lecturers)	Indicator	Sub Indicator
	Relevance Aspect	Relevance of the material to the achievement of learning objectives; Adequacy of the material; Integrated with other fields
	Aspects of material accuracy	Accuracy of facts and concepts; Accuracy of terms and symbols; Clarity of description/explanation of material
	Assessment aspects	Can measure learning outcomes; There are practice questions.
	Conceptual Breadth Aspect	Suitability of material with scientific developments; Suitability of concepts with the student level
	Presentation Aspects	The teaching material display is clear and attractive; there are learning instructions, the use

		of appropriate and meaningful illustrations and images, readability, and easy to use
	Substantial aspects	The existence of learning achievements; The existence of practice questions; The relationship between learning materials and the topic; The benefits or importance of teaching materials
	Media Organisation Aspects	Page size suitability; Image/table size suitability; Page density
	Language aspects	Using simple language, using clear sentence structure, and using standard and interesting language.
	Aspects of mathematical problem solving	Examples and practice questions, tailored to problems in pharmaceutical calculations and problem-based Material, can help solve problems in pharmaceutical calculations and support mathematical problem-solving skills.
Textbook Assessment Indicators for Users (Students)	Indicator	Sub Indicator
	Relevance Aspect	Relevance of the material to pharmaceutical science; Adequacy of the material; Integration with other fields; Benefits or importance of the teaching material
	Presentation Aspects	The teaching material display is clear and attractive; there are study instructions, the use of appropriate and meaningful illustrations and images, readability, and easy-to-use
	Media Organisation Aspects	Page size suitability; Image/table size suitability; Page density
	Language aspects	Using simple language, using clear sentence structure, and using standard and interesting language.
	Aspects of mathematical problem solving	Examples and practice questions according to problems in pharmaceutical calculations; Material can help solve problems in pharmaceutical calculations; Can support pharmaceutical problem-solving skills

Data Analysis Techniques and Criteria

The collected data were then analysed to determine the level of validity and suitability of the textbook with each criterion, as shown in Tables 3 and 4.

Table 3. Frequency Distribution of Validity Percentage Values (Leonardy, 2022)

Interval (%)	Description
81.26-100	Very Valid
62.51-81.25	Valid
43.76-62.50	Quite Valid
25.00-43.75	Not Valid

Table 4. Interpretation of the feasibility score of teaching materials (Saputra, 2021)

Interval (%)	Description
81-100	Very Worthy
61-80	Worthy
41-60	Quite Worthy
21-40	Less Worthy
0-20	Not Worthy

Product Specifications

The developed product is a pharmaceutical mathematics textbook on measurement units and concentration expressions that integrates mathematical concepts with real pharmaceutical applications. It is written in simple language, enriched with illustrations, tables, and problem-solving-based contextual exercises, enabling students to connect theory to practice effectively. Compared to existing textbooks, this product offers the advantage of explicitly linking mathematical concepts to pharmaceutical contexts in each chapter, providing problem sets directly relevant to pharmaceutical calculations, and being validated as valid, practical, and effective by experts and users.

Results and Discussion

The research stages are divided into the Analyse Stage, Design Stage, Develop Stage, Implement Stage, and Evaluate Stage.

Analyze Stage

The Analysis stage involved a needs analysis related to the availability of pharmaceutical mathematics textbooks on the market, as well as a curriculum analysis, a literature review, and observations of textbook user needs. The needs analysis was conducted by examining the availability and criteria of existing teaching materials. The literature review involved searching for published research in journals and identifying curriculum achievement targets for pharmaceutical mathematics courses at both the diploma and undergraduate levels. Observations were conducted through a book search to identify the strengths and weaknesses of currently available pharmaceutical mathematics teaching materials. The pharmaceutical mathematics textbooks currently available on the market are four, published between 2018 and 2022, each with an ISBN; three of these textbooks only cover mathematical concepts.

