Development of TextBook to Support Merdeka Curriculum on the Atomic Structure of Phase E

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Article History:
Received: Jun 27, 2023
Revised: Jul 10, 2023
Accepted: Jul 23, 2023
Published: Jan 01, 2024

Keywords:
Atomic Structure, Merdeka Curriculum, Textbook.

Kata kunci:
Buku Ajar, Kurikulum Merdeka, Struktur Atom.

How to cite:
Susanti, A., Mawardi, M., & Suryani, O. (2024). Development of TextBook to Support Merdeka Curriculum on the Atomic Structure of Phase E. *Edunesia : Jurnal Ilmiah Pendidikan, 5*(1), 101-115.

Abstract: As a result of the COVID-19 pandemic, it caused a very significant change in education. The learning was done online. So that makes the Indonesian student lose. The free curriculum also demands free study, as summarized in PROPELA. That's why research needs to be done to develop textbooks to support the study of the free curriculum matter, atomic structure phase E, and test the validity and practicality of this teaching material. This type of research is called Educational Design Research (EDR) with the Plomp model, which is: (1) preliminary research; (2) development or prototyping; and (3) assessment (not done). Research data from validation is insulated using Aiken's v formula, while registered data is analyzed in a present-day way. Based on the study's results, the teaching material has been valid, with an average score of 0.91. The use of the scripture is easy to understand and view, practical learning, and benefits of teaching, with an average score of 72%. This coursebook is valid and helpful through the formative tests that have been carried out. The final average value of 0.94 is proof of this validity. In addition, this coursebook is also equipped with mental model problems that are proven to help students solve existing problems. This is known from the responses of active and excellent students in solving these problems. In addition, the time spent working on the questions is also sufficient, so it only uses time outside of learning hours.

Abstrak: Akibat pandemi COVID-19 mengakibatkan perubahan yang sangat signifikan didunia pendidikan. Pembelajaran dilakukan secara daring. Sehingga menjadikan pelajar indonesia mengalami learning loss. Selain itu, kurikulum merdeka menuntut pembelajaran dilakukan secara merdeka, yang dirangkum pada PROPELA. Oleh karena itu, perlu dilakukan penelitian yang bertujuan untuk mengembangkan buku ajar untuk menunjang pembelajaran kurikulum merdeka materi struktur atom Fase E dan menguji kevalidan serta kepratisan dari bahan ajar ini. Jenis penelitian ini adalah educational design research (EDR) dengan tahapan Plomp, yaitu: (1) Preliminary research, (2) protyping phase, dan (3) assessment phase (tidak dilakukan). Data hasil penelitian dari angket validasi dianalisis dengan menggunkan rumus Aiken`s V, sedangkan data angket praktikalitas dianalisis dengan cara presentase. Berdasarkan hasil penelitian didaptakan buku ajar telah valid dengan skor rata-rata 0,91. Buku ajar yang dikembangkan terbukti praktis dalam kemudahan penggunaan, tampilan, efisien pembelajaran, manfaat bahan ajar, dengan rata-rata skor 72%. Selain itu buku ajar ini juga dilengkapi soal model mental yang terbukti membantu peserta didik dalam menyelesaikan soal yang ada. Hal ini diketahui dari respon peserta didik yang aktif dan asik dalam menyelesaikan soal-soal tersebut. Selain itu, waktu penyelesaian dalam mengerjakan soal-soal juga cukup, sehingga tidak menggunakan waktu di luar jam pembelajaran.

https://doi.org/10.51276/edu.v5i1.626

A. Introduction

The COVID-19 (Corona Virus Disease 2019) pandemic is a dangerous virus outbreak that continues to spread globally. Every day, the number of cases confirmed positive for COVID-19 continues to grow, thus having an impact on various aspects of life, one of which is education (Rodiawati, 2021). In 2020–2021, it can be said that there has been an era of the COVID-19 pandemic resulting in rapid and unexpected changes in life, and there is no certainty that the COVID-19 pandemic will end (Herpika & Mawardi, 2021). Education prepares the younger generation to run energy and fulfil their goals more effectively and efficiently (Maypalita & Zainul, 2018). One of the levels is the SMA/MA level, where the learning system is transferred to an online or distance learning system (Mawardi et al., 2021).

