MaPan : Jurnal Matematika dan Pembelajaran
p-ISSN: 2354-6883 ; e-ISSN: 2581-172X
Volume 11, No 2, Dec 2023 (241-258)
DOI: https://doi.org/10.24252/mapan.2023v11n2a3

THE VALIDITY OF E-MODULE TEACHING MATERIALS IN APPLIED MATHEMATICS COURSES

Fitriani Halik[1)], Bonitalia[2)], Suardi[3)], Nur Saiful[4)], Najmawati Sulaiman[5)]
[1,3,5]Politeknik Negeri Media Kreatif
[2]STMIK Adhi Guna
[4]Universitas Islam Negeri Alauddin Makassar
[1,3,5]Jl.Srengseng Sawah Raya No. 17 Kec. Jagakarsa, Jakarta Selatan, Indonesia
[2]Jl. Undata No.3 Kota Palu, Sulawesi Tengah
[4]Jl. H. M. Yasin Limpo Nomor 36 Samata-Gowa
Email: fitriani960219@gmail.com[1)], liabonita039@gmail.com[2)],
suardi@polimedia.ac.id[3)], nursaiful06@gmail.com[4)],
najmawatisulaiman123@gmail.com[5)]

Received August 3, 2023; Revised September 29, 2023; Accepted November 30, 2023

Abstract:
This research is a type of research and development that aims to determine the validity of e-module teaching materials in applied mathematics courses for students. This research includes referring to the 4D development model which consists of several phases, namely the stages of defining, designing, developing, and disseminating. The product developed is in the form of e-module teaching materials in applied mathematics courses. The test subjects in this study were graphic engineering students at the State Polytechnic of Creative Media Makassar. The instrument used in this study was a validation sheet consisting of two validators from design experts and materials experts. Based on the results of the research that has been done, an analysis of the validation results: (1) graphic validity, namely 4.7 is in the very valid category; (2) language validity, which is 4.9, is in the very valid category; (3) construct validity is 4.9 is in the very valid category; and (4) e-module presentation that is 4.7, is in the very valid category so that the average value of all aspects is 4.8 which is in the very valid category. So that it can mean that the e-module teaching materials in applied mathematics courses that have been developed are declared valid to be used as teaching materials in the learning process.

Keywords: Validity, E-Module, Applied Mathematics

VALIDITAS BAHAN AJAR E-MODUL PADA MATA KULIAH MATEMATIKA TERAPAN

Abstrak:
Penelitian ini merupakan jenis penelitian pengembangan (research and development) yang bertujuan untuk mengetahui validitas bahan ajar e-modul pada mata kuliah matematika terapan. Penelitian ini mengacu pada model pengembangan 4D yang terdiri dari beberapa fase yang meliputi tahap define (pendefinisian), Design (perancangan), develop (pengembangan), disseminate (penyebaran). Produk yang

dikembangkan berupa bahan ajar e-modul pada mata kuliah matematika terapan. Subjek uji coba dalam penelitian ini adalah mahasiswa teknik grafika Politeknik Negeri Media Kreatif PSDKU Makassar. Instrumen yang digunakan dalam penelitian ini adalah lembar validasi yang terdiri atas dua orang validator yang berasal dari ahli desain dan ahli materi. Berdasarkan hasil penelitian yang telah dilakukan diperoleh analisis hasil validasi: (1) kelayakan kegrafikan yaitu 4,7 berada pada kategori sangat valid; (2) kelayakan bahasa yaitu 4,9 berada pada kategori sangat valid; (3) kelayakan isi yaitu 4,9 berada pada kategori sangat valid; dan (4) kelayakan penyajian yaitu 4,7 berada pada kategori sangat valid sehingga diperoleh nilai rata-rata dari keseluruhan aspek yaitu 4,8 berada pada kategori sangat valid. Sehingga dapat disimpulkan bahwa bahan ajar e-modul pada mata kuliah matematika terapan yang telah dikembangkan dinyatakan valid untuk digunakan sebagai bahan ajar pada proses pembelajaran.

Kata Kunci: Validitas, E-Modul, Matematika Terapan

How to Cite: Halik, F., Bonitalia, Suardi, Saiful, N., & Sulaiman, N. (2023). The Validity of E-Module Teaching Materials in Applied Mathematics Courses for Students. *MaPan : Jurnal Matematika dan Pembelajaran*, *11*(2), 241-258. https://doi.org/10.24252/mapan.2023v11n2a3

INTRODUCTION

Education has a very central role in improving the quality of human resources (Halik, Acfira, & Tawaddud, 2022). Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and the skills needed by themselves and society (Hidayat & Abdillah, 2019). Effective efforts to shape human character can be made by improving the quality of education (Halik, Acfira, & Tawaddud, 2022). Learning in the 21st century requires the integration of learning with everyday life processes, one alternative is to integrate several fields into STEM (Science, Technology, Engineering, and Mathematics).

The dynamic development of science and technology requires that each individual can select, receive, and manage information to master technology and develop knowledge. To select, receive, and manage information, critical, logical, systematic, and creative thinking tools are needed, one of which is mathematics. Mathematics is a basic science that can develop the ability to communicate using numbers and use the acuity of reasoning to be able to solve everyday problems (Halik, Acfira, & Tawaddud, 2022). In Bloom's

taxonomy, the ability to understand is at a higher level than knowledge. However, this does not mean that knowledge is not needed, because to be able to understand something, knowledge is needed (Sudjana, 2009). According to the NCTM principles and standards for school mathematics, a combination of factual knowledge, procedural facilities, and conceptual understanding is required for students to use mathematics (Lestari & Surya, 2017). When studying mathematics, students are required to be able to focus on solving a problem, so learning mathematics must be planned in such a way that students' problem-solving abilities can be increased (Turnip & Karyono, 2021). In solving mathematical problems, students often experience difficulties so solving problems results in errors (Laman & Halik, 2023). Learning Media plays a quite determining role in the success of a process of learning. This shows that the effectiveness and efficiency of learning can be achieved, them, the use of learning media (Sari & Gautama, 2022)

In the process of teaching and learning in tertiary institutions, lecturers play an important role as facilitators to convey lecture material so that it can be understood by students. One of the courses at the Creative Media State Polytechnic, especially in the graphic engineering study program, is applied mathematics. This course is a compulsory subject for students of the graphic engineering study program in semester 1. The studies and materials related to applied mathematics are very broad. It should be realized that the abilities of each student are different, plus the learning process seems monotonous so it makes students less interested in paying attention to the material presented by the lecturer. The use of teaching materials that have never changed from year to year is also a factor in the low interest in student learning which has an impact on low learning outcomes.

Teaching materials as an important part to be able to improving student learning outcomes are deemed necessary to be designed in such a way that the function of teaching materials can be achieved (Ainun, 2019). To realize the function of teaching materials, it is necessary to pay attention to everything that supports the success of the learning process, such as considering the concepts, types, and steps for selecting teaching materials (Purnomo, 2011). The selection of certain learning approaches, models, strategies, and methods greatly influences student attitudes and expected learning achievement. If a lecturer only relies on the lecture method, this will make students bored in the learning process (Yakub, 2019). This can be overcome by improving learning

materials that support students' problem-solving abilities, one of which can be based on e-Modules (Islahiyah, Pujiastuti, & Mutaqin, 2021).

E-Module teaching materials are variations of traditional materials that use information technology to make existing modules more interesting and interactive. It is designed with the aim that students can study independently without guidance from lecturers and contains all the important components of the aforementioned tools. Therefore, e-Modules must explain the main skills that students have achieved, present them in good and interesting language, and be equipped with representatives (Madjijd, 2013). The existence of e-Modules can enable lecturers to make more use of digital technology as a teaching tool to increase their mathematical knowledge through the use of electronic teaching materials, including the use of electronic devices that can improve learning in the form of audiovisual, audio, film, and related learning materials, the use of which intended to be easy to understand and use good learning materials (Larkin & Calder, 2016).

The results of research conducted by Aprianka, Setiani, and Imswatama (2021) stated that the results of the validation scores from media experts received a score of 90% in the very appropriate category. The validation score from material experts received a score of 84% in the very appropriate category. The material validation assessment focuses on assessing aspects of appropriateness of content, appropriateness of presentation, appropriateness of language, and contextual assessment. So that the e-module developed for students is valid and suitable for use as mathematics teaching material because it meets the assessment criteria. In line with the research above, the research conducted by Turnip and Karyono (2021) with the research title Developing e-Module Mathematics in Improving Critical Thinking Skills shows that based on the results of student responses in trials have indicated a positive response to e-modules that developed so that e-modules can be disseminated and socialized to teachers so they can be used as teaching materials in the learning process for fifth-grade elementary school students. In addition, there is also research conducted by Ramadhani and Fitri (2020) with the title Research on the validity of the EPUB3-based mathematics e-module using the Rasch model analysis which shows that in terms of the content of applied mathematics material in the e-module it is feasible to use in learning mathematics. Based on the description of this background researchers can develop ideas for further development research with the title "Validity of Mathematics E-Module Teaching Materials in Applied Mathematics Courses in Students".

