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Development of chemistry questions integrated with religious values on acid-base topic

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Stimulus;

Abstract

Religious character education is a learning process that teaches values to shape a virtuous and cultured character. Education based on religious values can develop a good personality, including learning chemistry by integrating Islamic values. This research aims to analyze the feasibility of chemistry questions integrated with religious values. This research used a research and development type with the ADDIE model. The study participants were all students in class XI IPA MAS Darul Ulum Banda Aceh through saturated sampling techniques. Data was collected using expert validation sheets and teacher and student response questionnaires for multiple-choice questions. The validation results show that out of the 20 questions developed, 4 of them are invalid, and 16 are valid. Based on the validation from experts and chemistry education practitioners, the chemistry questions integrated with religious values for the Acid-base Topic is a feasible assessment. The validity index, 0.9, was obtained using Aiken's scale, and the reliability index, 0.85, based on IRA (interrater agreement), is valid and reliable. Based on responses, most students and chemistry teachers agree that questions based on religious values can have an impact on the following: (1) increase interest and motivation in learning chemistry; (2) increase knowledge about the relationship between chemical concepts and religious teachings; (3) increase awareness to obey the creator; and (4) increasing confidence in the greatness of Allah *Subhanahu wa Ta'ala*. The purpose of character education in chemistry learning can be achieved by using test questions that are integrated with religious values.

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Introduction

Education is a system that must be integrated with other existing systems to achieve the established goals of improving the quality of human life in all aspects (Syafe'i, 2015) (Rukmana et al., 2022). In terms of its process, education will continue to take place in line with the dynamics of changes in society's social and cultural settings from time to time. Speaking of the goals of education, it is indeed inseparable from the essence of education itself. Religious education is defined as education that views the universality of creating integrative values of divinity, humanity, and nature in the context of humanization and liberalization of humans so that they can carry out their duties and functions as stewards on earth as a form of devotion to God and fellow humans (Sholihah et al., 2019). The implementation of education in Aceh has an Islamic culture because Aceh is one of the provinces that implement Islamic Law. The

implementation of Islamic Law is emphasized in Aceh Qanun No. 5 of 2008 Article (5) Paragraph 2, which states that the national education system implemented in Aceh is based on Islamic values. In its implementation, the Aceh provincial education department has a vision and mission to ensure the implementation of human beings based on faith, piety, and noble character in realizing a society that is advanced, just, prosperous, and cultured while still emphasizing the characteristics and Islamic culture of the Acehnese society. Religious values are one of the values in character education. Religious values are values related to the One Almighty God. Religious values are the underlying values of character education because Indonesia is religious (Azzet, 2016). Universal religious values are possessed by each religion so that there will be no majority domination towards minorities.

The religious values incorporated into character education are crucial because an individual's belief in the truth of values derived from their religion can be a strong motivation in building their character. A student's character is built upon the values of their religion, which leads to strong faith and piety, as well as possessing noble morals. Instilling religious values is essential to cultivating a work ethic and scientific ethos among all academic community members within the educational institution (Zainudin, 2020).

Religious character education teaches values that can shape a character with noble morals and manners. Education that is based on religious values will form a good personality. Islamic values can be integrated into the chemistry learning process so that it can lead students to achieve knowledge (cognitive), understanding, and application of religious values that can build student characters, including attitudes of sincerity, thoroughness, honesty, hard work, and perseverance (Sugilar et al., 2018).

The religious character traits that can be developed in this research are obedience, gratitude, mutual assistance, and environmental preservation (Gunawan et al., 2019). One relevant way to apply this is by integrating the values contained in religious character into the learning activities of every subject listed in the school curriculum, including chemistry. Integrating religious character values into learning activities means combining, incorporating, and applying values that are believed to be good and right to shape, develop, and nurture the nature or personality of the students and national identity when learning activities occur (Zubaedi, 2013).

The word integration comes from the English word "integration," which means completeness or wholeness. The integration of chemistry with religious values is aimed at enhancing the religious character of students by aligning chemistry with religion. Several integrations of religious values in chemistry have been conducted as follows: (1) presenting them in organic textbooks (Syamsuri & Fadiawati, 2022); (2) constructing mnemonic of chemistry elements (group 17) topic (Winarni & Syahrial, 2022); (3) presenting them in the handout on salt hydrolysis (Nira et al., 2021); (4) mixing in the steps of learning stoichiometry material (Suryaningsih et al., 2020); (5) developing teaching material based on Islamic value for crude oil topics (Faeha et al., 2019); and (6) developing religious value in context-rich problem learning for chemistry bonding topics (Wahyuni et al., 2014).

Chemistry is about theory, concepts, laws, facts, and chemical procedures as a science and spiritual, intellectual, ethical, aesthetic, social, economic, and political values (Sulastri et al., 2018). One of the goals of learning chemistry in senior high school is to realize the beauty of nature and the greatness of Allah *Subhanahu wa Ta'ala*. However, in reality, there is still a gap between chemistry and religion in the teaching and learning process at schools. Following the curriculum requirements, the integration of religious values in chemistry learning shows

that science and religion are closely related (Gunana et al., 2021; Saputro et al., 2022; Nasution & Darmana, 2023). The integration of religious values can also be manifested in the chemistry test questions

Questions are part of an instrument test to measure the achievement of learning. The questions developed in this study are in the form of higher-order thinking skills (HOTS). Developing questions need exploitation from various phenomena and objects (Habiddin & Page, 2019). Religious value is one of the sources of intellectual stimulus in question.

