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Pengembangan Buku Ajar Kimia Dasar untuk Pendidikan Biologi Bermuatan *Science, Environment, Technology, and Society* (SETS) dan Terintegrasi Nilai-nilai Keislaman

(Design of a Basic Chemistry Textbook for Biology Education Incorporating Science, Environment, Technology, and Society (SETS) and Integrating Islamic Values)

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ABSTRACT. Teaching materials are essential tools for achieving quality learning. A needs analysis revealed the absence of a basic chemistry textbook tailored for biology education. This research aims to develop a basic chemistry textbook for biology education that incorporates SETS (Science, Environment, Technology, and Society) and integrates Islamic values. It also aims to analyze its feasibility and practicality. The research method employed the 4D development model, which consists of Define, Design, Develop, and Disseminate. The final product validation results showed scores of 90.28% for material validation, 91.67% for design validation, and 92.5% for integration of Islamic values validation. Overall, the validation results indicated that the textbook is highly feasible for use. The practicality test, conducted through questionnaires distributed to students who used the product, yielded a score percentage of 85.67%, which falls into the "practical" category. This indicates that the textbook is practical for use in learning. In practice, this research provides a valuable learning resource that can support lecturers and students in connecting basic chemistry concepts to real-life contexts and Islamic perspectives.

INTRODUCTION

Teaching materials are essential components for achieving quality learning. The learning process becomes more structured, engaging, and enjoyable for students when supported by appropriate teaching materials. [1]. The availability of teaching materials is also vital for educators in maximizing the effectiveness of the learning process, as well as supporting students' independence in learning and optimizing their potential [2]. However, the availability of basic chemistry course materials for biology education students is still minimal.

Based on the needs analysis conducted with Biology Education students, it was found that no basic chemistry textbook is available specifically designed to cover the fundamental concepts of chemistry that support biology learning. Thus far, students have studied basic chemistry materials using textbooks and other resources intended for the field of chemistry or for chemistry education, whose content focuses and depth differ. In fact, the basic chemistry materials required by biology education students are more focused on topics that are closely related to living organisms and the environment [3].

Chemistry is a science that studies the composition, structure, properties, and transformations of matter, along with the energy changes that accompany them [4]. Basically, chemistry, as a branch of science, is closely related to the environment and therefore cannot be separated from everyday life. Environmental issues are closely linked to society and technological development. Hence, chemistry as part of science will be more meaningful if studied in an integrated manner with the environment, technology, and society [5].

The perspective of science as an integral unity with the environment, technology, and society is referred to as SETS (Science, Environment, Technology, and Society). Learning that incorporates SETS emphasizes the idea that students should understand that everything occurring in daily life is inseparable from the interconnected and mutually influencing aspects of science, environment, technology, and society [6]. The understanding of SETS is recommended by environmental experts as well as scholars of the sociology of science, who emphasize the integration of social norms and responsibilities into learning [7]. Basic chemistry learning incorporating SETS allows students to learn contextually based on real-life facts, thereby enhancing their abilities in critical thinking, scientific skills, and social competence [8].

As an Islamic higher education institution, UIN Jurai Siwo carries the mission of developing Islamic values in the implementation of education, research, and community service. One effort to realize this mission is to

integrate Islamic values not only into religious courses but also into general courses, including basic chemistry. Basic chemistry, which discusses the properties, systems, patterns, composition, and transformations of matter, inherently contains spiritual values that can enrich students' Islamic insights [9]. Chemistry learning that incorporates Islamic values should ideally foster the balanced development of students across their intellectual, emotional, and spiritual dimensions, thereby nurturing a generation that is both faithful and knowledgeable [10]. Thus, developing a textbook that incorporates SETS while taking Islamic values into account is considered a progressive step.

RESEARCH METHOD

This study is a Research and Development (R&D), adopting the Thiagarajan and Semmel development model, namely the 4D model (Define, Design, Develop, Disseminate). In this research, a basic chemistry textbook for biology education incorporating SETS and Islamic values will be developed. The stages carried out in this study include:

1. *Define*

Activities at this stage involve conducting a needs analysis of the product to be developed, based on curriculum analysis, subject matter, and student characteristics. Subsequently, the learning objectives and outcomes are formulated.

2. *Design*

Activities at this stage involve designing a basic chemistry textbook for biology education incorporating SETS and Islamic values, in accordance with the curriculum analysis presented in the Semester Learning Plan (RPS), material analysis, and student characteristics. The design includes content presentation, the interconnection among science, environment, technology, and society, the integration of Islamic values and practices, and evaluation. This stage also involves designing the cover, determining the book size, and selecting colors and illustrations that support the material.