RESEARCH METHOD

The method used in this study is a model of research and development. The research model is the development of research methods used to produce a specific product and test the effectiveness of the product (Sugiyono, 2009). The product to be developed in this research is teaching materials in the form of e-modules on applied mathematics material. This research was conducted at the Makassar Creative Media State Polytechnic which is located at Jalan Perintis Kemerdekaan VI No 50 Kec. Makassar City Tamalanrea. The subjects of this research are Graphic Engineering students for the 2022/2023 academic year. E-module that has been developed was tested on students of the Graphic Engineering Study Program. The material to be tested is material in applied mathematics courses which includes the basics of arithmetic, algebra, linear equations, and systems of linear equations and trigonometry.

The development model used in this research is the 4D development model. The 4D development model consists of several phases which include defining, designing, developing, and disseminating. The instrument used in this study was a questionnaire validation assessment sheet with data collection techniques through a validation test which was carried out by asking for expert judgment, namely 2 lecturers consisting of material experts and design experts. The assessment indicators for material expert validation and design expert validation include 4 assessment aspects, namely graphic validity, language validity, construct validity, and e-module presentation. The researcher took these assessment aspects because several kinds of literature read stated that these four aspects were able to measure the level of material validity and media validity of the e-module being developed. Analysis of the level of validity of the e-module using the criteria for the validity of teaching materials can be seen in the following table.

Table 1. Category Level of Validity

Average Score	Classification
$4{,}0 \leq V \leq 5{,}0$	Very Valid, can be used without revision
$3{,}0 \leq V < 4{,}0$	Valid, can be used without revision
$2{,}0 \leq V < 3{,}0$	Quite Valid, can be used but needs minor revision
$1{,}0 \leq V < 2{,}0$	Less Valid, it is recommended not to use it because it needs major revisions
$V < 1{,}0$	Not valid, can't be used

RESULTS AND DISCUSSION

The development of the e-module has been carried out with a 4D development model consisting of 4 stages, define, design, develop, and disseminate. However, the dissemination stage was not carried out perfectly due to time and cost constraints, so it was only disseminated to other mathematics lecturers for use in other classes. The explanation of these development stages can be described as follows:

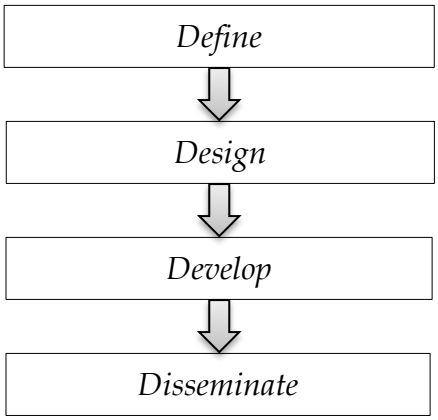


Figure 1. Development 4D Model

1. Define

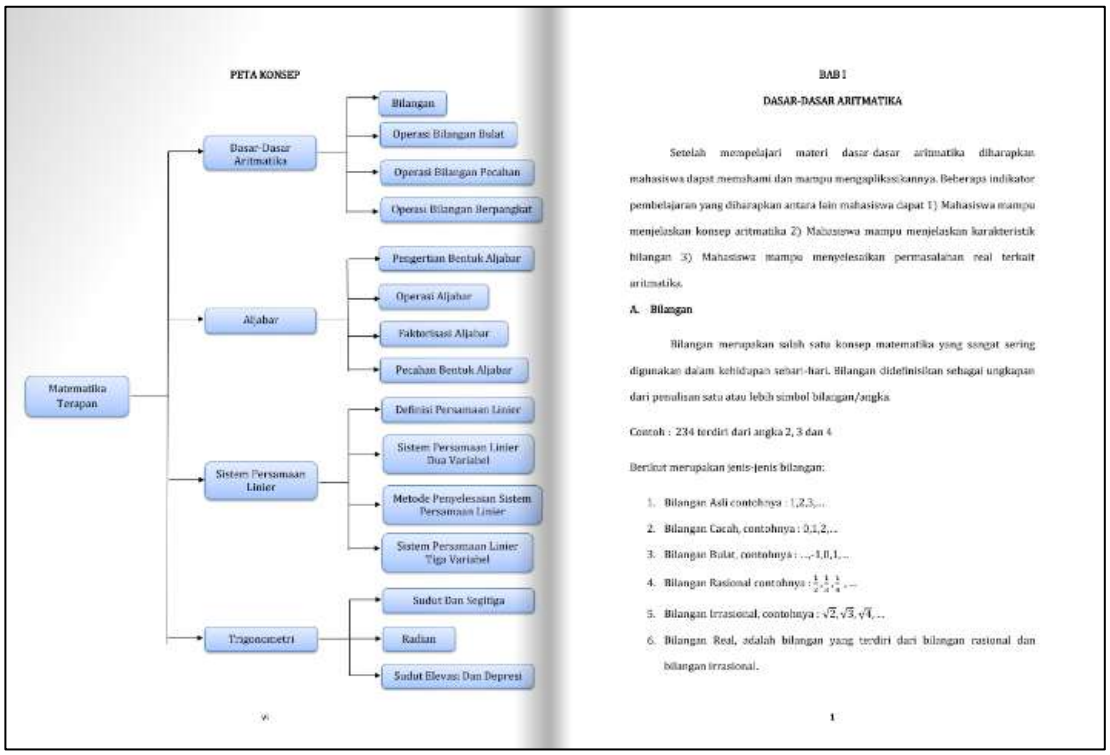
This defined stage includes activities that will be carried out by researchers to produce the validity of the product to be developed. The things that researchers do during the planning stage starts from making a Semester Implementation Plan (RPS), collecting books related to the material and learning media that will be developed, relevant references used in applied mathematics material, and choosing an attractive and appropriate design. with student characteristics, and preparation of research instruments. In making the RPS, researchers discussed with lecturers who teach the same subject so that later the learning steps used could be maximized when implemented using e-module teaching materials. For books used in creating material content in e-modules, subject lecturers recommend that the material presented also contain material from printed books according to the applicable curriculum. This is because the content of the material presented in the e-module is by competencies. However, researchers also add material from other sources, so that later the material in the learning media will be more complete and make it easier for students.

There are several research instruments used by researchers, namely graphic validity, language validity, construct validity, and e-module presentation. All instruments are first validated by validators to assess whether the instruments used are suitable for use or not. Before being used, they are first validated by experts to assess whether the instruments used are suitable for use or not. If there are still improvements to the validated instrument, the researcher will revise it first before using it.

2. Design

The preparation of the design is done by compiling the framework of teaching materials by selecting materials or problems by the basic statistics of basic material by selecting reference images or information to complete the e-module teaching materials and framing the layout of the material on the e-module teaching materials by the preparation of the material topics. This e-module contains 4 materials, namely the basics of arithmetic, algebra, linear equations, and systems of linear equations and trigonometry. There are several advantages of this e-module teaching material. The advantages over printed modules are that they are more interactive, easy to use, can display audio, images, video, and animation, and have configuration checks/tests that allow immediate feedback. Apart from that, this e-module is also equipped with problem-solving questions which are presented at the end of each chapter. The e-module design being developed can be seen as shown in the following figure.

Figure 2. E-Module Cover



PETA KONSEP

Matematika Terapan

- Dasar-Dasar Aritmatika
  - Bilangan
  - Operasi Bilangan Bulat
  - Operasi Bilangan Pecahan
  - Operasi Bilangan Berpangkat
- Aljabar
  - Pengertian Bentuk Aljabar
  - Operasi Aljabar
  - Faktorisasi Aljabar
  - Pecahan Bentuk Aljabar
- Sistem Persamaan Linier
  - Definisi Persamaan Linier
  - Sistem Persamaan Linier Dua Variabel
  - Metode Penyelesaian Sistem Persamaan Linier
  - Sistem Persamaan Linier Tiga Variabel
- Trigonometri
  - Sudut Dan Segitiga
  - Radian
  - Sudut Elevasi Dan Depresi

vi

BAB I

DASAR-DASAR ARITMATIKA

Setelah mempelajari materi dasar-dasar aritmatika diharapkan mahasiswa dapat memahami dan mampu mengaplikasikannya. Beberapa indikator pembelajaran yang diharapkan antara lain mahasiswa dapat 1) Mahasiswa mampu menjelaskan konsep aritmatika 2) Mahasiswa mampu menjelaskan karakteristik bilangan 3) Mahasiswa mampu menyelesaikan permasalahan real terkait aritmatika.

A. Bilangan

Bilangan merupakan salah satu konsep matematika yang sangat sering digunakan dalam kehidupan sehari-hari. Bilangan didefinisikan sebagai ungkapan dari penulisan satu atau lebih simbol bilangan/angka.

