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## INTEGRATING SCIENCE AND ISLAM : DEVELOPMENT OF TEACHING MATERIALS FOR ENVIRONMENTAL CHEMISTRY COURSES

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### Abstract

The teaching materials on chemistry integrated into Islam are not yet available at the university level. Teaching materials can be used in learning activities. This study aims to develop integrated Islamic chemistry teaching materials for environmental chemistry courses. This research uses the Four Steps Material Teaching Development method (4STMD). 4STMD consists of four stages, namely the selection stage, structuring stage, characterisation stage, and reduction stage. At the stage of selection and structuring, the results of integration between environmental chemistry subjects and the Qur'an, Hadith, Fiqih, and Aqedah Morals are obtained. At the characterisation stage, the concepts tested have easy characteristics, with an overall score of 86.9%. Based on the characterisation test results, the reduction phase in this research was not carried out because all concepts have easy characteristics. The completed teaching materials are then tested for feasibility by experts based on material aspects, presentation, language, and graphics. Based on the results of the feasibility test of the teaching materials, the average score is 95%. This shows that the teaching materials are considered worthy with a 'very good' predicate.

**Keywords:** teaching materials; Islamic integrated chemistry; environmental chemistry

### Abstrak

*Bahan ajar kimia terintegrasi keislaman belum tersedia di tingkat Universitas. Bahan ajar dapat digunakan dalam kegiatan pembelajaran. Penelitian ini bertujuan untuk mengembangkan bahan ajar kimia terintegrasi keislaman pada Mata Kuliah Kimia Lingkungan. Penelitian ini menggunakan metode Four Steps Teaching Material Development (4STMD). 4STMD terdiri dari empat tahapan, yaitu tahap seleksi, tahap strukturisasi, tahap karakterisasi, dan tahap reduksi. Pada tahap seleksi dan strukturisasi, didapatkan hasil integrasi antara mata kuliah kimia lingkungan dengan Al Qur'an, Hadits, Fikih, dan Akidah Akhlak. Pada tahap karakterisasi, keseluruhan konsep yang diujikan memiliki karakteristik mudah, dengan nilai keseluruhan rata-rata sebesar 86,9%. Berdasarkan hasil uji karakterisasi, tahap reduksi pada penelitian ini tidak dilakukan karena seluruh konsep memiliki karakteristik mudah. Bahan ajar yang telah selesai disusun selanjutnya di uji kelayakannya oleh ahli berdasarkan aspek materi, penyajian, bahasa, dan grafika. Berdasarkan hasil uji kelayakan bahan ajar, didapatkan nilai rata-rata sebesar 95%. Hal ini menunjukkan bahwa bahan ajar dinyatakan layak dengan predikat sangat baik.*

**Kata kunci:** bahan ajar; kimia terintegrasi keislaman; kimia lingkungan

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## Introduction

Education aims “to develop the potential of students to become human beings who believe and devote to God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, become democratic and responsible citizens” (UU RI No.20 Tahun 2003). To achieve these objectives, we need a guideline called a curriculum. The curriculum is a set of plans and arrangements regarding learning outcomes of graduates, study materials, and assessment processes that are used as guidelines for the implementation of the study program (Standar Nasional Pendidikan Tinggi, 2015). The curriculum used in Higher Education refers to the Indonesian National Qualifications Framework (KKNI) curriculum.

KKNI is an embodiment of the quality and identity of the Indonesian nation related to Indonesia's national higher education system to produce human resources from learning outcomes. Learning outcomes in each study program, based on Minister of Research, Technology and Higher Education Regulation number 51 of 2015, each study program, especially the chemistry education study program, is allowed to add learning outcomes in accordance with the university's vision, namely the integration of Islam in environmental chemistry courses.

