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Inorganic Chemistry Textbook-Integrated Science and Religion as Characteristics of Islamic Higher Education

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Abstract

Nowadays, studies related to the integration between religion and science were attracting the interest of many researchers from religious universities in order to confirm the paradigm of the general public about the dichotomy between religion and science. This study used the ADDIE instructional design to develop an inorganic chemistry textbook that was integrated with science and religion, describing the textbook's characteristics as well as responses from lecturers and students about the developed textbook. This textbook's features are based on chemical representations (macroscopic, submicroscopic, and symbolic) and are integrated with Qur'an verses and research findings. Validators have given an excellent assessment of the aspects of construction, readability, content suitability, and presentation of the material from the developed textbook with percentages of 100%, 92.5%, 96.88%, and 88.57%, respectively. Lecturers have responded favorably to aspects of content suitability and presentation, as well as attractiveness and usefulness. The graphic aspect, as well as the attractiveness, have elicited very positive responses from students. Based on this, the developed textbooks could be approved for use.

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Introduction

The general public's perception of religion and science is a dual thing that cannot be put together (Suryadi et al., 2018; Taufiqurrahman et al., 2021). The dichotomy between religion and science has contributed to the decline of Islamic civilization. On the other hand, there is essentially no distinction between the two in Islam. (Faruqi, 2007; Kurniawan, 2019; Mustopo, 2017). Humans benefit from all sciences (Launonen, 2021; Sayem et al., 2021; Sørensen, 2021).

Science can be used to both maintain and strengthen faith (Polanyi, 2013; Rawlins, 1947). Religion, on the other hand, can provide people with guidance and direction. In addition to the Qauliyah verses, the Qur'an contains the Kauniyah verses to emphasize that religion and science do not conflict (Ecklund et al., 2011; Ecklund & Park, 2009).

Today, researchers are interested in studying the integration of science and the Qur'an (Abidin, 2017; Asmara, 2016; Herman, 2021; Mukri et al., 2019; Nuryantini, 2018; Purwati et al., 2018; Yusoff et al., 2021). This is done to confirm and clarify the general public's perception of the religion-science dichotomy.

On the other hand, the research paradigm in learning activities is universal (de Bruin & van Merriënboer, 2017; Wang et al., 2021). The integration of research findings into learning can be accomplished by including them as components of teaching materials. As a result, there is a link between the knowledge studied and the novelty of issues in the field of study (Austin et al., 2008; Botwinick, 1984; McDaniels et al., 2016; Vereijken et al., 2018).

Chemistry, as a branch of natural science, is concerned with the study of matter, including its structure and composition, properties, changes, and the things that accompany those changes. In chemistry, there are four branches of scientific study: physical chemistry, which serves as a scientific foundation, analytical chemistry, which serves as a tool or instrument, and organic and inorganic chemistry, which serves as study material. There are numerous references to chemistry in the Qur'an (Astuti et al., 2020; Muslim et al., 2018; Sati & Anhar, 2020).

As one of the undergraduate educations at UIN Raden Fatah Palembang, the learning process in the department of chemistry is required to accommodate the integration of religion and science. This is done as a feature of the department at Islamic Higher Education compared to a similar department at Higher Education. One of the core courses in inorganic chemistry at the Department of Chemistry of UIN Raden Fatah Palembang is Inorganic Structures and Compounds. The majority of the content in this course is solid state. This course is fundamental and a prerequisite, so it must be completed. However, the majority of the reference books available for this course are in English. Atkins et al. (2010), Housecroft & Sharpe (2012), Huheey et al. (1993), and Miessler (2004) wrote some of the books. Their use has an impact on student competency mastery. This is due to students' limited ability to study English books. On the other hand, the Indonesian language reference books, like Effendy (2008), Effendy (2010), and Sugiyarto & Suyanti (2010), do not include science, the Qur'an, or research findings.

Based on interviews with both lecturers and students, it was determined that a textbook for basic inorganic chemistry courses in Indonesian that integrates science and the Qur'an and follows the characteristics of learning at the higher education level is required. As a result, in this article, we will review the outcomes of the development of an inorganic chemistry textbook that integrates science, the Qur'an, and research findings.

Method

The following steps were taken in the development of this Inorganic Chemistry textbook to adapt the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) instructional design (Branch, 2009). This instructional design was chosen because the stages are simple, systematic, effective, and efficient. This instructional design can also help developers implement a learner-centered approach, making the program more relevant and meaningful for learners (Peterson, 2003).