The curriculum analysis revealed that students' achievement in using mathematics as a tool in pharmaceutical calculations, both for the diploma and undergraduate levels, overlapped with the chapters on units of measurement and concentration, which are fundamental and essential materials. Current pharmaceutical mathematics teaching materials only cover mathematical concepts applicable to pharmaceutical calculations, but none of them detail the connection between these mathematical concepts and pharmaceutical calculations. The questions provided do not yet include contextual problems used in pharmaceutical calculations. Currently, there is a need for textbooks that can be used as teaching materials and provide a direct understanding of mathematical concepts in pharmaceutical calculation problems. A comparison of existing and newly developed textbooks is presented in Table 5 below.

Table 5. Comparison of existing and developed teaching materials

Existing Pharmaceutical Mathematics Books	The Pharmaceutical Mathematics Book has been developed
1) Uses complex language 2) Discussion of material focuses on mathematical concepts 3) Discussion of the relationship between mathematical concepts and pharmacy is limited 4) Discussion of questions focuses more on solving mathematical concepts	1) Uses simpler language 2) Discussion of material focuses on solving pharmaceutical calculations using mathematical concepts 3) Discussion of the relationship between mathematical and pharmaceutical concepts is included in each chapter 4) Problem discussion focuses more on solving pharmaceutical calculations 5) Supports pharmacy students' mathematical problem-solving skills

Design Stage

At this stage, an analysis of the curriculum used was carried out, determining the material, describing the competencies of the measurement unit material and concentration statements, creating a design for the sequence of teaching material components, creating a sequence of materials to be made in the teaching material, designing the portion of images, charts, and writing in 1 page, determining the size, density, and organization of the page, and collecting the material. At this stage, the design of the teaching material was made according to the material displayed, starting from the level of density, portion of images and display of example questions to make it easier to read.

Develop Stage

At this stage, teaching materials were created according to the pre-designed plan, which included writing a title, creating learning instructions, placing learning objectives at the beginning of the activity, and selecting materials that aligned with the learning objectives. The development of these teaching materials also aimed to support Mathematical Problem Solving Skills (MPSS). It began by creating a material mapping that could support MPSS, then ensuring that the practice questions provided were included in the problem-solving questions. A problem-solving question contains a situation that encourages someone to solve a problem in a way that is not immediately known the solution (Duha & Harefa, 2023) and problem-solving questions are usually presented in story problems (Rahmawati, 2018). After the teaching materials had been completed, an expert validation test was carried out (Jalinus et al., 2021) consisting of 1 pharmacy lecturer and one mathematics lecturer as material experts, and one language lecturer and one pharmacy lecturer as media experts.

Media Expert Evaluation

The purpose of the trial with media experts was to assess the feasibility and gain opinions about the developed teaching materials, as well as to obtain information in the form of improvements, suggestions, and criticisms for evaluation and revision of the teaching materials. The trial by media experts was based on indicators such as those in Table 1. Some of the input provided was: 1) The cover design should have been made more attractive, 2) The font type was inappropriate, 3) The images and illustrations were unclear, 4) The pages were too crowded

The input from media experts was used to revise the teaching materials. Improvements made based on input from the media expert were: 1) Creating a new cover, 2) Using Times New Roman font

and 1.5 spacing to minimise clutter and improve readability, and 3) Adding images of measuring instruments and illustrations to the questions.

The following is the revised appearance of the teaching materials, as suggested by the media expert.