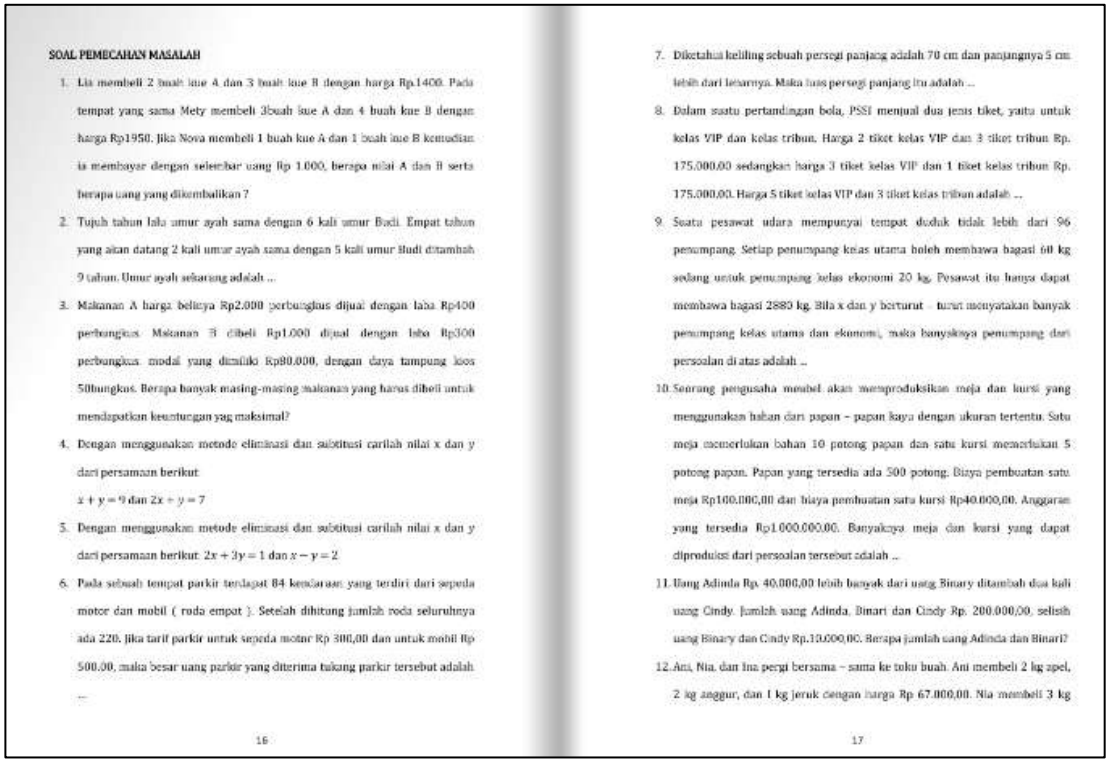
Contoh : 234 terdiri dari angka 2, 3 dan 4

Berikut merupakan jenis-jenis bilangan:

1. Bilangan Asli contohnya : 1,2,3,...
2. Bilangan Cacah, contohnya : 0,1,2,..
3. Bilangan Bulat, contohnya : ...,-1,0,1,..
4. Bilangan Rasional contohnya : $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ...$
5. Bilangan Irrasional, contohnya : $\sqrt{2}, \sqrt{3}, \sqrt{4}, ..$
6. Bilangan Real, adalah bilangan yang terdiri dari bilangan rasional dan bilangan irrasional.

1

Figure 3. Concept Map



SOAL PEMECAHAN MASALAH

1. Lia membeli 2 buah kue A dan 3 buah kue B dengan harga Rp.1400. Pada tempat yang sama Mety membeli 3buah kue A dan 4 buah kue B dengan harga Rp1950. Jika Nova membeli 1 buah kue A dan 1 buah kue B kemudian ia membayar dengan selembar uang Rp 1.000, berapa nilai A dan B serta berapa uang yang dikembalikan ?
2. Tujuh tahun lalu umur ayah sama dengan 6 kali umur Budi. Empat tahun yang akan datang 2 kali umur ayah sama dengan 5 kali umur Budi ditambah 9 tahun. Umur ayah sekarang adalah ...
3. Makanan A harga belinya Rp2.000 perbungkus dijual dengan laba Rp400 perbungkus. Makanan B dibeli Rp1.000 dijual dengan laba Rp300 perbungkus. modal yang dimiliki Rp80.000, dengan daya tampung kios 50bungkus. Berapa banyak masing-masing makanan yang harus dibeli untuk mendapatkan keuntungan yag maksimal?
4. Dengan menggunakan metode eliminasi dan subtitusi carilah nilai x dan y dari persamaan berikut
   $x + y = 9$ dan $2x + y = 7$
5. Dengan menggunakan metode eliminasi dan subtitusi carilah nilai x dan y dari persamaan berikut: $2x + 3y = 1$ dan $x - y = 2$
6. Pada sebuah tempat parkir terdapat 84 kendaraan yang terdiri dari sepeda motor dan mobil (roda empat). Setelah dihitung jumlah roda seluruhnya ada 220. Jika tarif parkir untuk sepeda motor Rp 300,00 dan untuk mobil Rp 500.00, maka besar uang parkir yang diterima tukang parkir tersebut adalah ...

16

7. Diketahui keliling sebuah persegi panjang adalah 70 cm dan panjangnya 5 cm lebih dari lebarnya. Maka luas persegi panjang itu adalah ...
8. Dalam suatu pertandingan bola, PSSI menjual dua jenis tiket, yaitu untuk kelas VIP dan kelas tribun. Harga 2 tiket kelas VIP dan 3 tiket tribun Rp. 175.000,00 sedangkan harga 3 tiket kelas VIP dan 1 tiket kelas tribun Rp. 175.000,00. Harga 5 tiket kelas VIP dan 3 tiket kelas tribun adalah ...
9. Suatu pesawat udara mempunyai tempat duduk tidak lebih dari 96 penumpang. Setiap penumpang kelas utama boleh membawa bagasi 60 kg sedang untuk penumpang kelas ekonomi 20 kg. Pesawat itu hanya dapat membawa bagasi 2880 kg. Bila x dan y berturut – turut menyatakan banyak penumpang kelas utama dan ekonomi, maka banyaknya penumpang dari persoalan di atas adalah ...
10. Seorang pengusaha mebel akan memproduksikan meja dan kursi yang menggunakan bahan dari papan – papan kayu dengan ukuran tertentu. Satu meja memerlukan bahan 10 potong papan dan satu kursi memerlukan 5 potong papan. Papan yang tersedia ada 500 potong. Biaya pembuatan satu meja Rp100.000,00 dan biaya pembuatan satu kursi Rp40.000,00. Anggaran yang tersedia Rp1.000.000,00. Banyaknya meja dan kursi yang dapat diproduksi dari persoalan tersebut adalah ...
11. Uang Adinda Rp. 40,000,00 lebih banyak dari uang Binary ditambah dua kali uang Cindy. Jumlah uang Adinda, Binari dan Cindy Rp. 200.000,00. selisih uang Binary dan Cindy Rp.10.000,00. Berapa jumlah uang Adinda dan Binari?
12. Ani, Nia, dan Ina pergi bersama – sama ke toko buah. Ani membeli 2 kg apel, 2 kg anggur, dan 1 kg jeruk dengan harga Rp 67.000,00. Nia membeli 3 kg

17

Figure 4. Problem-Solving Questions

3. Develop

At this stage, modifications are made to the initial form of learning materials that have been prepared at the defined stage through validation tests. The validation test used is graphic validity, language validity, construct validity, and e-module presentation. Graphic validity assessment indicators include e-module size, e-module cover design, and module content design. Language validity assessment indicators include the language used is easy for students to understand, the sentences used to explain the material are easy to understand, the sentences used do not give rise to double meanings, and conformity with good and correct Indonesian language rules. Construct validity assessment indicators include suitability of the material with learning indicators, completeness of the learning material in a systematic order and arrangement, material in the e-module is easy for students to understand, material in the e-module can motivate student learning, material in the e-module is appropriate to the student's level of ability. Graphic validity assessment indicators include Practice questions at the end of the lesson that are on the material and learning objectives and there is support for presenting the material in the module (Reference). Based on the validity test using the validity assessment sheet instrument, the following results were obtained.

Table 2. The Validation Results of Teaching Material

No.	Score	Classification
Graphic Validity	4,7	Very Valid
Language Validity	4,9	Very Valid
Construct Validity	4,9	Very Valid
E- Module Presentation	4,7	Very Valid
The Total Average	4,8	Very Valid

Table 2 above shows that the average value of the test results for the validity of the e-module teaching materials is 4.8 with very valid criteria. This shows that the e-module teaching materials produced in this research are valid. Both the components of graphic validity, language validity, construct validity, and e-module presentation can be used with minor revisions. Revisions are made on the responses and suggestions given by each expert, either directly or written in the suggestion column. The suggestions from the expert team can be seen in the following table.