Online learning can result in learning activities being carried out more optimally than in face-to-face education. The obstacles in implementing online learning are caused by students' difficulty adapting to the learning situation and teachers who are not ready to learn suddenly (Nengsih & Mawardi, 2021). This situation will be an obstacle to implementing learning. In addition, the learning process will be teacher-centred, as students will find it difficult to ask questions about material they need help understanding, and it will be difficult for them to discuss with their group mates. Therefore, this situation will inevitably result in learning activities that fail to run smoothly (Siregar & Mawardi, 2022). Moreover, further studies have paid attention to the impact of changes in the learning process during the pandemic. The findings of these studies show, among other things, the occurrence of learning loss (Kemdikbud, 2021).

Learning loss is the loss of specific knowledge or skills that results in the deterioration of the learning process (Donnelly & Patrinos, 2021). With this in mind, the government is reviewing and developing policies that can form a pandemic adaptation curriculum that makes us aware of the characteristics of each learner. Seeing that learning loss needs to be sufficiently addressed by choosing the three proposed curricula, Nadiem Makarim, the Minister of Education and Culture, devised an merdeka curriculum (Jojor & Sitohang, 2022). The Merdeka Curriculum is a new curriculum expected to create higher quality and more dynamic education, especially for millennials (Kurniati et al., 2022).

The merdeka curriculum is a curriculum that demands independence from students. This means that students can expand the knowledge gained from formal and non-formal education. Learners are not given restrictions on understanding the concept of learning that takes place. In addition to demanding independence from students, this curriculum requires teachers to hone students' creativity (Manalu, 2022).

Chemistry, which is part of the Natural Sciences (IPA) or science, is a collection of systematically arranged knowledge and, in its use, is generally limited to natural symptoms. The nature of chemistry includes four elements, namely: (1) product: in the form of facts, principles, laws, theories, and models; (2) process: namely, problem-solving procedures through the scientific method, which include observation, hypothesis formulation, experimental design, experiment or investigation, hypothesis testing through

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experimentation; evaluation, measurement, and conclusion drawing; (3) application: the application of scientific methods or work and science concepts in everyday life; (4) attitude: namely, curiosity about materials, natural phenomena, living things, and causal relationships that cause new problems that can be solved through correct procedures. One of the materials studied by students is an atomic-structure material. Atomic structure is the primary material that must be learned. Atomic structure is an abstract chemistry subject requiring a relatively complex type of idea-based conceptual knowledge because it includes various concepts, rules, laws, principles, models, and theories. Atomic structure is considered abstract and complex because atoms and their structures cannot be observed directly by the eye because of their tiny size, but the scope of the material is vast (Sari & Ulianas, 2021). 68.3% of students consider the atomic structure of the material to be one of the advantages of nanotechnology. The material has dense and interrelated sub-materials (Rahayu & Ismawati, 2023).

Under the four compositions above, learning chemistry involves introducing the main ideas (Mawardi, 2016). According to Gilbert (2009), understanding the main concepts in chemistry involves a mental representation (picture) of the idea and the phenomenon to which the idea relates. To help students understand these central ideas, teaching materials are needed. Teaching materials are systematically arranged materials used to assist teachers in carrying out teaching and learning activities to create an environment that allows students to learn (Rismawati et al., 2022).

These teaching materials can be categorized into four categories, which are in line with Rahmawati et al (2019) statement, namely, printed teaching materials (published), interactive multimedia teaching materials (interactive teaching materials), and teaching materials that have a function as a guide for a teacher in the learning process and are a substance of competence that must be taught to students. One of these teaching materials is a textbook. Textbooks as learning resources are essential to get attention because they can complement, maintain, and enrich the learning repertoire and increase students' activity and creativity. Good, standard, and innovative textbooks can improve student learning achievement. Students are motivated to use books in the classroom during learning and outside the school for enrichment and merdeka education (Situmorang, 2013).

As a source of information and a medium for developing students' critical thinking skills, the textbook should have good quality and meet specific standards. Developing various kinds of books provides many choices for educational institutions, teachers, and students to get the books they want, including textbooks that will be used in schools. Selecting the correct text that is easy to understand and learn, contains material by the applicable curriculum, and involves students will support the achievement of learning objectives. The quality of a good book in developing students' thinking skills can be seen in substance, content, and language. In terms of importance, it must have a clear systematization of science, while in terms of language, it must have high readability and be communicative. The essential ability to read and understand discourse affects students'

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thinking skills in the learning process. Therefore, a book that is easy to read, understand, and comprehend by students is needed (Asasi, 2009).