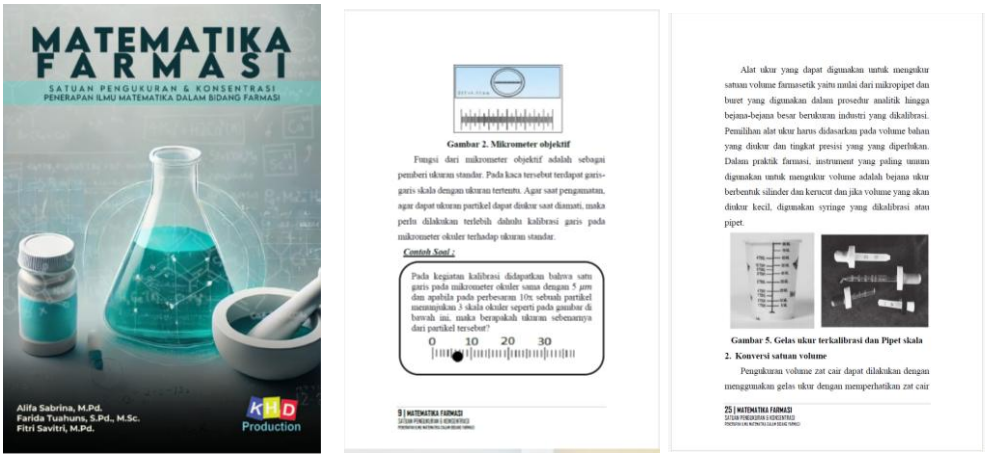

Image 2. Display of teaching materials after revision (Media)

Media experts were given a questionnaire to evaluate the teaching materials. Based on the data recapitulation, the results of the media expert evaluation questionnaire are as follows:

Table 6. Media Expert Evaluation Results

No.	Assessment Aspects	Average Score Percentage	Interpretation
1.	Presentation Aspects	87.5%	Very Valid
2.	Substantial aspects	84.4%	Very Valid
3.	Media Organisation Aspects	83.3%	Very Valid
4.	Language aspects	87.5%	Very Valid
Overall average of aspects		85.7%	Very Valid

Based on the results of the media expert test, the average percentage of assessments given by the media experts is 85.7%, indicating a very valid interpretation. This suggests that the developed teaching materials can be effectively utilised in mathematics learning.

Material Expert Evaluation

The purpose of the material expert trial was to determine the feasibility of the developed teaching materials and to obtain information in the form of improvements, suggestions, and criticisms for evaluation and revision of the learning media. The material expert trial of the teaching materials was based on indicators as shown in Table 1. During the feasibility test, material experts provided input to improve the teaching materials, enabling them to be used as a learning resource. Some of the input provided in writing was: 1) Concentration calculations should still use the mathematical concept of equivalent comparisons, rather than those commonly used in pharmaceutical calculations, as this is an application of mathematical concepts; 2) Sample questions needed to be added and adapted to pharmaceutical science, and 3) Practice questions needed to be added.

The input from the material experts was used to revise the teaching materials. The following is a display of the revised teaching materials, incorporating suggestions from material experts.

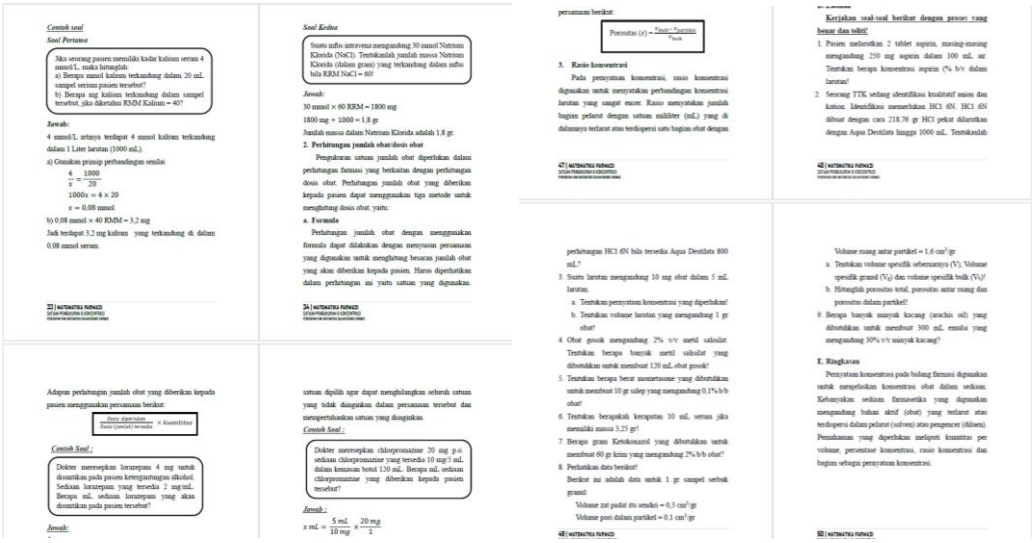

Image 3. Revised Teaching Materials Appearance (Materials)

Subject matter experts were given a questionnaire to evaluate the teaching materials. Based on the data recapitulation, the results of the subject matter expert evaluation questionnaire are as follows.