3. *Develop*

Activities at this stage focus on developing the textbook product based on the previously created design. The product developed at this stage is called Prototype 1. Experts then validate prototype 1 to ensure its feasibility before being tested. Expert validation consists of material validation and design validation. After validation, the product is revised based on the experts' feedback and suggestions. Once declared feasible, Prototype 2 is produced and prepared for testing. The trial is conducted with students as users to gather feedback on the practicality of the developed product, followed by further revisions based on user input. If Prototype 2 meets the practicality criteria, the final textbook product is obtained, ready for dissemination.

4. *Disseminate*

Activities at this stage include printing, publishing, and disseminating the product developed in the previous stage for use by the intended users.

The data collection techniques in this study included interviews, literature review, and questionnaires. The interview was conducted to gather information for a needs analysis of a basic chemistry textbook for biology education, incorporating SETS and Islamic values—the literature review aimed to collect references on basic chemistry materials. Meanwhile, the questionnaire was intended to obtain data on the product's feasibility based on validation results from validation sheets, as well as practicality data from users via a practicality questionnaire.

The results of validation and practicality testing were then analyzed to determine the percentage scores of validation and practicality using the following formula [11]:

$$\text{VS} = \frac{Validation\ Score}{Maximum\ Score} \text{ x } 100\% \quad (1)$$

$$\text{PS} = \frac{Practicality\ Score}{Maximum\ Score} \text{ x } 100\% \quad (2)$$

VS = Validation Score Percentage

PS = Practicality Score Percentage

After that, the percentages of the validation and practicality scores were interpreted according to the criteria in Table 1.

Table 1. Criteria for product feasibility and practicality.

Score Percentage	Criteria	Description
90% ≤ SV ≤ 100%	Very Feasible	No revision needed
80% ≤ SV < 89,9%	Feasible	Minor revision
60% ≤ SV < 79,9%	Less Feasible	Major revision
0% ≤ SV < 59,9%	Not Feasible	Cannot be used

RESULTS AND DISCUSSION

Initial Product Development

The product developed in this study is a basic chemistry textbook for biology education, oriented toward SETS and integrated with Islamic values. This textbook was developed in response to the needs of lecturers and students for a basic chemistry textbook specifically designed for the Basic Chemistry course in the Biology Education Study Program, which has not yet been available. Most existing references are intended for chemistry, chemistry education, or chemical engineering programs, and their content does not align with the needs of biology education students. Learning resources play an essential role in university courses, as they are among the factors influencing students' learning difficulties. The lack of accessible learning resources, either directly or indirectly, can significantly affect students' learning success [12].

The need for a basic chemistry textbook oriented toward SETS is also evident from students' difficulties in connecting the basic chemistry concepts they study with real-life contexts related to the environment, technology, and society, which is one of the factors contributing to the unmet learning outcomes. The development of a SETS-oriented textbook is therefore undertaken to address this problem. Chemistry learning using the Science, Technology, and Society (SETS) approach has been shown to influence students' thinking skills and scientific literacy [13]. Integrating SETS into learning significantly fosters environmental awareness and enhances student achievement [14]. The research findings also indicate that teaching materials connected to environmental contexts have a strong influence on enhancing awareness, a culture of responsibility, and environmental care attitudes [15], [16].

The fact that 30% of students in the Biology Education Study Program come from Islamic boarding schools underscores the importance of integrating Islamic values into the textbook. Research findings indicate that the use of teaching materials incorporating Islamic values positively influences students' learning interest and achievement [17], [18]. The educational background of students from Islamic boarding schools makes them more inclined to learning aligned with Islamic values. Integrating science with religious values is essential to foster individuals with advanced knowledge and a more open mindset [19].

The basic chemistry textbook for biology education was developed based on the learning outcomes of the Basic Chemistry course for Biology Education, as stated in the Lesson Plan (RPS). The textbook was designed in accordance with the Ministry of Higher Education (DIKTI) guidelines, using the UNESCO standard size (15 cm × 23 cm), Arial font 12 pt, 1.5 line spacing, and 3 cm margins on all sides (top, right, left, and bottom).

The content of the developed textbook includes: title page, preface, table of contents, learning outcomes, concept maps, material explanations, practice questions, and references. The use of concept maps in teaching materials can enhance the quality of learning by making it more meaningful, systematic, and comprehensive (Zulkarnain, 2020). In addition, the provision of structured practice questions in chemistry learning has a significant impact on students' conceptual understanding [21].

Product Validation

Validation is a crucial stage in research and development, as it determines the feasibility and quality of the product being developed. At this stage, the assessment focuses on the validity of the developed content, the appropriateness and relevance of the material to the aspects of SETS, the accuracy of the integration of Islamic values, and the attractiveness of the product design. The validation results are presented as follows.