Integration comes from the idea of a dichotomy between the general sciences and the religious sciences (Muslim et al., 2023; Al-Hadab, 2016; Rifai et al., 2014). Integration can be defined as a combination of one element with another element so that it forms a unity (Kurniawan, et al., 2023; Anas et al., 2013; Ramli, 2014). Several countries such as Yemen, Malaysia, and Brunei Darussalam have implemented integration between science and Islam (Al-hadabi, 2016; Hashim & Abdallah, 2013; Lubis, 2015; Zain et al., 2016)

According to the madrasa science competition (KSM 2018), the way to integrate environmental chemistry with Islam is to include an Islamic context sourced from the Al-Qur'an, Hadith, Fiqh, moral creeds, Islamic cultural history and natural phenomena (Muslim et al., 2021; Fauzan, 2017; Munadi, 2016) into environmental chemicals. There are many scientific verses in the Qur'an. There are approximately 750 scientific verses that talk about aspects of nature (Al-hadabi, 2016; Ashtankar, 2016; Manoiu, Düzgüneş, Azzeddine, & Manoiu, 2016; Izhar Ariff Mohd Kashim et al., 2023; Khalid et al., 2022; Rachmatullah et al., 2022; Suciati et al., 2022; Woodford, 2020; Yani & Joewono, 2021). These verses talk about the relationship between humans and nature, plants, animals, organisms and their environment (Fahyuni et al., 2020; Freitas et al., 2018; Izhar Ariff Mohd Kashim et al., 2023; Mustafa et al., 2021; Manoiu et al., 2016).

Integration between environmental chemistry and Islam is important in the chemistry learning process because humans were created as caliphs on earth so as not to cause damage to the earth (AlJuwaie et al., 2020; Muslim, 2016) . However, the reality shows that there has been visible damage on the face of the earth due to human actions, so this integration becomes very important, especially the lack of availability of learning resources in the form of Islamic integrated environmental chemistry teaching materials. In teaching and learning activities, teaching materials have a very important role (Fitriani, Mahmud, & Darmana, 2016; Silaban, Septiani, & Hutabarat, 2015) . Integrated Islamic teaching materials that can increase the reader's knowledge, both in terms of knowledge, skills and personality (Safkolam et al., 2021; Perbukuan, 2014) .

The Islamic integrated Environmental Chemistry course is considered very important for students in higher education. It is hoped that with Islamic integrated Environmental Chemistry science can become a joint movement to preserve the environment, in order to create a comfortable and healthy environment in the future (Ramli & Muslim, 2019; Nusnowati, 2012). There are so many blessings and gifts that Allah SWT has bestowed upon us, both in heaven and earth, land and water, and in humans; all for the benefit and good of humanity (Aqsha et al., 2009; Kasmoo et al., 2015).

## Method

This study uses the Research and Development (R & D) method. The research uses the Four Step Teaching Materials Development Method (4STMD), developed by Sjaeful Anwar (2014), then evaluate the results of development by conducting a feasibility test. 4STMD consists of four stages, namely the selection stage, structuring stage, characterisation stage, and didactic reduction stage.

### Selection stage

At the selection stage, various information is selected according to needs, so that the information obtained is effective and related to the material to be developed (Hendri & Setiawan, 2016). The selection phase includes: 1) analysis of learning outcomes related to environmental chemistry courses; 2) develop indicators; 3) concept analysis; 4) develop values that can be incorporated into teaching material; and 5) validation by experts.

The instrument used in the selection stage is a concept suitability validation sheet with Islamic integration. This validation sheet uses a Guttman scale questionnaire.

Table 1. Criteria scoring Guttman Scale

No.	Answers	Score
1.	Yes	1
2.	No	0

### Structuring

Structuring phase aims to connect between one concept with another concept so that there is no partial learning (Ashri & Hasanah, 2016). The procedure in the structuring stage includes: 1) create a concept map of the concepts that exist in the draft collection of selection material; 2) create a macro structure; and 3) adjusting the structure of the subject matter into a draft product to be developed.