Table 3. Suggestions And Improvements

Suggestion	Action
The cover of the e-module used must be made more attractive.	Revise the cover of the e-module used to make it more attractive.
The contents of the material in the e-module should be concise and clear.	Make the contents of the material in the e-module concise and clear.
The composition of the material sub-chapters must be systematic.	Make a more systematic arrangement of material sub-chapters.
The number of questions in the e-module should be reduced.	Reducing the portion of the questions in the e-module.

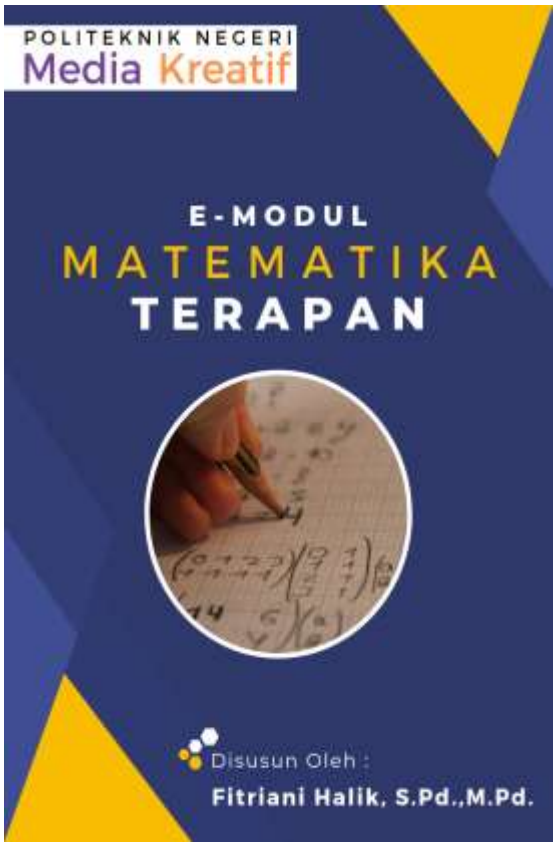
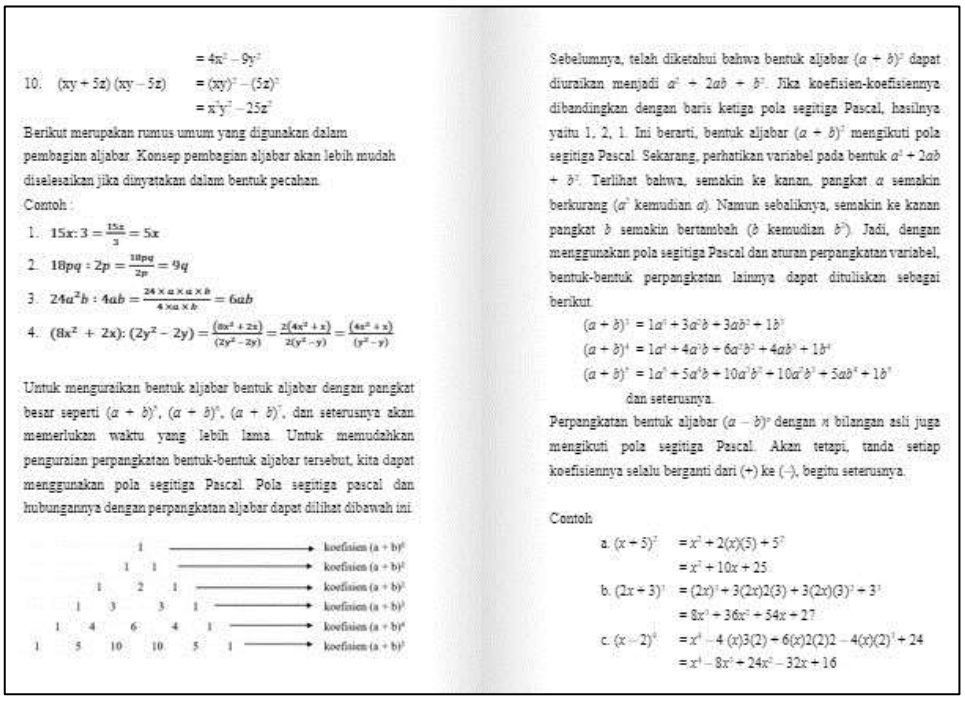


Figure 5. Before Revision

Figure 6. After Revision



$= 4x^2 - 9y^2$

10. $(xy + 5z)(xy - 5z)$ $= (xy)^2 - (5z)^2$
$= x^2y^2 - 25z^2$

Berikut merupakan rumus umum yang digunakan dalam pembagian aljabar. Konsep pembagian aljabar akan lebih mudah diselesaikan jika dinyatakan dalam bentuk pecahan.

Contoh :

1. $15x : 3 = \frac{15x}{3} = 5x$
2. $18pq : 2p = \frac{18pq}{2p} = 9q$
3. $24a^2b : 4ab = \frac{24 \times a \times a \times b}{4 \times a \times b} = 6ab$
4. $(8x^2 + 2x) : (2y^2 - 2y) = \frac{(8x^2 + 2x)}{(2y^2 - 2y)} = \frac{2(4x^2 + x)}{2(y^2 - y)} = \frac{(4x^2 + x)}{(y^2 - y)}$

Untuk menguraikan bentuk aljabar bentuk aljabar dengan pangkat besar seperti $(a + b)^5$, $(a + b)^6$, $(a + b)^7$, dan seterusnya akan memerlukan waktu yang lebih lama. Untuk memudahkan penguraian perpangkatan bentuk-bentuk aljabar tersebut, kita dapat menggunakan pola segitiga Pascal. Pola segitiga pascal dan hubungannya dengan perpangkatan aljabar dapat dilihat dibawah ini

1 → koefisien $(a + b)^0$
1 1 → koefisien $(a + b)^1$
1 2 1 → koefisien $(a + b)^2$
1 3 3 1 → koefisien $(a + b)^3$
1 4 6 4 1 → koefisien $(a + b)^4$
1 5 10 10 5 1 → koefisien $(a + b)^5$

Sebelumnya, telah diketahui bahwa bentuk aljabar $(a + b)^2$ dapat diuraikan menjadi $a^2 + 2ab + b^2$. Jika koefisien-koefisiennya dibandingkan dengan baris ketiga pola segitiga Pascal, hasilnya yaitu 1, 2, 1. Ini berarti, bentuk aljabar $(a + b)^2$ mengikuti pola segitiga Pascal. Sekarang, perhatikan variabel pada bentuk $a^2 + 2ab + b^2$. Terlihat bahwa, semakin ke kanan, pangkat a semakin berkurang (a^2 kemudian a). Namun sebaliknya, semakin ke kanan pangkat b semakin bertambah (b kemudian b^2). Jadi, dengan menggunakan pola segitiga Pascal dan aturan perpangkatan variabel, bentuk-bentuk perpangkatan lainnya dapat dituliskan sebagai berikut.

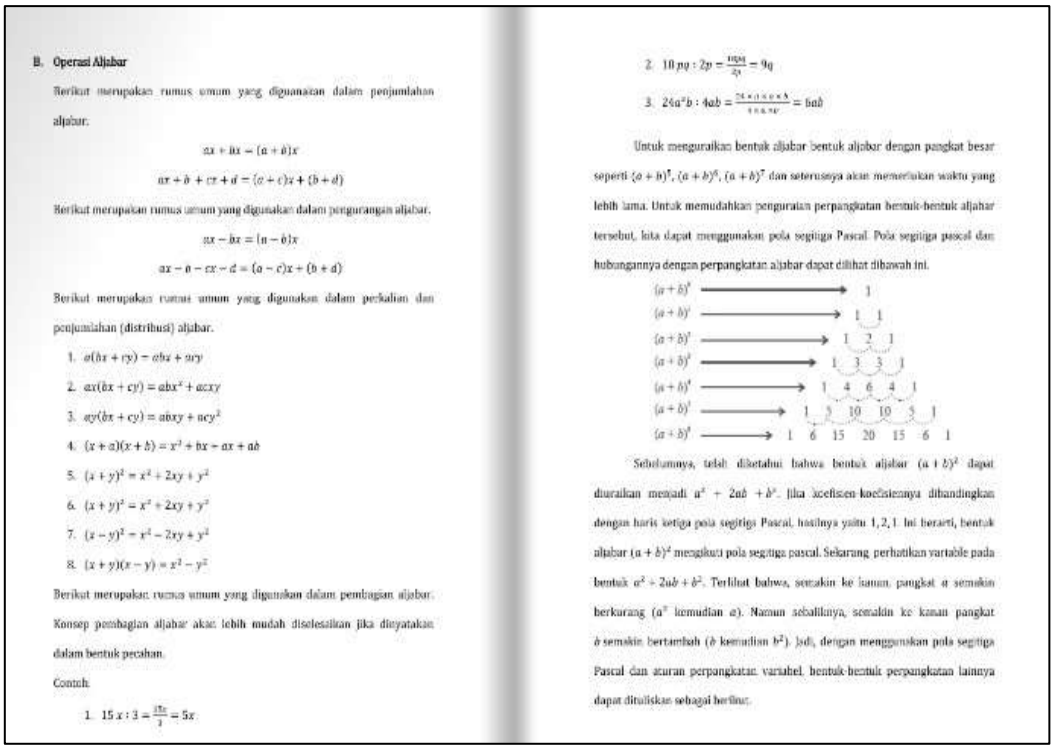
$(a + b)^3 = 1a^3 + 3a^2b + 3ab^2 + 1b^3$
$(a + b)^4 = 1a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + 1b^4$
$(a + b)^5 = 1a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + 1b^5$
dan seterusnya.