However, the textbook criteria presented above have not been met in the textbooks available to support merdeka curriculum learning. This statement is by the responses of the teachers when interviewed. Chemistry teachers at Public Senior High School 1 Padang, Public Senior High School 8 Padang, and Senior High School Pembangunan Lab. UNP These teachers stated that the preparation of material that is not sequential, less interesting, and unclear makes students have difficulty understanding the material. The teachers need a learning support book that is interesting, clear and has neat components (such as more detailed material content, multi representations that are easy to understand, a more attractive book display, and activities that can help students improve their understanding of the material). Even though Rudzitis (in Hasibuan & Silaban, 2017) suggests the quality of a textbook is very important in science learning, Textbooks are the primary tool in teaching and learning activities at every level of education. However, so many low-quality science textbooks contain many errors in methods and other concepts.

Research results from Islamiyah (2023) It was obtained that (1) educators need innovation in chemistry textbooks and chemistry books used in schools before being developed have met BSNP and contextual criteria, but there are still shortcomings, so it is necessary to develop textbooks; (2) contextual-based chemistry electronic books developed have met BSNP and contextual criteria; (3) student chemistry learning outcomes are higher than the KKM value (tcount> table (8.087> 1.714); (4) the increase in student learning outcomes (n-gain) of 0.74 is included in the high category; (5) the level of student learning motivation is very high to learn chemistry when using contextual-based chemistry electronic books; (6) student responses are very good to contextual-based chemistry electronic textbooks so that contextual-based chemistry electronic books can be used in chemistry learning at school. Besides that, Suardika (2019) stated that the product in this study is a high school chemistry textbook for class X based on Toulmin's argument. The characteristics of the developed textbook are to the demands of the 2013 curriculum. Each argumentative paragraph in the developed textbook follows Toulmin's argumentation pattern and is equipped with an argument map. Most of the developed coursebook assessments received good category ratings from expert validators. The average score of all aspects of expert validation results is 4.25, with an outstanding category. The readability test results showed that the student readability of chemistry textbooks was in the exceptional category. The average score of all aspects of the readability test reached 4.37. Based on the test results, the high school chemistry textbook class X, based on Toulmin's argument, has very good validity.

The difference in this textbook will be seen in the use of the merdeka curriculum and the discussion of material by the demands of the merdeka curriculum. The discussion of this material is more detailed, presents AKM questions, has learning support activities based on PROPELA, and is arranged more interestingly. Therefore, with the development of coursebooks to support merdeka curriculum learning on valid and practical Phase E

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atomic structure material, it is hoped that students can understand chemistry subjects well. As for the specific objectives of the development of this coursebook, describe 1) the characteristics of coursebooks based on an merdeka curriculum, 2) the validity of the products developed based on expert judgment, and 3) the practicality of the coursebook developed based on the results of the practicality test of the chemistry teacher of Public Senior High School 8 Padang and students of Public Senior High School 8 Padang.

B. Method

Instruments in the form of validity and practicality questionnaires will be used to test the object of research, which are textbooks that help students learn Phase E SMA/MA atomic structure material on their own. The instrument will be given to 3 lecturers of the Chemistry Department at FMIPA UNP, 2 chemistry teachers at Public Senior High School 8 Padang, and 9 Public Senior High School 8 Padang Phase E students.

The research at FMIPA UNP and Public Senior High School 8 Padang was conducted during the stages of the Plomp model development (Plomp & Nieveen, 2013). The first stage in Plomp's model is the preliminary research stage. At this stage, a needs analysis and a context analysis of the research problem are carried out. Furthermore, a literature study is carried out, where in this activity, theories are looked for so that a solution to the problem can be obtained. After that, the next step is to develop the concepts learned in atomic structure material.