Analyze. This step is taken to gather information and review reference books that are available and used in learning. This is accomplished through literature and curriculum studies, as well as needs analysis via interviews with 2 lecturers and 20 students who have taken or are currently enrolled in courses.

Design. This step is completed in order to create a textbook with the desired characteristics. In this case, the textbook outline is created in accordance with the lesson plan.

Develop. Product development is carried out at this step in the form of a draft textbook based on the outline design. The draft textbook is validated by experts at this step.

Implement. The validated textbook draft was put through its paces with 2 lecturers and 20 students. At this step, questionnaires and interviews were also used to gather feedback on the draft textbook.

Evaluate. This step is used to improve the draft of the textbook based on user feedback during the trial before it is included, widely tested, and disseminated.

The data collected through the questionnaire technique was analyzed by coding it, tabulating it based on the classification, and scoring the respondents' responses using the Likert scale. Furthermore, calculating the percentage of respondents' answers and processing the number of respondents' answer scores. Then, using Arikunto's interpretation of the questionnaire, calculate the average percentage of answers on the questionnaire and interpret the percentage of answers on the questionnaire as a whole (Arikunto, 2021).

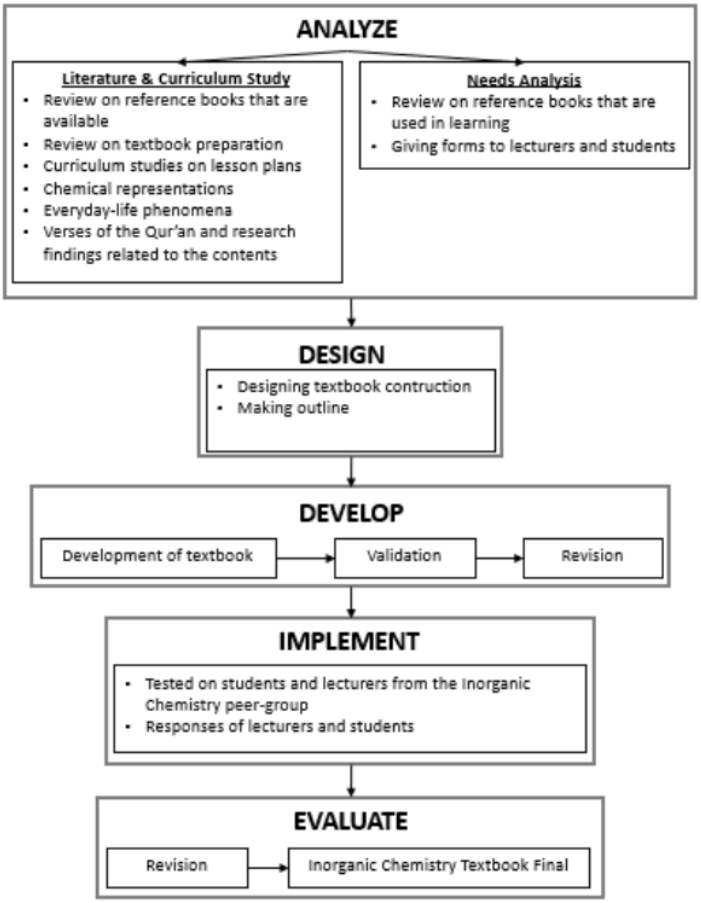

Figure 1. Flow chart ADDIE instructional design in development of Inorganic Chemistry Textbook

Results and Discussion

Step 1. Analyze

Literature review

According to a literature review of reference books related to inorganic chemistry studies available at the Department of Chemistry of UIN Raden Fatah Palembang, the majority of publications were foreign and in English. This book's review of solid-state chemistry material is so limited that other sources are frequently used to supplement it. No book integrates science and religion that has been available and used as a teaching resource. The literature review is carried out at this stage to identify the benefits and drawbacks of the reference books used. This is consistent with Jiménez-Pulido's (2022) and Huet's (2022) recommendations that a literature review is conducted to identify the benefits and drawbacks of study material.