Perpangkatan bentuk aljabar $(a - b)^n$ dengan n bilangan asli juga mengikuti pola segitiga Pascal. Akan tetapi, tanda setiap koefisiennya selalu berganti dari (+) ke (–), begitu seterusnya.

Contoh

a. $(x + 5)^2 = x^2 + 2(x)(5) + 5^2$
$= x^2 + 10x + 25$
b. $(2x + 3)^3 = (2x)^3 + 3(2x)2(3) + 3(2x)(3)^2 + 3^3$
$= 8x^3 + 36x^2 + 54x + 27$
c. $(x - 2)^4 = x^4 - 4(x)3(2) + 6(x)2(2)2 - 4(x)(2)^3 + 24$
$= x^4 - 8x^3 + 24x^2 - 32x + 16$

Figure 7. Before Revision



B. **Operasi Aljabar**

Berikut merupakan rumus umum yang digunakan dalam penjumlahan aljabar.

$$ax + bx = (a + b)x$$

$$ax + b + cx + d = (a + c)x + (b + d)$$

Berikut merupakan rumus umum yang digunakan dalam pengurangan aljabar.

$$ax - bx = (a - b)x$$

$$ax - a - cx - d = (a - c)x + (b + d)$$

Berikut merupakan rumus umum yang digunakan dalam perkalian dan penjumlahan (distribusi) aljabar.

1. $a(bx + cy) = abx + acy$
2. $ax(bx + cy) = abx^2 + acxy$
3. $ay(bx + cy) = abxy + acy^2$
4. $(x + a)(x + b) = x^2 + bx + ax + ab$
5. $(x + y)^2 = x^2 + 2xy + y^2$
6. $(x + y)^2 = x^2 + 2xy + y^2$
7. $(x - y)^2 = x^2 - 2xy + y^2$
8. $(x + y)(x - y) = x^2 - y^2$

Berikut merupakan rumus umum yang digunakan dalam pembagian aljabar. Konsep pembagian aljabar akan lebih mudah diselesaikan jika dinyatakan dalam bentuk pecahan.

Contoh:

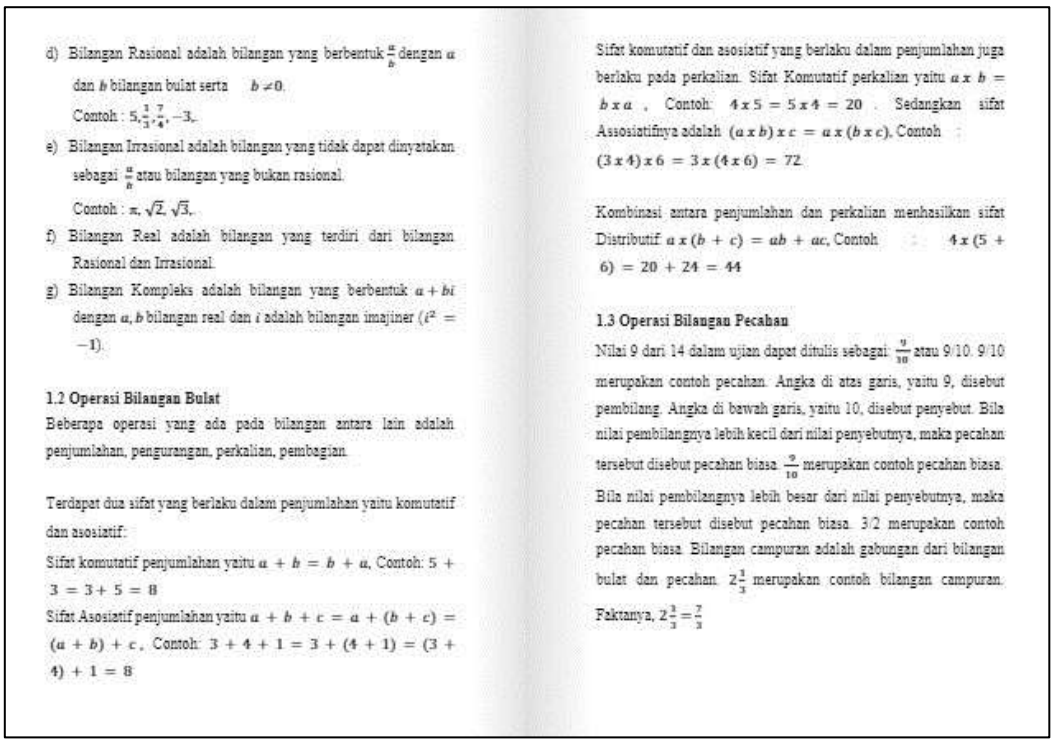
1. $15x : 3 = \frac{15x}{3} = 5x$
2. $10pq : 2p = \frac{10pq}{2p} = 9q$
3. $24a^2b : 4ab = \frac{24 \times a \times a \times b}{4 \times a \times b} = 6ab$

Untuk menguraikan bentuk aljabar bentuk aljabar dengan pangkat besar seperti $(a + b)^5$, $(a + b)^6$, $(a + b)^7$ dan seterusnya akan memerlukan waktu yang lebih lama. Untuk memudahkan penguraian perpangkatan bentuk-bentuk aljabar tersebut, kita dapat menggunakan pola segitiga Pascal. Pola segitiga pascal dan hubungannya dengan perpangkatan aljabar dapat dilihat dibawah ini.

$(a + b)^0$ ⟶ 1
$(a + b)^1$ ⟶ 1 1
$(a + b)^2$ ⟶ 1 2 1
$(a + b)^3$ ⟶ 1 3 3 1
$(a + b)^4$ ⟶ 1 4 6 4 1
$(a + b)^5$ ⟶ 1 5 10 10 5 1
$(a + b)^6$ ⟶ 1 6 15 20 15 6 1

Sebelumnya, telah diketahui bahwa bentuk aljabar $(a + b)^2$ dapat diuraikan menjadi $a^2 + 2ab + b^2$. Jika koefisien-koefisiennya dibandingkan dengan baris ketiga pola segitiga Pascal, hasilnya yaitu 1, 2, 1. Ini berarti, bentuk aljabar $(a + b)^2$ mengikuti pola segitiga pascal. Sekarang perhatikan variable pada bentuk $a^2 + 2ab + b^2$. Terlihat bahwa, semakin ke kanan, pangkat a semakin berkurang (a^2 kemudian a). Namun sebaliknya, semakin ke kanan pangkat b semakin bertambah (b kemudian b^2). Jadi, dengan menggunakan pola segitiga Pascal dan aturan perpangkatan variabel, bentuk-bentuk perpangkatan lainnya dapat dituliskan sebagai berikut.

Figure 8. After Revision



d) Bilangan Rasional adalah bilangan yang berbentuk $\frac{a}{b}$ dengan a dan b bilangan bulat serta $b \neq 0$.
Contoh : $5, \frac{1}{3}, \frac{7}{4}, -3,$.

e) Bilangan Irrasional adalah bilangan yang tidak dapat dinyatakan sebagai $\frac{a}{b}$ atau bilangan yang bukan rasional.
Contoh : $\pi, \sqrt{2}, \sqrt{3},$.

f) Bilangan Real adalah bilangan yang terdiri dari bilangan Rasional dan Irrasional.

g) Bilangan Kompleks adalah bilangan yang berbentuk $a + bi$ dengan a, b bilangan real dan i adalah bilangan imajiner ($i^2 = -1$).

1.2 Operasi Bilangan Bulat

Beberapa operasi yang ada pada bilangan antara lain adalah penjumlahan, pengurangan, perkalian, pembagian.