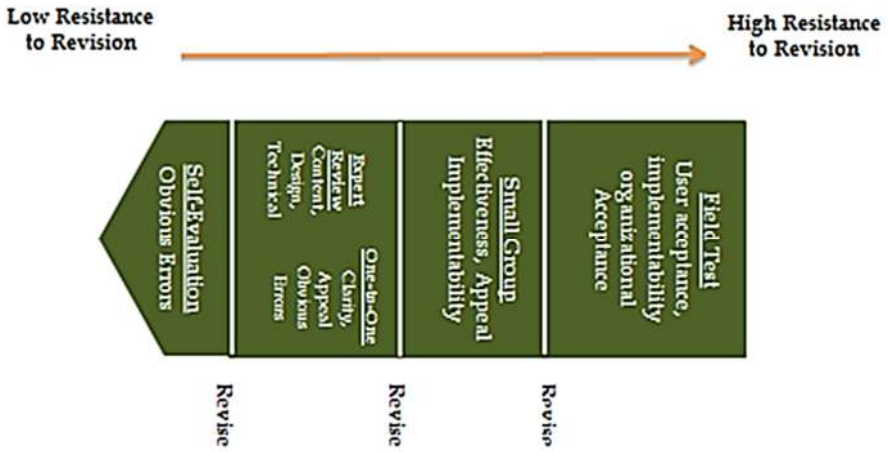

Figure 1. The Stages of Formative Evaluation of Educational Development Research (Plomp & Nieveen, 2013)

The validator's scoring of each statement was analyzed by applying Aiken's validity formula as follows:

$$V = \frac{\Sigma s}{n\,(c-1)}$$

$$S = r - I_o$$

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Description :

S = The score assigned by the validator minus the lowest score of the category used.
r = Validator's preferred category score.
I_o = The Lowest score in the scoring category.
n = Number of validators.
c = The validator selects many categories.

The range of Aiken's validity index is 0 to 1, where a high Aiken's validity index indicates the validity of the product (Aiken, 1985) on items using 5 validators and 5 categories of category choices, as attached in Table 1. The validity criteria for textbooks to support the implementation of the merdeka curriculum based on the Aiken validity index are seen in the following table:

Table 1. Indicator index validated by Aiken 5 Validator

Aiken's V Scale	Category
V ≥ 0.80	Valid
V < 0.80	Invalid

(Source: Aiken, 1985)

The assessment of the practicality sheet was obtained through a learner response questionnaire, which was analyzed using a formula modified from Purwanto (2010). Here are the following:

$$NP = \frac{R}{SM} \times 100$$

Description :

NP = The per cent value sought or expected.
R = The raw score obtained by the learner.
SM = An ideal maximum score for the test.
100 = Fixed number.

The level of practicality of coursebooks based on the merdeka curriculum will be displayed after conversion into the table categories below.

Table 2. Conversion of the Practicality Level of Teaching Books to Support the Implementation of the Merdeka Curriculum

Rate	Validity
86% - 100%	Very practical
76% - 85%	Quite practica
60% - 75%	Practical
55% - 59%	Less practical
≤ 54%	Not practical

(Source: Purwanto, 2010).

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C. Results and Discussion

Result

Preliminary Research

Textbooks are an essential part of the implementation of education. Through textbooks, teachers will find learning easier, and students will be more assisted in learning. Textbooks can be made according to the needs and characteristics of the teaching material to be presented. This study will test the textbooks developed for validity and practicality. Of course, to complete the research to expectations, it is necessary to carry out several stages, including.

In the first stage, preliminary research was conducted to analyze the needs and context, review the literature, and develop the conceptual framework needed for the examination (Aumi & Zainul, 2018). A needs analysis was conducted to determine problems related to the demands of the merdeka curriculum. This needs analysis was performed by interviewing three chemistry teachers from different schools to discover their perceptions and descriptions of problems in the field. Learning activities at school are adjusted to the implementation of merdeka curriculum learning. This interview was conducted with the chemistry teacher of Public Senior High School 1 Padang, Public Senior High School 8 Padang chemistry teacher, and Senior High Schol Pembangunan Laboratory UNP.

Based on the results of these interviews, it can be concluded that the main problem at school is related to the textbooks used, which need to be revised to assist teachers in delivering material. In addition, the available texts need to contain coherent material. Therefore, a textbook is required to support learning, and of course, the reader is not only used to confirm concepts; it can also attract students' interest in education and help students be active in learning.

The context analysis examines the curriculum and syllabus. This analysis is done to pinpoint, describe, and organize the learning objectives, resources, and instructional materials that must be created. The learning outcomes that students must possess to meet the requirements of the autonomous program were investigated in the first stage. The atomic structure material of phase E was subjected to this examination.

Then, a literature review was done to build a theoretical foundation for interventions based on the development research and the solutions found to help instructors and students deal with problems they face when learning chemistry through scientific research.

A conceptual framework was developed Based on the context analysis and literature study results. Problem identification comes from needs analysis and context analysis, where teaching tools are needed to support the learning process based on the demands of the merdeka curriculum. Based on the literature study, one of the teaching tools that can be used is a textbook based on a separate curriculum. The textbook is tailored to the needs of learners based on an merdeka curriculum.