A literature review on textbook preparation was also conducted, including criteria and characteristics of good, interesting, and ideal textbooks, as well as chemical phenomena in everyday life, Qur'anic verses, and research results related to substances. A solid-state that can be incorporated into the upcoming textbook. Curriculum studies on lesson plans and chemical representations (macroscopic, submicroscopic, and symbolic) were also carried out. The findings of this literature and curriculum review are then used as a guide in the creation and revision of textbooks. According to Kavanagh et al. (2017), a literature review was carried out to find out and clarify related problems, requiring a solution in the form of reconstruction of learning programs.

Needs Analysis

Based on the contents of the needs analysis form, which was sent to two lecturers from the inorganic chemistry peer group as respondents, it was discovered that all lecturers used textbooks that were not written by themselves but by others. These books are used because the material is delivered in an easy-to-understand manner, and some visualization helps the reader understand the material. However, there are drawbacks to using the book in the classroom, such as students having difficulty understanding the material because they speak English. Students in the study program have a low level of English proficiency. Furthermore, material delivery must be tailored to the indicators and learning outcomes outlined in the lesson plan. It must also be combined with other books to compensate for the lack of material to be delivered in the textbooks used. The books used, on the other hand, do not integrate science and religion (Qur'an/Hadits). Concerning this, needs analysis was a necessary step in identifying and determining competency indicators that students needed to achieve (Branch, 2009; Bundrage & Mapson, 2022).

According to the needs analysis form, the inorganic chemistry peer-group lecturer had never created a textbook that combined science and religion. However, a lecturer has been confirmed to have created student worksheets that guide learning and are integrated with science and religion. The compiled student worksheets are created by adjusting the learning indicators. The lecturers hope that there will be a textbook on inorganic chemistry, particularly on the discussion of solid states that integrate science and religion. This is due to their dedication to Islamic higher education, which is rich in Islamic nuances. It is hoped that this book will foster faith and gratitude to Allah SWT while also distinguishing Islamic higher

education with scientific rigor.

Based on the needs analysis form, which was distributed to ten students as respondents, it was discovered that the book Inorganic Chemistry, written by Catherine E. Housecroft and Alan G. Sharpe, was used as the primary reference during their lectures. According to them, the book is extremely useful because it contains illustrations that help students visualize the material being studied, particularly in the discussion of solid state. Most argue, however, that they should try to understand the material because the books used are in English, and they must first translate it.

Based on the follow-up questions in the needs analysis form, it was determined that the students hoped for a reference book in Indonesian and its delivery in a communicative manner, as well as visualizations or pictures that would help them understand the material being studied. Furthermore, they hope that the book will include Islamic values including realizing the regularity of the solid-state structure as a manifestation of the greatness of Allah SWT and knowledge of the solid-state structure as a result of human creative thinking, whose truth was tentative.

Step 2. Design

Textbook construction

The textbook is divided into three sections: the introduction, the content, and the closing. An outer front cover, a French page, an inner cover, and offering page, an introduction, a table of contents, a list of pictures, and a list of tables are all planned for the introductory section. The division of construction in this book is following the opinion of Fadiawati & Syamsuri (2018). The content section is intended to include information on learning outcomes, indicators, Qur'anic or Hadits verses related to the material to be studied, discourses that introduce the reader to the material to be studied, and a description of the material. The closing section includes a bibliography, a glossary, and a back cover with a synopsis of the book and author information.

Outline

The developed textbook's outline refers to the findings of the literature review and available lesson plans. The main topic of this book, solid state chemistry, is covered in detail. The book's contents begin with an explanation of the metal solid geometry packaging model as well as geometric calculations to determine packaging efficiency. It also discusses metallic theories and their physical properties and alloys. Then, go over the geometrical model of ionic solids and how to calculate the radius ratio. The book concludes with a discussion of crystal defects in the metallic, alloy, and ionic solids.

Step 3. Develop

Textbook's characteristics

The textbook is compiled and developed following the outline that has been created. A draft textbook is obtained at this step. The following characteristics can be found in the developed textbook: (a) begins with *basmalah* and Qur'an verses related to material content at the beginning of the chapter; (b) the textbook is accompanied by discourses containing phenomena in everyday life to orient readers to read the material to completion; (c) the

material content is presented systematically in the order of competency achievement indicators; (d) the material content is delivered communicatively in Indonesian; (e) textbook is accompanied by chemical representations (macroscopic, submicroscopic, and symbolic) that support the clarity of presentation of learning materials; (f) textbook is accompanied by the most recent research results to accommodate the advancement of science and technology; and (g) textbook also review the relationship between the material and the Qur'anic verses quoted. Students will be more likely to use textbooks as learning resources if they are well-designed and contain interesting content and illustrations (Behnke, 2021; Giannarou, 2021; Hernawan et al., 2012).