Terdapat dua sifat yang berlaku dalam penjumlahan yaitu komutatif dan asosiatif:

Sifat komutatif penjumlahan yaitu $a + b = b + a$, Contoh: $5 + 3 = 3 + 5 = 8$

Sifat Asosiatif penjumlahan yaitu $a + b + c = a + (b + c) = (a + b) + c$, Contoh: $3 + 4 + 1 = 3 + (4 + 1) = (3 + 4) + 1 = 8$

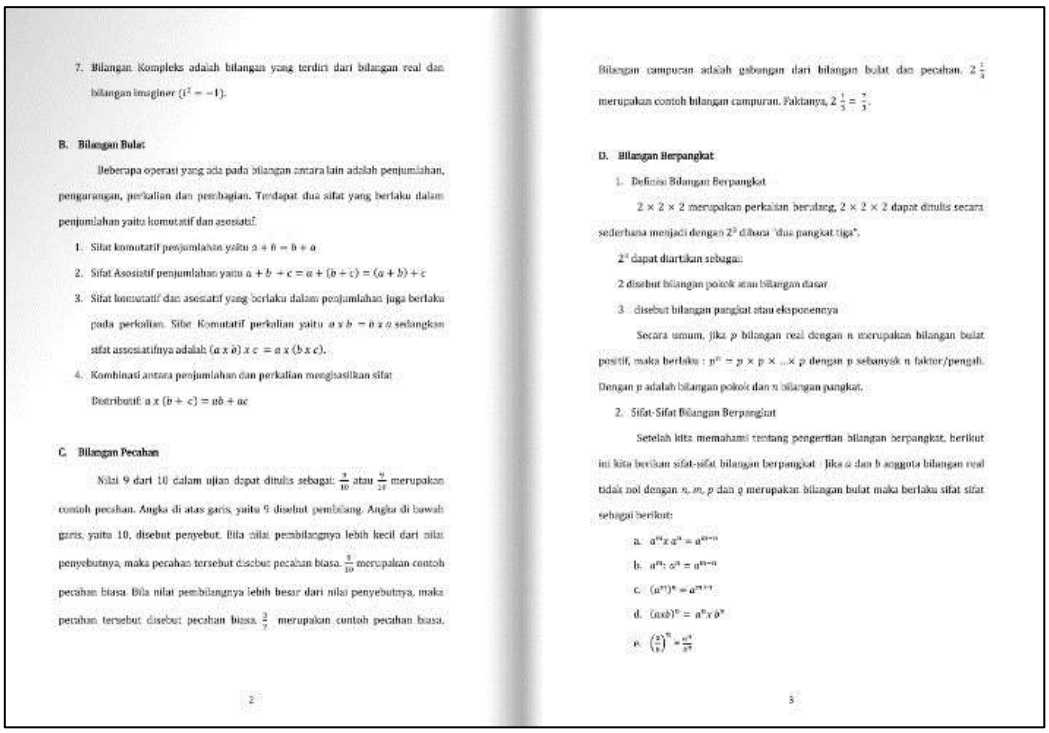
Sifat komutatif dan asosiatif yang berlaku dalam penjumlahan juga berlaku pada perkalian. Sifat Komutatif perkalian yaitu $a \times b = b \times a$, Contoh: $4 \times 5 = 5 \times 4 = 20$. Sedangkan sifat Assosiatifnya adalah $(a \times b) \times c = a \times (b \times c)$, Contoh : $(3 \times 4) \times 6 = 3 \times (4 \times 6) = 72$

Kombinasi antara penjumlahan dan perkalian menhasilkan sifat Distributif $a \times (b + c) = ab + ac$, Contoh : $4 \times (5 + 6) = 20 + 24 = 44$

1.3 Operasi Bilangan Pecahan

Nilai 9 dari 14 dalam ujian dapat ditulis sebagai: $\frac{9}{10}$ atau 9/10. 9/10 merupakan contoh pecahan. Angka di atas garis, yaitu 9, disebut pembilang. Angka di bawah garis, yaitu 10, disebut penyebut. Bila nilai pembilangnya lebih kecil dari nilai penyebutnya, maka pecahan tersebut disebut pecahan biasa. $\frac{9}{10}$ merupakan contoh pecahan biasa. Bila nilai pembilangnya lebih besar dari nilai penyebutnya, maka pecahan tersebut disebut pecahan biasa. 3/2 merupakan contoh pecahan biasa. Bilangan campuran adalah gabungan dari bilangan bulat dan pecahan. $2\frac{1}{3}$ merupakan contoh bilangan campuran. Faktanya, $2\frac{1}{3} = \frac{7}{3}$

Figure 10. Before Revision



7. Bilangan Kompleks adalah bilangan yang terdiri dari bilangan real dan bilangan imaginer ($i^2 = -1$).

B. Bilangan Bulat

Beberapa operasi yang ada pada bilangan antara lain adalah penjumlahan, pengurangan, perkalian dan pembagian. Terdapat dua sifat yang berlaku dalam penjumlahan yaitu komutatif dan asosiatif.

1. Sifat komutatif penjumlahan yaitu $a + b = b + a$
2. Sifat Asosiatif penjumlahan yaitu $a + b + c = a + (b + c) = (a + b) + c$
3. Sifat komutatif dan asosiatif yang berlaku dalam penjumlahan juga berlaku pada perkalian. Sifat Komutatif perkalian yaitu $a \times b = b \times a$ sedangkan sifat assosiatifnya adalah $(a \times b) \times c = a \times (b \times c)$.
4. Kombinasi antara penjumlahan dan perkalian menghasilkan sifat Distributif $a \times (b + c) = ab + ac$

C. Bilangan Pecahan

Nilai 9 dari 10 dalam ujian dapat ditulis sebagai: $\frac{9}{10}$ atau $\frac{9}{10}$ merupakan contoh pecahan. Angka di atas garis, yaitu 9 disebut pembilang. Angka di bawah garis, yaitu 10, disebut penyebut. Bila nilai pembilangnya lebih kecil dari nilai penyebutnya, maka pecahan tersebut disebut pecahan biasa. $\frac{9}{10}$ merupakan contoh pecahan biasa. Bila nilai pembilangnya lebih besar dari nilai penyebutnya, maka pecahan tersebut disebut pecahan biasa. $\frac{3}{2}$ merupakan contoh pecahan biasa.

Bilangan campuran adalah gabungan dari bilangan bulat dan pecahan. $2\frac{1}{3}$ merupakan contoh bilangan campuran. Faktanya, $2\frac{1}{3} = \frac{7}{3}$.

D. Bilangan Berpangkat

1. Definisi Bilangan Berpangkat

$2 \times 2 \times 2$ merupakan perkalian berulang, $2 \times 2 \times 2$ dapat ditulis secara sederhana menjadi dengan 2^3 dibaca "dua pangkat tiga".

2^4 dapat diartikan sebagai:

2 disebut bilangan pokok atau bilangan dasar

3 disebut bilangan pangkat atau eksponennya

Secara umum, jika p bilangan real dengan n merupakan bilangan bulat positif, maka berlaku : $p^n = p \times p \times \ldots \times p$ dengan p sebanyak n faktor/pengali. Dengan p adalah bilangan pokok dan n bilangan pangkat.

2. Sifat-Sifat Bilangan Berpangkat

Setelah kita memahami tentang pengertian bilangan berpangkat, berikut ini kita berikan sifat-sifat bilangan berpangkat : Jika a dan b anggota bilangan real tidak nol dengan n, m, p dan q merupakan bilangan bulat maka berlaku sifat sifat sebagai berikut:

a. $a^m x a^n = a^{m+n}$

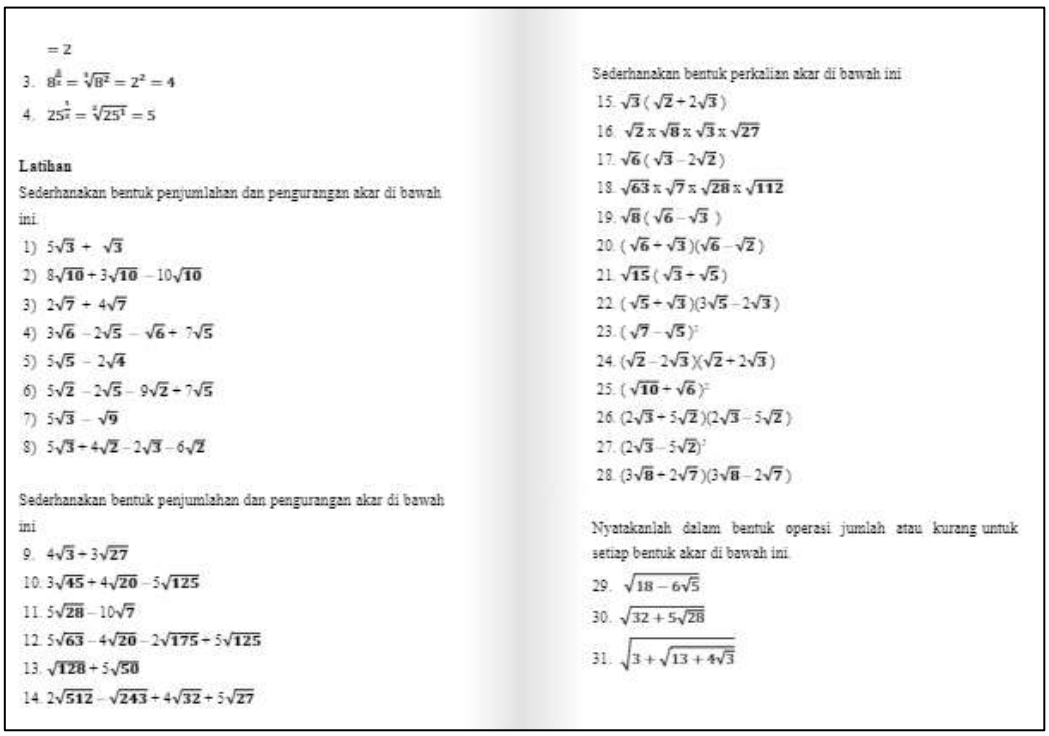
b. $a^m : a^n = a^{m-n}$

c. $(a^m)^n = a^{m \times n}$

d. $(axb)^n = a^n x b^n$

e. $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Figure 11. After Revision



$= 2$

3. $8^{\frac{2}{3}} = \sqrt[3]{8^2} = 2^2 = 4$
4. $25^{\frac{1}{2}} = \sqrt[2]{25^1} = 5$

Latihan

Sederhanakan bentuk penjumlahan dan pengurangan akar di bawah ini.