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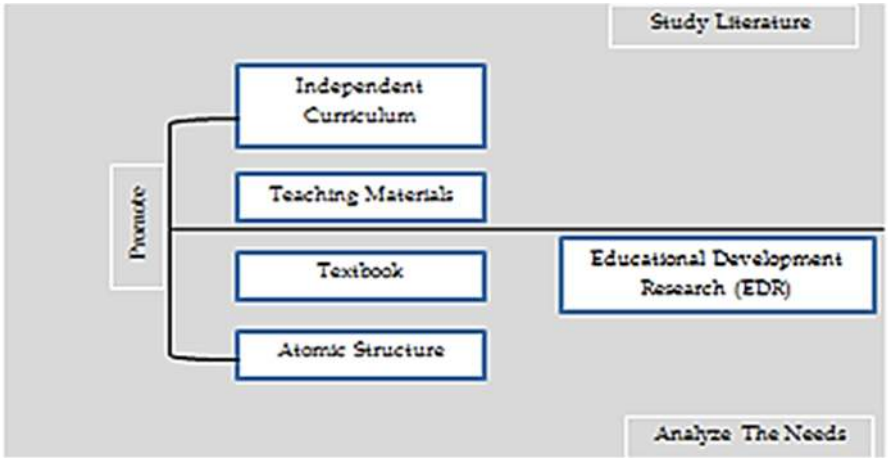

Figure 2. Conceptual Framework

Development Prototyping Phase

At this stage, textbooks to support merdeka curriculum learning will begin to be designed. In this stage, we will discuss the step-by-step process of making textbooks through various formative evaluations (self-evaluation, expert review, one-to-one evaluation, and small group).

Prototype I

Furthermore, the initial product is designed due to the initial research stage. At this stage, the textbook components are made with atomic-structure material. At this stage, the learning outcomes are determined to be learning objectives, making concept maps, covers, a preface, a table of contents, and other components by the content standards of the Ministry of Education.

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Figure 3. Making the Cover, About the Book, and Concept Map

Prototype II

At this stage, I am revising and reviewing textbooks made in the prototype I am carrying out. Activities carried out include formative evaluation in the form of self-evaluation using a checklist from the textbook. The list's contents include checking the

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completeness of the components and the suitability of the content with the demands of the merdeka curriculum. The checklist must be revised again if there are errors or incompletenesses.

Prototype III

Furthermore, expert review This assessment was carried out to test the validity of the textbook developed. In this study, 5 validators were needed, of which 3 were chemistry lecturers from FMIPA UNP, and 2 were chemistry teachers from Public Senior High School 8 Padang. This test was carried out by filling out a validity questionnaire that had been made by the researcher as needed. From the test, it was found that the coursebook made was valid; this can be seen through the following data:

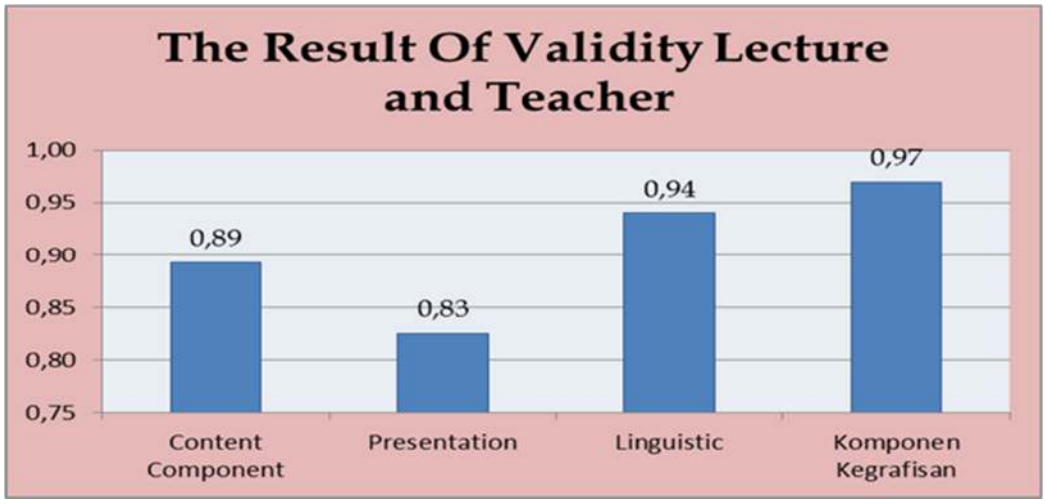

Figure 4. Results of Expert Validity Test

The results of the graph data above were obtained from the value given by the validator in the validity questionnaire. The results of the expert test obtained an average value of 0.91. This means that if you look at Table 1, the validity criteria are included in the valid category. This score indicates that the textbook is feasible to test in the field. In addition, the language score obtained a score of 0.94, which means that the language in the coursebook can make it easier for students to understand.