Content Validation

The first round of content validation achieved a 72.2% score, placing it in the *fair* category. In this validation stage, the experts provided twelve suggestions for improvement. The first suggestion was to expand the sub-chapters in the chapters on Chemical Bonding, Hydrocarbon Compounds, and Macronutrients. Accordingly, revisions were made by adding more specific sub-chapters to these sections to enable students to understand the

material more systematically. The second suggestion was that the course learning outcomes should be presented at the beginning of the textbook. In contrast, the third suggestion emphasized that learning objectives should be clearly stated at the beginning of each chapter. These revisions were carried out by including the course learning outcomes at the beginning of the textbook and the learning objectives at the beginning of each chapter, in line with the Guidelines for Writing Academic Textbooks, which recommend that textbooks include both learning outcomes and learning objectives [22].

The fourth suggestion was that chemical terms and foreign terminologies should be accompanied by explanations to avoid misinterpretation. In response, revisions were made by providing clear explanations and formatting foreign terms in italics. The fifth suggestion emphasized the need for relevant, up-to-date examples accompanied by illustrations. At the same time, the sixth suggested that process-oriented content, such as chemical reactions, should be supported with diagrams depicting reaction mechanisms to facilitate students' understanding. The researcher revised the textbook accordingly. These revisions were grounded in research findings indicating that the use of challenging, meaningful, and real-life–related tasks can support the achievement of learning objectives [23] Moreover, learning supported by visual illustrations has been shown to enhance students' understanding and learning outcomes significantly [24]. The presented images can illustrate the explained material more effectively [25]. The seventh suggestion was to add examples to clarify the concepts presented. This recommendation is consistent with the previous suggestion to include illustrative examples.

The eighth suggestion was that the textbook should employ sentences that stimulate students to think and ask questions. The researcher revised the material accordingly, as questioning skills are recognized to foster shifts in students' thinking patterns and support the construction of the knowledge they aim to achieve [26]. As prospective teachers, students are required to develop questioning skills as a means of communication and as a tool to foster both learning motivation and critical thinking [27].

The ninth suggestion was that the examples provided in the material should reflect situations commonly experienced by students. The researcher addressed this recommendation by adding case examples related to students' daily lives. Contextual learning that connects the material being studied with real-life situations has been shown to enhance students' conceptual understanding [28]. The tenth suggestion was to incorporate technology-related concepts into the material. The researcher addressed this by integrating content and technology, ensuring that the developed textbook is truly oriented toward SETS.

The eleventh suggestion was to include elements relating the material to society in the chapters on the Periodic Table of Elements and Hydrocarbon Compounds. The researcher addressed this by adding societal connections to the content. Chemical elements in the periodic table are widely used to meet societal needs, such as in pharmaceuticals, cosmetics, fertilizers, and other applications. Similarly, hydrocarbon compounds have a significant impact on various social and economic aspects, as the oil and gas industry constitutes a key pillar of the economy [29]. The twelfth suggestion highlighted that the use of hydrocarbon fuels in everyday life is essential for society, but it can also pose environmental challenges due to their negative impacts.

The final suggestion from the content experts was the need to include SETS-related questions in the evaluation section. The researcher addressed this recommendation by adding practice questions to encourage students to think critically and solve problems within the SETS framework. Learning that integrates science, technology, and society has been shown to enhance problem-solving skills and scientific attitudes significantly [30].

The researcher addressed all suggestions and feedback from the content experts, taking into account supporting theoretical foundations and relevant previous studies. The second validation yielded a 90.28% score, indicating that the textbook can be used without further revisions. Thus, the developed product—a Basic Chemistry Textbook for Biology Education, oriented toward SETS and integrated with Islamic values—is deemed highly feasible from a content perspective.

Design Validation

The first design validation yielded a score of 72.91%, placing it in the *fair* category. The design experts provided six suggestions. The first suggestion was to adjust the margins; accordingly, the researcher revised the textbook margins from 2 cm on all sides (top, right, left, and bottom) to 3 cm to make the layout more proportional. The second suggestion was to replace the Qur'an image on the cover, as it was too small and poorly proportioned. The third suggestion was to add images or icons representing SETS on the cover. The researcher addressed these

recommendations by redesigning the cover to reflect the integration of SETS and Islamic values clearly. The cover appearance before and after the revisions is shown in Figure 4.5.

(a) (b)

Figure 1. (a) Textbook cover before revision; (b) Textbook cover after revision

The fourth suggestion was to bold the sub-chapter text. The researcher revised the textbook accordingly, bolding the titles of each sub-chapter to help readers distinguish between sections. The fifth suggestion was to add illustrative images to clarify the material. In response, the researcher added illustrations to make the content easier to understand. The use of illustrative images can enhance learning motivation, facilitate students' retention of the material, and improve learning outcomes [31],[32]. The final suggestion from the design experts was to adjust the position and size of images to ensure relative uniformity. The researcher followed this recommendation to make the textbook layout more visually appealing. The second design validation yielded a 91.67% score, placing it in the highly feasible category, indicating that the product is suitable for use without further revisions. Consequently, the next stage could proceed, namely the trial phase.