### Characterisation

Students' understanding of the concepts in the draft product is measured through a characterisation test. Concept characterisation is done by giving instruments to students questions. Data obtained from the results of the characterisation test are then given a value, for the correct answer given a value of 1 (one), and for the wrong answer given a value of 0 (zero). Each question is then calculated using the following formula (Ashri & Hasanah, 2016):

$$\% \text{ item} = \frac{\text{gain score}}{\text{total score}} \times 100\%$$

The criteria for achieving concept understanding tests can be seen in Table 2 (Arifin & Sjaeful, 2016):

Table 2: Criteria Understanding the Concept

Percentage	Level of Understanding
60% <P ≤ 100%	High
40% <P ≤ 60%	Medium
P ≤ 40%	Low

### Reduction

Reduction is the process of adjusting or reducing the level of difficulty in the product developed. The reduction of the level of difficulty in the concept phase reduction is carried out in several ways, including (1) the annotations in the form of images, symbols, sketches and experiments; (2) use of analogies; (3) generalisation; and (4) particular mechanism (Arifin & Sjaeful, 2016)

### Evaluation

The product of teaching materials that has been reduced further tested for its feasibility by experts. The feasibility test of the product uses a questionnaire sheet which includes aspects of the feasibility of content (material), presentation, language, and graphics. Here are the criteria for assessing the feasibility of product:

Table 3. Likert Scale Scoring Criteria

Criteria	Score
Appropriate	4
Most appropriate	3
A small portion matches	2
Not suitable	1

(Adapted from Puskurbuk, 2016)

To determine the feasibility of the product as a whole, the calculation of the overall value is obtained from each aspect. The product are declared feasible if they meet the criteria in Table 4 (Perbukuan, 2014, p. 48):

Table 4. Final Score Total and Its Meaning

Final score	Meanings
Score ≥ 85	Worthy with a very good predicate
55 ≤ Score <85	Worthy of a good predicate
Score <55	Not feasible

## Results and Discussion

Development of Islamic integrated environmental chemistry teaching materials using the four steps teaching materials development (4-STMD) method which consists of 4 stages. The first stage is selection, determining the environmental chemistry textbook as the main reference that will be integrated with Islam. The second stage is structuring, creating a material structure based on a macro structure which is the appearance of Islamic integrated teaching material

products. The third stage is characterisation, getting easy and difficult category material. The fourth stage, namely reduction, makes difficult environmental chemistry easier to understand.

In the selection stage, the selection of information related to the material that will be developed in the product is done, namely material on environmental chemistry. In this step, the researchers conducted an analysis of the PLO and CLO environmental chemistry courses. Based on the results of the analysis, the PLO contained in the chemistry education study program is “master knowledge integrated science, Islam and Indonesianness in learning chemistry”. CLO subject of environmental chemistry is “explain the meaning of pollution, type of pollution, sources of pollution, factors that affect pollution, and the impact of pollution”.

The next step is to collect references that will be used to develop an integrated Islamic environmental chemistry. References that have been collected are then selected based on the completeness of the material contained in the reference source. The main reference used is a book written by Manihar Situmorang (2017). This book was chosen because the material in the book is more complete than other references. The book can be seen in Figure 1.

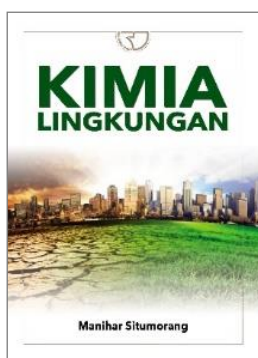


Figure 1. The Main Reference Used to Develop Teaching Materials Integrated with Islam

Other references are used, among others, Achmad, R. (2004). *Kimia Lingkungan*. Yogyakarta: ANDI; Keraf, S., (2010). *Krisis dan Bencana Lingkungan Hidup Global*. Yogyakarta: Kanisius; Manahan, S. E. (2000). *Environmental Chemistry*. New York: CRC Press LLC; Nugroho, A. (2005). *Bioindikator Kualitas Udara*. Jakarta: Penerbit Universitas Trisakti; Saeni, M. S. (1989). *Kimia Lingkungan*. Bogor: Institut Pertanian Bogor; Sastrawijaya, A. T. (2009). *Pencemaran Lingkungan*. Jakarta: Rineka Cipta; Sodiq, M. (2014). *Ilmu Kealaman Dasar*. Jakarta: Kencana Prenada Media Grup.