1) $5\sqrt{3} + \sqrt{3}$
2) $8\sqrt{10} + 3\sqrt{10} - 10\sqrt{10}$
3) $2\sqrt{7} + 4\sqrt{7}$
4) $3\sqrt{6} - 2\sqrt{5} - \sqrt{6} + 7\sqrt{5}$
5) $5\sqrt{5} - 2\sqrt{4}$
6) $5\sqrt{2} - 2\sqrt{5} - 9\sqrt{2} + 7\sqrt{5}$
7) $5\sqrt{3} - \sqrt{9}$
8) $5\sqrt{3} + 4\sqrt{2} - 2\sqrt{3} - 6\sqrt{2}$

Sederhanakan bentuk penjumlahan dan pengurangan akar di bawah ini

9. $4\sqrt{3} + 3\sqrt{27}$
10. $3\sqrt{45} + 4\sqrt{20} - 5\sqrt{125}$
11. $5\sqrt{28} - 10\sqrt{7}$
12. $5\sqrt{63} - 4\sqrt{20} - 2\sqrt{175} + 5\sqrt{125}$
13. $\sqrt{128} + 5\sqrt{50}$
14. $2\sqrt{512} - \sqrt{243} + 4\sqrt{32} + 5\sqrt{27}$

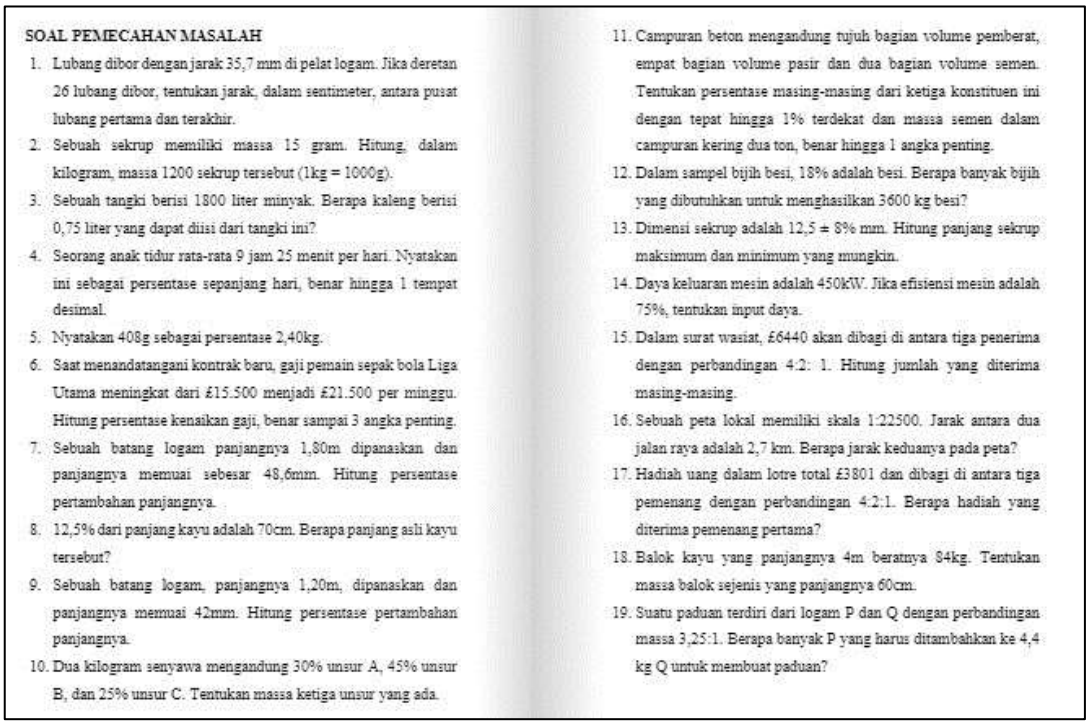
Sederhanakan bentuk perkalian akar di bawah ini

15. $\sqrt{3}(\sqrt{2} + 2\sqrt{3})$
16. $\sqrt{2} \times \sqrt{8} \times \sqrt{3} \times \sqrt{27}$
17. $\sqrt{6}(\sqrt{3} - 2\sqrt{2})$
18. $\sqrt{63} \times \sqrt{7} \times \sqrt{28} \times \sqrt{112}$
19. $\sqrt{8}(\sqrt{6} - \sqrt{3})$
20. $(\sqrt{6} + \sqrt{3})(\sqrt{6} - \sqrt{2})$
21. $\sqrt{15}(\sqrt{3} + \sqrt{5})$
22. $(\sqrt{5} + \sqrt{3})(3\sqrt{5} - 2\sqrt{3})$
23. $(\sqrt{7} - \sqrt{5})^2$
24. $(\sqrt{2} - 2\sqrt{3})(\sqrt{2} + 2\sqrt{3})$
25. $(\sqrt{10} + \sqrt{6})^2$
26. $(2\sqrt{3} + 5\sqrt{2})(2\sqrt{3} - 5\sqrt{2})$
27. $(2\sqrt{3} - 5\sqrt{2})^2$
28. $(3\sqrt{8} + 2\sqrt{7})(3\sqrt{8} - 2\sqrt{7})$

Nyatakanlah dalam bentuk operasi jumlah atau kurang untuk setiap bentuk akar di bawah ini.

29. $\sqrt{18 - 6\sqrt{5}}$
30. $\sqrt{32 + 5\sqrt{28}}$
31. $\sqrt{3 + \sqrt{13 + 4\sqrt{3}}}$

Figure 12. Before Revision



SOAL PEMECAHAN MASALAH

1. Lubang dibor dengan jarak 35,7 mm di pelat logam. Jika deretan 26 lubang dibor, tentukan jarak, dalam sentimeter, antara pusat lubang pertama dan terakhir.
2. Sebuah sekrup memiliki massa 15 gram. Hitung, dalam kilogram, massa 1200 sekrup tersebut (1kg = 1000g).
3. Sebuah tangki berisi 1800 liter minyak. Berapa kaleng berisi 0,75 liter yang dapat diisi dari tangki ini?
4. Seorang anak tidur rata-rata 9 jam 25 menit per hari. Nyatakan ini sebagai persentase sepanjang hari, benar hingga 1 tempat desimal.
5. Nyatakan 408g sebagai persentase 2,40kg.
6. Saat menandatangani kontrak baru, gaji pemain sepak bola Liga Utama meningkat dari £15.500 menjadi £21.500 per minggu. Hitung persentase kenaikan gaji, benar sampai 3 angka penting.
7. Sebuah batang logam panjangnya 1,80m dipanaskan dan panjangnya memuai sebesar 48,6mm. Hitung persentase pertambahan panjangnya.
8. 12,5% dari panjang kayu adalah 70cm. Berapa panjang asli kayu tersebut?
9. Sebuah batang logam, panjangnya 1,20m, dipanaskan dan panjangnya memuai 42mm. Hitung persentase pertambahan panjangnya.
10. Dua kilogram senyawa mengandung 30% unsur A, 45% unsur B, dan 25% unsur C. Tentukan massa ketiga unsur yang ada.
11. Campuran beton mengandung tujuh bagian volume pemberat, empat bagian volume pasir dan dua bagian volume semen. Tentukan persentase masing-masing dari ketiga konstituen ini dengan tepat hingga 1% terdekat dan massa semen dalam campuran kering dua ton, benar hingga 1 angka penting.
12. Dalam sampel bijih besi, 18% adalah besi. Berapa banyak bijih yang dibutuhkan untuk menghasilkan 3600 kg besi?
13. Dimensi sekrup adalah 12,5 ± 8% mm. Hitung panjang sekrup maksimum dan minimum yang mungkin.
14. Daya keluaran mesin adalah 450kW. Jika efisiensi mesin adalah 75%, tentukan input daya.
15. Dalam surat wasiat, £6440 akan dibagi di antara tiga penerima dengan perbandingan 4:2: 1. Hitung jumlah yang diterima masing-masing.
16. Sebuah peta lokal memiliki skala 1:22500. Jarak antara dua jalan raya adalah 2,7 km. Berapa jarak keduanya pada peta?
17. Hadiah uang dalam lotre total £3801 dan dibagi di antara tiga pemenang dengan perbandingan 4:2:1. Berapa hadiah yang diterima pemenang pertama?
18. Balok kayu yang panjangnya 4m beratnya 84kg. Tentukan massa balok sejenis yang panjangnya 60cm.
19. Suatu paduan terdiri dari logam P dan Q dengan perbandingan massa 3,25:1. Berapa banyak P yang harus ditambahkan ke 4,4 kg Q untuk membuat paduan?