Table 7. Material Expert Evaluation Results

No.	Assessment Aspects	Average Score Percentage	Result
1.	Relevance Aspect	87.5%	Very Valid
2.	Aspects of material accuracy	87.5%	Very Valid
3.	Assessment aspects	81.3%	Very Valid
4.	Conceptual Breadth Aspect	81.3%	Very Valid
5.	Aspects of Mathematical Problem Solving	93.7%	Very Valid
Overall average of aspects		86.26%	Very Valid

Based on the results of the material expert test, the average percentage of assessments given by media experts is 86.26%, with a Very Valid interpretation. Based on the trial results with material and media experts, the overall average percentage of assessments is 85.98%, indicating a Very Valid interpretation. Therefore, the teaching materials are suitable for testing with lecturers and students as users.

Implement Stage

At this stage, the teaching materials, which had been declared valid and suitable for use, were piloted with two lecturers and 10 students in small groups. Suggestions and criticisms from the pilot test were then used to revise the textbook. The respondents in the small group differed from those in the large group (used for assessment) but shared the same characteristics as the large group sample, namely, being first-year students. Discussions with lecturers in small groups yielded the following input: 1) Additional equipment images and illustrations were needed for the questions to improve understanding, 2) Additional material related to pharmaceutical physics was needed to utilize all scientific knowledge and integrate it, 3) Some materials could not be used as example questions because they lacked material in the subject matter, 4) Some example questions were not realistic, for example, in the preparation of ointment bases, where the amount used was excessive and unreasonable.

Discussions with students in small groups yielded the following input: 1) Simplify the language, 2) Additional equipment images and illustrations were needed for questions to improve understanding. Comments and suggestions from trial respondents were recorded and used as a reference for revising the teaching materials being developed. The revised textbook, based on suggestions from lecturers and students, was then piloted with students in large groups.

Evaluate Stage

The evaluation stages in this study were formative evaluation and summative evaluation (Jalinus et al., 2021). Formative evaluation is an evaluation carried out at each stage of the ADDIE model, while summative evaluation is an evaluation conducted to assess the suitability of the teaching materials that have been developed. This is achieved by administering questionnaires to 2 lecturers and 35 students to evaluate the teaching materials. Evaluation of teaching materials was conducted based on the results of the product assessment in the form of teaching materials, suggestions provided by media experts, pharmaceutical experts, and mathematics experts, who identify limitations and weaknesses in the teaching materials content for improvement based on the experts' suggestions, in order to maximise the quality of teaching materials development. Product evaluation was also conducted by examining the results achieved by users (students and lecturers) and additional suggestions provided by lecturers and students who had already used the teaching materials.

Teaching Material Feasibility Test Stage (Evaluation)

Textbook quality standards need to consider aspects of validity, practicality, and effectiveness in use (Siregar et al., 2022). Validity was demonstrated based on lecturer and student evaluations, as shown in Tables 6 and 7. Furthermore, a quality textbook was also based on consideration of the latest curriculum, including the knowledge and components used. Validity aspects were measured in questionnaires administered to lecturers and students, reflected in the sub-indicators in Tables 1 and 2. Furthermore, the development of teaching materials took into account the curriculum during the needs analysis stage, where the teaching materials were developed with attention to the outcomes of the pharmaceutical mathematics course. This was also assessed in the material expert questionnaire, with statements such as "Suitability of learning objectives to teaching materials" (a very valid interpretation) and "The taught material is adequate in helping students master competencies in the field of pharmacy" (a valid interpretation). The teaching materials were also developed in accordance with new knowledge as requested by the subject matter expert questionnaire. The statement "Suitability of the material to scientific developments" was interpreted as valid. The teaching materials were developed by linking mathematics and pharmacy, as assessed in the statement "Mathematical concepts are integrated with pharmaceutical sciences" with a very valid interpretation. Based on this description, the teaching materials developed can be considered to meet the validity aspect.