After completing the validity test stage, a one-to-one evaluation was carried out. At this stage, the researcher interviewed three students in Phase E. The students interviewed had different levels. This was obtained from the results of recommendations by the chemistry teacher who taught them. The results of the test received an excellent learner response.

Prototype IV

At this stage, the valid textbooks were tested for small-group evaluation. At this stage, 9 phase E students conducted small discussions on the activities in the textbook. Two

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chemistry teachers at Public Senior High School 8 Padang also carried out the practicality. Then the researcher gave a questionnaire and directions on how to fill out the questionnaire. So that the following data was obtained:

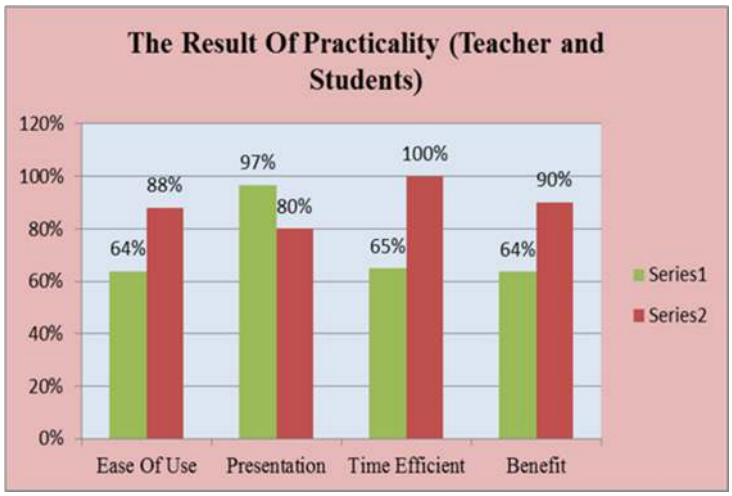

Figure 5. Teacher and Learner Practicality Test Results

Looking at these two data points, the textbook developed can help teachers deliver the material. It can be a textbook to support merdeka curriculum learning on atomic structure material phase E. This textbook is practical.

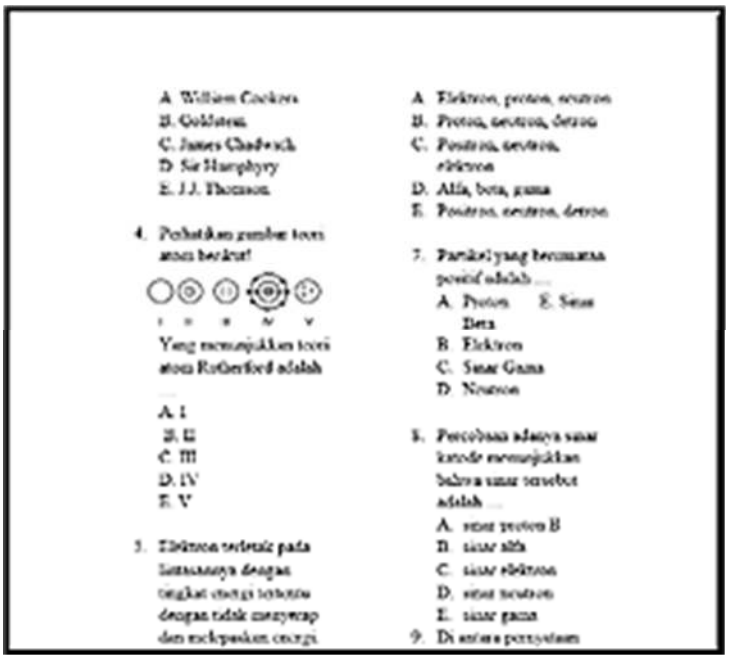

Figure 6. Example of a Mental Model Question

With the form of the problem as above, it helps students solve existing problems. This is known from the responses of active and excellent students in solving these problems. In addition, the time spent working on the questions is also sufficient, so it only

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uses time outside of learning hours. By looking at the overall results of the data obtained, this textbook already has good practicality and validity, so this textbook can be used as a reference.