Verses of the Qur'an related to inorganic solid state

According to Purwanto (2008), there are three patterns of interaction between science and Islam, namely the Islamization of science, Islamic science, and science-Islam. In learning, the integration between religion and science could be applied by connecting the verses of the Quran with the concepts that were being studied by students (Nuryantini, 2018). Thus, according to Fogarty (1991), the corresponding model of integration is a type of connection.

The following Quranic verses are interspersed with a review of the material covered in the textbook. Surah An Nahl verse 13 and Surah Al Furqan verse 2 correspond to metallic solids and ionic solids, respectively. Verse 25 of Surah Al Hadid corresponds to the material of metallic bond theories. The alloy material is mentioned in Surah Al Kahf verse 96 and Surah Al Anbiya verse 80. The material defects in the crystal are represented by Surah Al A'la verses 1-2.

Chemical representation related to inorganic solid state

According to Johnstone (2000), chemical phenomena can be explained by three different levels of representation: macroscopic, submicroscopic, and symbolic. According to Tasker & Dalton (2006), chemistry involves processes of changes that can be observed in macroscopic or laboratory dimensions (e.g., changes in color, odor, bubbles), but not changes that cannot be seen with the naked eye, such as changes in structure. Modeling is the only way to simulate processes at the submicroscopic or imaginary molecular level. These molecular changes are then abstractly symbolically described in two ways: qualitatively using special notation, language, diagrams, and symbols, and quantitatively using mathematics (equations and graphs). Some examples of how chemical representations can be presented in Figure 2 and 3.

The results of expert validation on the textbook draft

After finishing the draft of the textbook, it was validated by two experts in their fields. Validators with expertise in pedagogy validate aspects of construction and readability, while validators with expertise in inorganic chemistry content validate aspects of content suitability and presentation. This agrees with Fadiawati & Syamsuri (2018) that after a textbook is created, it should be evaluated to ensure that it meets the criteria for a good textbook.

This textbook has been very well prepared, according to the validator's assessment of the construction aspect. The construction aspect received a 100 percent rating, placing it in the very high category. In terms of readability, the validator also gave the textbook a thumbs up.

The validator assigned a 95.2 percent rating to the readability aspect, placing it in the very high category. The validator has suggested that the textbook's cover design be changed. According to him, the textbook's cover design does not accurately represent the material's content. At the suggestion, the textbook's cover design was replaced as presented in Figure 4.