A textbook is deemed to meet the practical aspect if it is easy to use for both lecturers and students. The practical aspect is reflected in several questions in the questionnaire, with complete indicators presented in Table 1. The effectiveness of a textbook can be achieved if the developed textbook meets expectations and is realised. This is evident in the assessment of students as users, namely the statement "Usefulness of the teaching material" which received an excellent assessment, thus the developed teaching material can be considered to meet the practical aspect.

Furthermore, the content of the teaching material is appropriate and relevant to the calculations in the pharmacy course, as evidenced by the relevance aspect, which received an 87.5% rating from material experts and lecturers, and an 87.84% rating from students, with a perfect interpretation. Based on this description, the developed teaching material can be considered effective. Quantitative calculations regarding the textbook's suitability are presented in Table 8. The purpose of the user

trial was to determine user opinions regarding the developed teaching material. The teaching material trials involved users, lecturers (two lecturers), and students (35 students), and were based on the indicators listed in Table 2.

Table 8. Lecturer and Student Evaluation Results

	No.	Assessment Aspects	Average Score Percentage	Interpretation
Lecturer Evaluation Results	1.	Relevance Aspect	87.5%	Very Worthy
	2.	Aspects of material accuracy	95.8%	Very Worthy
	3.	Assessment aspects	75%	Worthy
	4.	Conceptual Breadth Aspect	87.5%	Very Worthy
	5.	Presentation Aspects	87.5%	Very Worthy
	6.	Substantial aspects	90.6%	Very Worthy
	7.	Media Organisation Aspects	83.3%	Very Worthy
	8.	Language aspects	83.3%	Very Worthy
	9.	Aspects of Mathematical Problem Solving	95.8%	Very Worthy
	Overall average of aspects		86.17%	Very Worthy

	No.	Assessment Aspects	Average Score Percentage	Interpretation
Student Evaluation Results	1.	Relevance Aspect	87.84%	Very Worthy
	2.	Presentation Aspects	80.83%	Worthy
	3.	Media Organisation Aspects	78.93%	Worthy
	4.	Language aspects	82.17%	Very Worthy
	5.	Aspects of Mathematical Problem Solving	84.95%	Very Worthy
	Overall average of aspects		82.94%	Very Worthy

During the trial with lecturers and students, all input from lecturers and students was accepted, and the teaching materials were revised and supplemented as suggested. Based on the results of the feasibility test with lecturers and students, the average assessment percentage was 84.55%, indicating a very feasible outcome. This suggests that the developed teaching materials are generally well-suited for use.

According to Lestari and Yudhanegara, problem-solving skills include solving routine, non-routine, applied routine, non-applied routine, applied non-routine, and non-applied non-routine problems (Riyanto et al., 2024). The questions presented in the developed teaching materials fall into the category of applied routine problem solving because they address real-life situations and calculation issues in the pharmaceutical field. Based on this description, the teaching materials can be said to support the Quality Assurance and Competency Assessment. The following is an example of a practice question in the chapter on mass measurement contained in the developed teaching materials.

E. Latihan Penguasaan Kefarmasian

Kerjakan soal-soal berikut dengan proses yang benar dan teliti!

1. Perhatikan resep berikut ini!

R/	Estropipat	0.0125%
	Basis krim ad	60 g
	Mf la No I	
	Sig. Krim Vaginal.	

Berapa banyak tablet Estropipat yang harus digunakan untuk menyiapkan resep di atas?

2. Dibuat emulsi tipe M/A sebanyak 100 gram dengan menggunakan emulgator campuran span 20 (HLB 8,6) dan tween 20 (HLB 16,7) sebanyak 5% dari formula. HLB campuran 12. Tentukan berapa gram emulgator (tween dan span) yang akan ditimbang!