Figure 7. Revised Cover and Material

Discussion

Learning is a relatively stable change that occurs in all kinds of behaviour due to experience. According to Winkel (in Kristiana & Radia, 2021), learning is a mental or psychological activity that occurs in active interaction with the environment and results in changes in knowledge, understanding, skills, and attitudinal values. These changes are relatively constant and lasting (Simangunsong, 2023).

In learning, of course, media teaching is needed, one of which is teaching materials. A teaching material is a set of teaching materials referring to the curriculum used to meet the standard of competence and basic competence that has been determined (Lestari, 2013). Lestari (2013) states that printed teaching materials can be handouts, teaching books, modules, brochures, and student worksheets. Non-printed materials include audio teaching materials such as cassettes, radios, black disks, and compact audio discs. Audio-visual learning materials include CAI (computer-assisted instruction) and web-based teaching materials (web-based learning materials).

From the above explanation, one of the printed teaching materials is a teaching book. The chemistry textbook is used as a learning medium in the classroom for teaching one of the subjects of the language taught in Phase E. Teaching books are an important part of the teaching process at school. A quality textbook will affect the quality of student learning outcomes. One of the subjects of the language taught is the atomic structure of matter. On the curriculum, merdeka discussion of atomic structure materials is limited to Niels Bohr's configuration. It is obtained from interviews with chemistry teachers in Public

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Senior High School 2 Padang, Public Senior High School 8 Padang, and Senior High School Pembangunan Lab. UNP.

From the results of the interview, the researcher then produced products with the beginning of the creation of the Learning Purpose (TP), the construction of conceptual maps, and the design so that the teaching books were subsequently made according to the needs. Five validators carry out this validity test: 2 are High School Chemistry Teachers in Public Senior High School 8 Padang, and 3 are UNP chemistry docents. From the validation results obtained, it was determined that the educational book developed was valid, with a score of 0.91. As for the language component, it got a score of 0.94, which, according to Maryanto et al (2021), is an essential aspect of learning media development. Effective and efficient language makes it easy for students to understand the content of the developed learning media. Sudewa et al (2021) stated that the proper use of language can stimulate the development of the learners thinking in understanding the information delivered.

A valid teaching book was then carried out with practicality tests for Public High School 8 Padang students. This practicality test is carried out to determine the practicality of the developed educational books. The practicality seen in this study is the practicality of using textbooks in terms of ease of use, appearance, time effectiveness, and benefits. As for the results obtained, that educational book developed practically. In addition, this teaching book can also help students solve problems merdekaly or in groups through the activities in the book. This is demonstrated by issues related to mental models.

D. Conclusion

The chemistry teaching books on the structure of the atomic materials to support the learning of the free phase E curriculum has been developed by the free course, the characteristics of the students, and the learning environment so that the textbook is made according to the learner's needs. The project the educational book developed has components: 1) cover, 2) introductory words, 3) list of contents, 6) about books, 7) Learning Access (CP), 8) Content Sections, and 9) List of Libraries. The content of the textbook has components: 1) the title of the chapter, 2) the image of the beginning of the chapter, 3) the purpose of learning (TP), 4) the keyword, 5) the concept map, 6) the content of the chapter, 7) adventure in the Maya World, 8) images and illustrations; 9) chemical information; 10) activities; 11) examples and discussion; 12) about understanding; 13) tables, 15) summaries, and 16) about the end of chapters with AKM type.

This textbook is valid and practical through the formative tests that have been carried out. This validity is demonstrated by applying the final average value of 0.91. The practical value of the teacher is 98%, and that of the pupils is 72%, so this textbook is practical. In addition, this teaching book is also equipped with a mental model that is proven to help students solve existing issues. This is known from the reactions of active and aggressive students to solving these issues. In addition, the work completion time is also sufficient, so do not use time outside of the learning hours.

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Based on the results of the research that has been concluded above, to improve the quality of education that meets the demands of the current merdeka curriculum, the following advice is needed: Teachers and students are expected to use a suitable textbook. This book can facilitate teachers and students in learning. It can improve the motivation of learners, critical thinking, cooperation, independence, and creativity, according to PROPELA. In addition, it is hoped that teachers can lead the students in improving literacy.

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