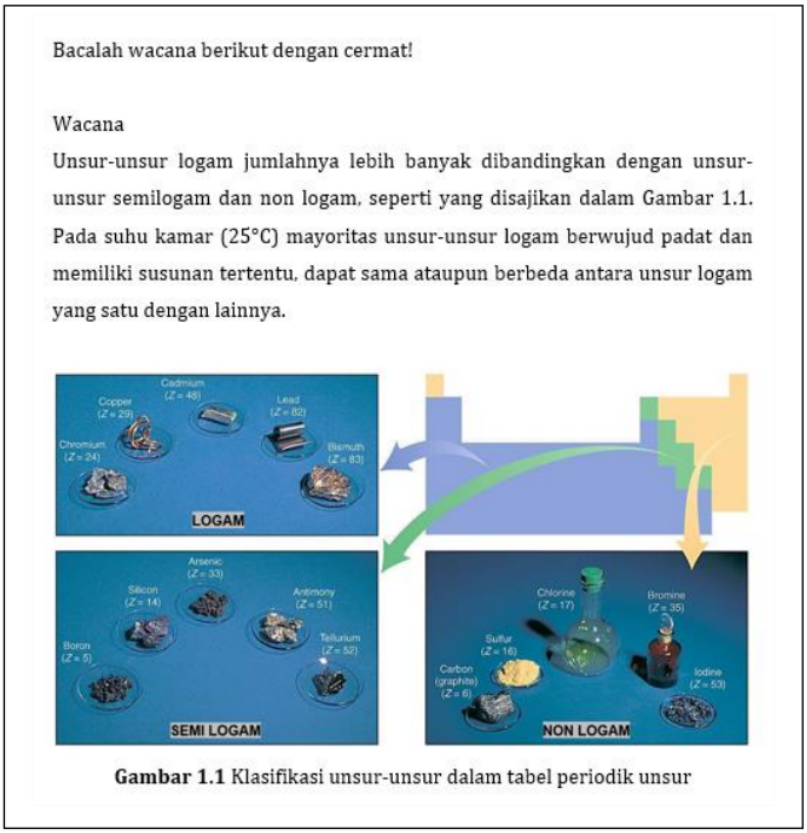

Figure 2. Macroscopic representations presented in Chapter 1 discourse

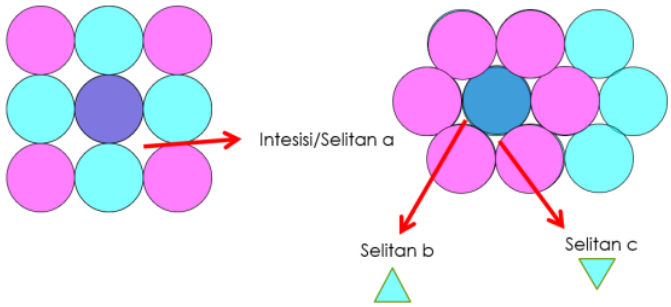

Figure 3. Submicroscopic and symbolic representations of the shape and direction of interstitial orientation in metal atom arrangements

(a)

(b)

Figure 4. Textbook's cover design: (a) before and (b) after changes

Based on the results of expert validation on the suitability of the textbook's contents, it was determined that the validator's percentage of values was 96.88 percent, which is very high. The validator responded that the indicators in the textbook had been clearly and measurably formulated and accommodated higher-order thinking skills based on Bloom's taxonomy when assessing the suitability aspect of the content.

The material in the textbook has been delivered very well in terms of material delivery, according to the validator. The assessment percentage given is 88.57 percent, with a very high category. In this regard, the validator provides input on the subject of the structure of ionic solids to add a review of ionic compound properties. The suggestion was quickly followed up on, and the discussion was included in the textbook.

Step 4. Implement

The draft textbook was tested on students and lecturers from the Inorganic Chemistry peer group after it was revised based on the results of the validator's assessment. Students were asked to evaluate and respond to the graphic aspect, as well as the attractiveness and usefulness aspects, during the trial. Meanwhile, peer-group lecturers in inorganic chemistry were asked to evaluate and respond to aspects of content suitability, material presentation, and attractiveness and usefulness.

The average percentage value given based on the student's assessment of the graphic aspect was 91.42 percent, with a very high category. Some students responded that there were many pictures in the textbook and that the language used was very communicative as if they were studying directly with the lecturer. Furthermore, submicroscopic images are extremely useful in comprehending the material.

Students also responded positively to the attractiveness and usefulness aspects, with an average percentage value of 98 percent in the very high category. Some students thought the textbooks that were created were very interesting because they linked the learning material with Koranic verses, allowing them to read one or two verses of the Qur'an while reading the book. There are also links between everyday phenomena as well as images related to the material being studied.

The textbook was by the outline and lesson plan, according to the inorganic chemistry peer-group lecturer on the aspect of content suitability. In the very high category, the average value given is 98.75 percent. The same is true for the material's presentation. The textbook has been designed in such a way that they make constructive use of communicative language to help readers understand the material being reviewed. In the very high category, the average value given is 100 percent. Regarding the attractiveness and utility of the textbook, all lecturers agreed that it was very interesting. To help students understand the material, many submicroscopic images are presented. The availability of chemical representation-based visualization at macroscopic, submicroscopic, and symbolic levels will assist students in learning chemical materials more easily (Syamsuri, 2015; Tania & Fadiawati, 2015). Furthermore, it integrates not only science and religion but also research findings, allowing it to stay current with scientific and technological developments. In the extremely high category, the average value given is 98.33 percent.

Step 5. Evaluate

Based on the textbook draft's test results, several paragraphs were not aligned right and left, so only that section needs to be revised. There are no parts that need to be revised in total. It's just that students and professors are hoping for color printing of the textbook.

Conclusion

A communicative inorganic chemistry textbook was developed and organized by incorporating not only religion but also chemical representations and research results. The validator's reaction to the material's construction, readability, content suitability, and presentation was very positive. The responses of lecturers and students to content suitability, material presentation, attractiveness and usefulness, and graphics are also very positive. Nevertheless, the book needs to be widely tested and disseminated to the audience.

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