Figure 13. After Revision

4. Disseminate

The teaching materials obtained at the final stage of development are then tested and distributed on a wider scale, for example in other classes and at other institutions. However, in this research, the dissemination stage was not carried out perfectly due to time and budget limitations, so it was only distributed to other lecturers for use in other classes and other study programs in applied mathematics courses.

Teaching materials have an important role in learning so the development of teaching materials must be appropriate and learning needs to be able to improve the abilities of students. The process of developing teaching materials has certain rules and regulations by the development model carried out. The development model used is a 4D development model with development steps, namely define, design, develop, and disseminate. One of the core stages is conducting a validation test. The validation test is carried out as an effort to produce good teaching materials that are relevant to the theoretical basis of development. The feasibility test is also very important to ensure whether or not the teaching materials are used in the learning process (Akbar, 2013).

The subjects of this research are Graphic Engineering students for the 2022/2023 academic year. There were 20 students consisting of 8 men and 12 women. The e-module that has been developed is tested on students of the Graphic Engineering Study Program. Based on the results of the analysis of the validation assessment sheet instrument conducted by 2 lecturers consisting of material experts and design experts, the average validation value was 4,8 with very valid criteria. This shows that the e-module is suitable for use by lecturers in the learning process as well as the desired aspects in this study. These aspects include aspects of graphic validity, language validity, construct validity, and e-module presentation.

Judging from the aspect of graphics, the e-module teaching materials were declared very valid by the two validators with an average value of 4,7. This shows that the size of the e-module teaching materials is by ISO standards, namely A4 size (210 x 297 mm), the font size and the color of the title of the e-module teaching materials used are attractive, proportional, and easy to read and do not use too many types of letters. In addition, the appearance of the layout elements on the front and back covers harmoniously has a match and is consistent. This is in line with what was conveyed by (Daryanto, 2013) that it is necessary to pay attention to the consistency of graphic selection so as not to confuse the user. The consistency used will have an impact on the convenience of students in using e-module teaching materials.

Judging from the aspect of language, the e-module teaching materials were declared very valid by the two validators with an average value of 4,9. This shows that the language used in the e-module teaching materials is following the correct Indonesian language rules, both in terms of readability and clarity of information. The use of language in the teaching materials of this e-module pays attention to accurate and communicative language following the level of education, namely clear, straightforward, and communicative. The use of language also pays attention to proper spelling, punctuation, and mechanical aspects by Enhanced Spelling guidelines. The choice of words and sentence structure is adjusted to the rules of good and correct Indonesian. This is in line with what was stated by Sitepu (2015) which states that language uses certain rules so that messages in the form of ideas and/or feelings of the sender can be conveyed appropriately.

Judging From the aspect of construct validity, e-module teaching materials were declared very valid by the two validators with an average score

of 4,9. This shows that the material contained in the e-module teaching materials follows the Semester Program Plan and Graduate Learning Outcomes and Course Learning Outcomes to be achieved in e-module teaching materials which are a summary from several sources so that it can make it easier for students to learn and understand the material following the applicable curriculum. This is confirmed by Prastowo (2011) who argues that the substance of good teaching materials to achieve predetermined competency standards and basic competencies includes knowledge, skills, and attitudes.

Viewed from the aspect of the presentation of the material, the e-module teaching materials were declared very valid by the two validators with an average value of 4.7. This shows that the material contained in the e-module teaching materials is systematically arranged. The presentation of the concepts in the e-module teaching materials does not lead to many interpretations, the material is according to students' abilities and the illustrations that exist can support the clarity of the material. One of the functions of teaching materials according to Prastowo (2011) which states that a teaching material must be able to maximize the role of students compared to the role of the teacher, make it easier to understand the material, be concise and practice, and facilitate the learning process.

CONCLUSION

Based on the results and discussion of this research, the e-module teaching materials developed using the 4D development model in applied mathematics material in graphic engineering study programs through validation tests using assessment sheet instruments obtained validation analysis results on aspects (1) graphic validity, namely 4,7 is in the very valid category, (2) language validity is 4,9 is in the very valid category, (3) construct validity is 4,9 is in the very valid category and (4) E-module Presentation is 4,7 is in the very category valid so that the average value of all aspects is 4,8 in the very valid category. So it can be concluded that the e-module teaching materials that have been developed are declared valid to be used in class as one of the teaching materials in the learning process, especially in applied mathematics courses. The development of e-module teaching materials should be developed for other materials so that they can make students more active and more interested in studying mathematics.

REFERENCES

Ainun, A. M. (2019). Development of teaching materials assisted by maple software in the calculus I course for students majoring in mathematics education, Faculty of Tarbiyah, and Teacher Training. [Skripsi]. UIN Alauddin Makassar.

Akbar, S. (2013). *Learning device instrument*. Bandung: PT Remaja Rosdakarya.

Aprianka, S., Setiani, A., & Imswatama, A. (2021). Validity of e-modules based on open-ended meterial systems of linear equations in two variables in online learning for vocational school students. *Journal Cendekia : Jurnal Pendidikan Matematika*, *5*(3), 3111–3122. https://doi.org/10.31004/cendekia.v5i3.896.

Daryanto. (2013). *Preparing modules (Teaching materials for teacher preparation in teaching)*. Yogyakarta: Gava Media.

Halik, F., Acfira, L., & Tawaddud, B. (2022). *Development of problem-based learning module in basic statistics for makassar graphic engineering students*. https://doi.org/10.4108/eai.16-11-2022.2326148.

Halik, F., Acfira, L., & Tawaddud, B. (2022). The validity of problem-based learning teaching material for teaching basic statistics to graphics engineering students. *MaPan: Jurnal Matematika dan Pembelajaran, 10*(2), 207–218. https://doi.org/https://doi.org/ 10.24252/mapan.2022v10n2a2.

Hidayat, R., & Abdillah. (2019). *Education science*. Medan: LPPPI.

Islahiyah, I., Pujiastuti, H., & Mutaqin, A. (2021). Development of e-modules with a problem-based learning model to improve students' mathematical problem-solving abilities. *AKSIOMA: Journal of the Mathematics Education Study Program*, *10*(4), 2107. https://doi.org/10.24127/ajpm.v10i4.3908.

Laman, E. G., & Halik, F. (2023). Analysis of students' errors in solving higher-order thinking skills mathematical problems of geometry based on hadar criteria viewed from prior knowledge. *MaPan: Jurnal Matematika dan Pembelajaran, 11*(1), 186–201. https://doi.org/10.24252/mapan.2023v11n1a12.

Larkin, K., & Calder, N. (2016). Mathematics education and mobile technologies. *Math Education*, *December 2015*, 1–7. https://doi.org/10.1007/s13394-015-0167-6.

Lestari, & Surya. (2017). The Effectiveness of realistic mathematics education approach on ability of students' mathematical concept understanding. *International Journal of Sciences*, *34*(1), 91–100.

Madjijd, A. (2013). *Learning strategies*. Bandung: PT Remaja Rosdakarya.

Prastowo. (2011). *Creative guide to creating innovative teaching materials*. Yogyakarta: Diva Press.

Purnomo, D. (2011). Development of mathematics teaching materials as a means of developing creative thinking. *AKSIOMA : Journal of the Mathematics Education Study Program*, *2*(1), 1. https://doi.org/10.26877/ aks.v2i1/ Maret.43.

Ramadhani, R., & Fitri, Y. (2020). Validity of EPUB3 Based Mathematics E-Modules Using Rasch Model Analysis. *Journal Gantang*, *5*(2), 95–111. https://doi.org/10.31629/jg.v5i2.2535.

Sari, P., & Gautama, M. I. (2022). Failure factors in learning media development sociology teacher at SMAN 15 Padang. *Naradidik: Journal of Education and Pedagogy*, *1*(1), 78–83. https://doi.org/10.24036/nara.v1i1.8.

Sitepu. (2015). *Writing textbooks*. Bandung: PT Remaja Rosdakarya.

Suarsana, & Mahayukti. (2013). Development of problem-solving oriented e-modules to improve students' critical thinking skills. *Indonesian Education Journal*, *2*(2), 264–275.

Sudjana, N. (2009). *Assessment of teaching and learning process results*. Bandung: Remaja Rosdakasya.

Sugiyono. (2009). *Educational research methods (quantitative, qualitative, and R&D)*. Bandung: Alfabeta.

Turnip, R. F., & Karyono, H. (2021). Development of mathematics e-modules to improve critical thinking skills. *Journal of Mathematics and Science Education*, *9*(2), 485–498. https://doi.org/10.25273/jems.v9i2.11057.

Yakub, R. D. (2019). Development of context-based mathematics learning tools on systems of linear equations in two variables class VIII MTs. [Skripsi]. UIN Alauddin Makassar.