Integration between environmental chemistry and Islamic context is based on the qauliyah verse that is Al Qur'an & Hadith, kauniyah verse that is natural phenomena, Fiqih and Akidah Moraal (Donia & Mortada, 2021; Rasyid et al., 2022). According to Hamzah (2015), integration is aimed at complementing and reinforcing the material of one discipline with other disciplines. The results of the integration of environmental chemistry concepts with Islam can be seen in Table 5.

Table 5. Results of Integration of Environmental Chemistry Concepts with Islam

No.	Concept of Environmental Chemistry	Islamic Integrated
1	Environmental pollution	Qur'an Surah Ar Rum, verse 41
2	Water pollution	Qur'an Surah Al-Anbiya, verse 30
3	Air Pollution Indicators (change color, taste, and smell)	Hadith Ibn Majah history (of holy water)
4	Sources of Water Pollution	Qur'an Surah Ar Rum, verse 41
5	Water Pollution by Agriculture	Qur'an Surah Al Araf, verse 31
6	Impact of Water Pollution	Qur'an Surah Syuraa, verse 30
7	Air Pollution Impacts on aesthetics	Hadith Muslim History, No. 91
8	Countermeasures of Water Pollution	The attitude of responsibility, in the Qur'an Surah Al Mudatsir, verse 38
9	Soil pollution	Qur'an Surah Al Araf, verse 25
10	Soil Pollution Indicators	Qur'an Surah Al A'raf, verse 56 letters
11	Soil Pollution Sources	Qur'an Surah Al Hadid, verse 22
12	Internal factors Soil Pollution	Qur'an Surah Al Araf, verse 31
13	External Factors Soil Pollution	Qur'an Surah Al Araf, verse 58
14	Soil Contamination Countermeasures	Qur'an surah An Nahl, verse 8
15	Air pollution	An attitude of gratitude in the Qur'an Surah an-Nahl, verse 18
16	Sources of Air Pollution	Qur'an Surah Al Qasas, verse 77
17	Impact of Air Pollution (fog photochemistry)	The story of the days of the Quraish, the Qur'an Surah Ad Dukhan, verses 10-11 & 15-16
18	Impact of Air Pollution (Acid Rain)	Hadith narrated by Ahmad (XIII / 291 no. 7554) Hadith narrated by Ahmad (III / 140).
19	Air Pollution Reduction	Hadith history of Imam Muslim, No. 1552

The next step is to do validation by scientific integration experts. Validation is done to obtain the truth and accuracy of Islamic integration content that has been developed, before being used for the next stage (Hendri & Setiawan, 2016). Based on the validation results, it was found that the integration of the inserted Islamic context was "appropriate" with the concept of material on environmental chemistry.

Table 5 shows that the Islamic integrated environmental chemistry course discusses sources of environmental pollution, the impact of environmental pollution and ways to overcome environmental pollution. The environmental pollution in question is water, land and air pollution (El-Seedi et al., 2019; Nadila et al., 2022; Suyadi & Widodo, 2019). This is explained in QS. Ar-Rum: 41 which explains that damage has been seen on land and at sea caused by the actions of human hands; Allah SWT wants them to feel some of the (consequences of) their actions, so that they return (to the right path). In QS. As-Shura: 30 explains that whatever misfortune befalls you is caused by the actions of your own hands, and Allah SWT forgives many (of your mistakes).

The next step is structuring. According to Ashri & Hasanah (2016), the purpose of structuring is to connect learning between one concept and another concept. The structuring stage consists of (1) concept mapping; (2) create a macro structure; and (3) adjusting draft teaching materials with material structure.

The concept map in this study was made from the concepts in the draft material as a result of concept analysis (Herron et al., 1977). Concept maps consist of concepts that are usually included in circles, squares, and other shapes. Relations between the concept indicated by the line connecting these two concepts (Novak & Cañas, 2008). Then make a macro structure, serves to

maintain the accuracy and clarity of the correlation between texts to facilitate the writing of teaching materials (Marfu'ah & Anwar, 2018)

The next stage is characterisation. Characterisation is done by giving instruments in the form of questions to students. This aims to find out concepts that are considered easy and difficult by students. The questions given are in the form of test questions determining the main ideas and determining the difficult or easy concepts developed.