Image 4. Problem Solving Example Questions

The process of solving mathematical problems is different from the process of solving mathematical problems. A mathematical problem can become a mathematical problem if it is solved through several relevant activities, and can only become a mathematical problem if the solution to the problem can be found immediately. The development of problem-solving skills can be done through practice, strengthening understanding at the end of the lesson, and developing concepts on various topics (Rahmawati, 2018). A statement is said to be a problem for someone if 1) the student understands the statement given but is a challenge to answer, 2) the question cannot be directly answered with routine procedures that are already known to the student, 3) has an algorithm to connect data with something unknown that makes students need to investigate, make connections, involve their knowledge to solve it (Rahmawati, 2022). Based on this theory, the following are the results of students' work on the practice questions in the mass measurement chapter shown in Image 5.

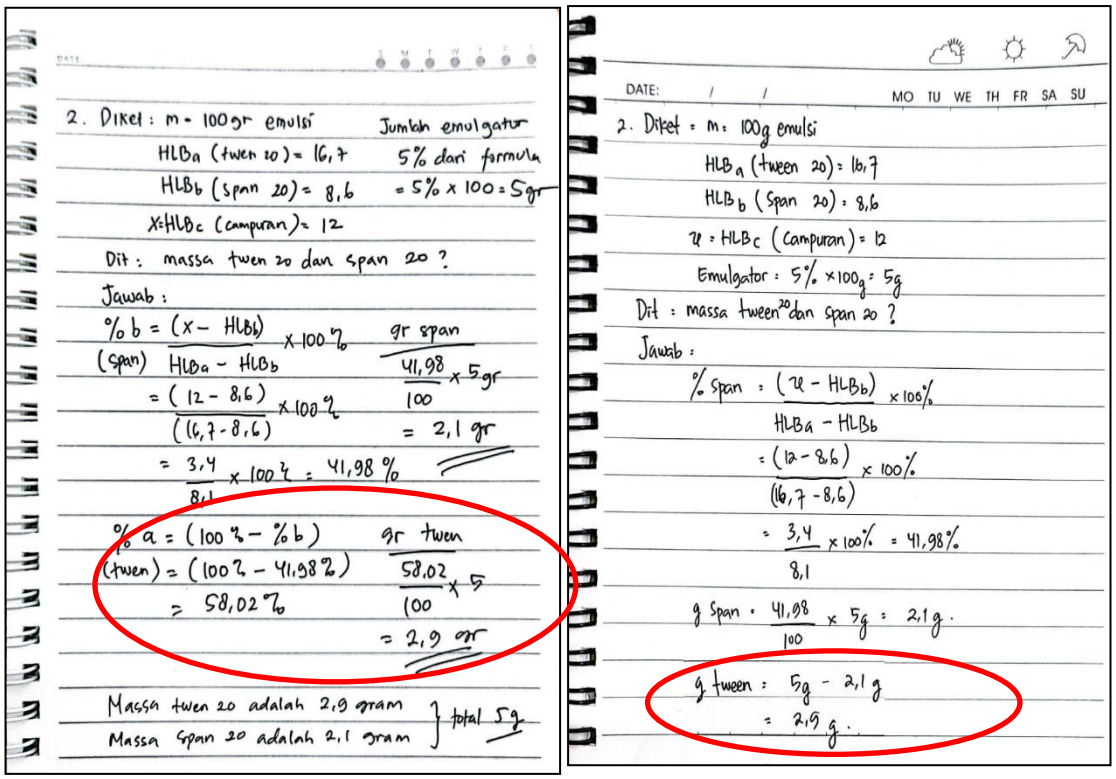

Image 5. Comparison of answers from student 1 (left) and student 2 (right)

In the same problem, students 1 and 2 used the same method, including calculating the mass of the span. However, they differed in their calculation methods for finding the mass of tween, although they produced the same final result. To find the mass of tween, student one first calculated the percentage of tween and then multiplied it by the total mass of the emulsifier. Student 2's solution, however, was more concise, subtracting the known total mass of the emulsifier from the mass of the span. Both students' answers were essentially the same. However, student 1 calculated the difference between the total percentage and the span percentage, while student 2 calculated the difference between the total emulsifier mass and the span mass.