Validation of the Integration of Islamic Values

The validation of the integration of Islamic values was conducted to ensure the accuracy of the values incorporated into the textbook and their alignment with the presented material. The first validation of the integration of Islamic values yielded an 80% score, which falls within the feasible range. However, the validators provided three suggestions to improve the product before proceeding to the trial phase.

The first suggestion was to integrate Islamic values into material that had not yet incorporated them. The researcher addressed this by revising the textbook to incorporate Islamic values throughout its content. The second suggestion was to add relevant hadiths on acid and base solutions, and the third was to include persuasive statements on piety. These recommendations were implemented to refine the textbook, ensuring that the integration of Islamic values is meaningful and impactful for readers. The integration of Islamic values can serve as a key factor in shaping individuals who are not only academically competent but also morally and emotionally strong [33].

Product Trial

The practicality of the developed product, a basic chemistry textbook for biology education, was evaluated based on questionnaires completed by students currently enrolled in the Basic Chemistry course in the Biology Education Study Program at UIN Jurai Siwo Lampung. The trial results yielded an 85.67% score, placing it in the *practical* category. This indicates that the textbook is practical and suitable for use in the learning process.

The practicality questionnaire consisted of 10 statements. The first statement, *"The textbook's overall appearance is appealing,"* received an average score of 3.4, indicating that 85% of students agreed that the textbook's overall appearance is attractive. The second statement, *"The font size and type are comfortable to read,"* received an average score of 3.67, indicating that 91.75% of students agreed. This is because the font size and type were selected in accordance with the textbook writing guidelines.

The third statement, *"The language used is easy to understand,"* received an average score of 3.33, indicating that 83.25% of students found the textbook's language readily comprehensible. Previous studies suggest that the use of proper and correct Indonesian is considered necessary by the majority of students (Naila et al., 2024). The

fourth statement, *"The displayed images make the material easier to understand,"* received an average score of 3.47, indicating that 86.75% of students agreed with this statement. The use of images in learning can increase students' interest, facilitate comprehension, and improve learning outcomes [35].

The fifth statement, *"The presented material enhances understanding of the interconnections between science, environment, technology, and society,"* received an average score of 3.47, indicating that 86.75% of students agreed with this statement. Environment- and community-based learning that takes global issues into account is effective in developing students' learning abilities and skills [36]. The sixth statement, *"The presented material broadens knowledge of chemistry concepts from an Islamic perspective and raises awareness of the greatness and power of Allah SWT,"* received an average score of 3.4, meaning that 85% of students agreed.

The seventh statement, *"The textbook can increase motivation to learn basic chemistry,"* received an average score of 3.27, indicating that 81.75% of students agreed that their motivation increased by using the developed textbook. Learning materials that incorporate Qur'anic verses can enhance students' learning motivation [37]. Learning that is linked to the environment has the potential to enhance students' environmental knowledge, attitudes, and behaviors [38]. The eighth statement, *"The textbook facilitates students in understanding basic chemistry material,"* received an average score of 3.53, the highest among all statements in the practicality questionnaire. This indicates that 88.25% of students agreed that the developed textbook makes it easier for them to comprehend the material.

The ninth statement, *"The example questions in the textbook facilitate students' understanding of the material,"* received an average score of 3.4, indicating that 85% of students found the example questions easier to understand. This aligns with previous research, which shows that learning using structured practice questions positively influences conceptual understanding [39]. The final statement of the practicality questionnaire, *"The use of the textbook helps overcome the limited classroom learning time,"* received an average score of 3.33, indicating that 83.25% of students felt that the limited time in the basic chemistry course could be mitigated by using the textbook as a learning resource at home. Learning that incorporates environmental education is crucial in addressing global challenges [40].

After the trial phase was completed, the developed product—a basic chemistry textbook for biology education oriented toward SETS and integrated with Islamic values—was printed, published, deposited in the library, and distributed among students of the Biology Education Study Program.

CONCLUSION

Based on the results of the research and development of the basic chemistry textbook for biology education oriented toward SETS and integrated with Islamic values, it can be concluded that the textbook was developed using the 4D development model by Thiagarajan and Semmel, which includes the steps of Define, Design, Develop, and Disseminate. The final product validation yielded percentage scores of 90.28% for content validation, 91.67% for design validation, and 92.5% for the validation of Islamic values integration. All validation results fall into the *highly feasible* category. The practicality trial, conducted through questionnaires distributed to student users, yielded an 85.67% score, which was categorized as *practical*. This indicates that the developed textbook is practical and suitable for use in the learning process.

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