The question instrument was compiled from the draft teaching materials integrated with Islam that had been developed previously. The number of concept understanding test questions consisted of 15 questions and was given to the Chemistry Education Students as many as 62 students. Students were asked to assess their understanding of the text presented and give answers that form the main idea (label concept) of the text. Understanding is calculated by the number of correct questions divided by the total score, then averaged. The characterisation test results can be seen in Table 6.

Table 6. Characteristics Test Results

No.	label concept	Concept percentage (%)	Criteria Text Concept
1	Water pollution	96.8	Easy
2	Physical indicators of water pollution	85.5	Easy
3	Source of water pollution	61.3	Easy
4	agricultural waste	93.5	Easy
5	The impact of water pollution	87.1	Easy
6	Water pollution prevention	79.0	Easy
7	pollution of soil	96.8	Easy
8	Biological indicators of soil pollution	87.1	Easy
9	Sources of soil contamination	91.9	Easy
10	Internal factors pollution of soil	88.7	Easy
11	bioremediation	87.1	Easy
12	Air pollution	88.7	Easy
13	Sources of air pollution	87.1	Easy
14	The impact of air pollution	79.0	Easy
15	Reduction of air pollution	95.2	Easy
	<b>Average</b>	<b>86.9</b>	<b>Easy</b>

The results of the Characterization Test in Table 6 show that of all the concepts tested the average percentage was 86.9% in the Easy category. According to Arifin & Sjaeful (2016) , if the percentage is above 60% then the Islamic integrated environmental chemistry concept teaching materials developed have a high level of understanding. This integrated Islamic environmental chemistry teaching material product has characteristics that are easy to understand.

The last stage is didactic reduction. The reduction stage is the step taken to reduce the difficulty level of teaching materials. But in this study didactic reduction was not used, because based on the results of the characterisation test, all the concepts developed had easy characteristics.

The product teaching materials integrated with Islam has been compiled, then the feasibility test is carried out by learning media experts. The purpose of the validation is to find out the weaknesses and deficiencies contained shortcomings found in the product developed. These weaknesses and shortcomings will be an improvement material in order to produce a better product.

The average percentage for the material / content, language, presentation, and graphic feasibility aspects is 95%. According to Perbukuan (2014, p. 48), if the percentage results obtained are above 85%, then the product developed is declared to be very good. The final product of this research is teaching materials integrated with Islam, which consists of 10 pages of the initial section, 94 pages of contents, and 6 pages of the final section.

## Conclusion

To conclude, the thorough development process of Islamic integrated environmental chemistry teaching materials, led by the 4-STMD phases, has resulted in excellent comprehension and feasibility. The characterisation test results obtained an average of 86.9%. Based on these data, it can be stated that all concepts have a high level of comprehensibility according to student understanding. The results of the feasibility test for products of integrated Islamic environmental chemistry teaching materials carried out on experts have appropriate criteria in the very good category with a percentage of 95%, with details, the material feasibility aspect is 100%, the language feasibility aspect is 100%, the presentation feasibility aspect is 93%, and graphic aspects of 91%. From selection to characterisation, combining environmental chemistry with Islamic teachings has resulted in ideas that students find easy to comprehend, as evidenced by a successful feasibility test with experts ranking the materials as very good.

This project contributes to educational innovation by providing a reproducible methodology for incorporating Islamic principles into environmental chemistry teaching. Despite restrictions such as time and resource availability, the study emphasises the need for continuing research in this area. Researchers should conduct field trials to assess student responses and evaluate the effectiveness of educational materials. Furthermore, studying issues other than those covered in this study, such as heavy metal toxicology and pesticide pollution, provides possibilities to broaden and deepen the instructional materials available. By implementing these recommendations, future research projects can continue to promote the integration of Islamic values into environmental chemistry education, encouraging a greater grasp of the subject while adhering to Islamic standards.

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