The teaching materials are said to support mathematical problem-solving skills, as evident not only in the practice questions, which are problem-solving activities, but also in Image 5, where students have implemented the steps in the problem-solving activity. The following are the problem-solving steps taken by the students.

Table 9. Student Problem-Solving Steps

No.	Problem-solving steps	Student problem-solving steps
1.	Understanding the problem	Students can write down the information they know and what information they need to look for (ask).
2.	Planning problem-solving strategies	Students can write the HLB (Hypophilic Lipophilic Balance) calculation formula.
3.	Implementing the settlement plan	a. Students can calculate the total amount of emulsifier based on the information they have, which is 5% of the formula.

No.	Problem-solving steps	Student problem-solving steps
		b. Students can calculate the span percentage = 41.98% to obtain a span mass of 2.1 grams and a tween mass of 2.9 grams.
4.	Double-check the truth	Students can conclude the answers obtained
5.	Solve problems using other strategies	No students have written any other alternative answers.

Upon re-checking the answers, only student 1 re-checked the answers by verifying the obtained results. In theory, the way to check the answers obtained is by re-checking the calculations done, concluding the answers obtained, and determining whether other methods can be used, and whether a better strategy is needed (Riyanto et al., 2024). In the indicator of solving problems using other strategies, it was not seen in the results of the two students, but student 2 had a different method to obtain the tween mass, and it was a more concise method than the method in student 1. Based on this, it can be seen that each student has their own strategy in solving problems.

This research contributes to improving the quality of pharmaceutical mathematics learning by providing a valid, practical, and effective textbook that integrates mathematical concepts with pharmaceutical applications. The problem-solving-based design enables students to connect theory with practice, strengthen their critical and systematic thinking skills, and reduce potential errors in dosage and formulation calculations. More broadly, this study contributes to the development of innovative learning resources in pharmacy education, enhancing both academic and professional competence of students.

This research aligns with prior studies that highlighted the role of teaching materials in improving mathematical problem-solving skills (Isnaeni et al., 2021; Sayudi et al., 2021). Similar to previous works, it adopts the ADDIE development model, which has been proven effective for producing systematic learning resources. However, earlier studies have mainly focused on mathematics learning in secondary education or conceptual aspects, rather than specifically within the context of pharmaceutical education. The novelty of this study lies in the development of a pharmaceutical mathematics textbook that explicitly integrates fundamental mathematical concepts with direct applications in pharmaceutical calculations, particularly on measurement units and concentration expressions. Unlike existing textbooks, this product adopts a problem-solving-based approach that not only emphasises conceptual mastery and calculations but also fosters students' critical, systematic, and contextual thinking relevant to pharmacy practice. The limitation of this study is that the content scope is restricted to measurement units and concentration expressions, without covering other essential topics in pharmaceutical mathematics. Furthermore, the trial was conducted with a relatively small sample (35 students and two lecturers), which limits the generalizability of the findings. The study also did not comprehensively measure the long-term impact of the textbook on students' learning outcomes.

Conclusion

The results of the research on the development of pharmaceutical mathematics teaching materials to support mathematical problem-solving abilities in the units of measurement and concentration found that the validity test results, overall, received a very valid interpretation from media and material experts. The results of the feasibility test for users, namely lecturers and students, were overall interpreted as Very Feasible. The developed teaching materials also meet the aspects of validity, practicality and effectiveness, thus indicating that the teaching materials created are suitable

for use in learning and are widely used. The teaching materials also support mathematical problem-solving abilities as seen from the results of solving problems carried out by students who have fulfilled the problem-solving steps, so it can be said that the developed teaching materials are suitable for use and can support problem-solving abilities. The results obtained from the research can be used to develop other chapters in pharmaceutical mathematics materials and to measure the effectiveness of teaching materials in enhancing students' problem-solving skills.

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