Based on the explanation above, chemistry questions that contain integrated religious values were developed and used in the test to measure students' understanding of chemistry, especially the acid-base material. Based on Arrhenius's Theory, acid-based is a substance that ionizes in water to produce H^+ ions, while a base is a substance that ionizes in water to produce OH- ions. Acids and bases are very familiar compounds in daily life (Pertiwi et al., 2022). Acids have a sour taste, while bases have a bitter taste. These acids and bases are easily found in daily life. They are also used in some household products, such as food, beverages (soft drinks), fruits, and even in the body, where there is acid, such as hydrochloric acid in the stomach and ascorbic acid in the blood. Students already know a number of salts, for example, table salt; one way of making it is based on an acid-base reaction (Furkan & Salleh, 2023; Barke, 2023). Even rainwater can also contain acid, but rainwater containing acid can cause environmental damage; this event is called acid rain (Alfiandy et al., 2021).

Based on information from chemistry teachers at MAS Darul Ulum Banda Aceh, information was obtained that the chemistry questions in textbooks and worksheets, especially in the acid-base material, have not been integrated with religious values. The chemistry questions used are duplicates of old questions and still need to be revised. As a result, the characteristics of the chemistry-religion knowledge of students have yet to be formed, and the efforts of teachers to overcome these problems still need to be made. Therefore, the development of questions that integrate religious values is needed to improve student evaluation quality and serve as a guide in preparing questions.

The development of chemistry questions integrated with religious values is also based on relevant similar research, such as Sobarningsih et al. (2019), who stated that Islamic-themed mathematics questions influence students' interest in the learning process. Gunana et al. (2021) stated that worksheets containing religious values on the colloid material influence students' learning outcomes, especially on the colloid material. Fitrah & Kusnadi (2022) stated that integrating Islamic values in teaching mathematics affects mathematics learning to develop students' character, including an honest attitude, consistent and systematic attitude towards rules, fair attitude, sense of responsibility, and self-confidence.

Developing chemistry questions integrated with religious values in the acid-base material for grade XI aims to improve the students' affective quality in understanding the learning material more deeply. By linking it to the Oneness of God, it has a meaningful and lasting impact on the students' understanding of the essential content of the learning material. It also creates a high sense of confidence and awareness of the greatness and power of Allah *Subhanahu wa Ta'ala*, especially in the acid-base material (Fatakh, 2010). Based on the above description, the study aims to develop chemistry questions in the acid-base material that contains religious values so that students are expected to have the competence, attitudes, and behaviours that align with these values, resulting in good character for their lives.

Method

This research is a Research and Development (R&D) study using the Analyze, Design, Development, Implementation, Evaluation (ADDIE) method., This research was conducted in the even semester of the 2022/2023 academic year in the 11th-grade science class at MAS Darul Ulum Banda Aceh. Data was collected using expert validation sheets and teacher and student response questionnaires. Prior to developing the questions, interviews were conducted with teachers and students to obtain information about the problems faced in the learning process, specifically in the acid-base material. The questionnaire includes teacher and student responses. The flowchart of the ADDIE model can be seen in the Figure 1.

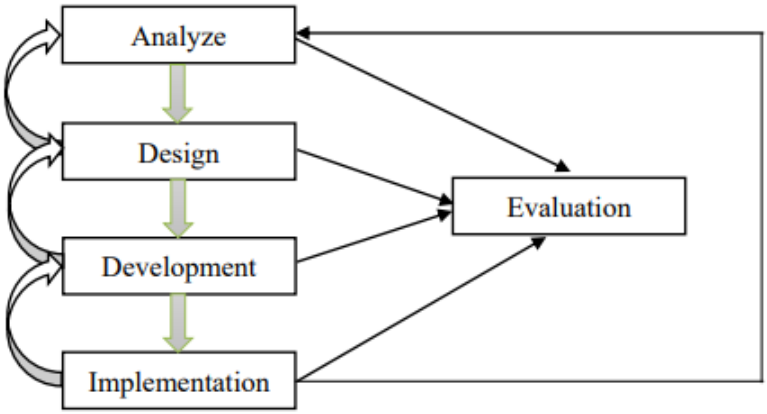


Figure 1. Flowchart of ADDIE

There are about 20 questions developed, in multiple-choice format. Data collection was conducted using instruments such as expert validation sheets, questionnaires for teacher responses, and questionnaires for student responses. The validation process was carried out by 2 qualified individuals in their respective fields. The subjects of this research were all 64 students of grade XI IPA at MAS Darul Ulum Banda Aceh.

Results and Discussion

The stages of developing value-laden questions begin with the analysis phase, in which the author's analysis comprises three elements: needs analysis, curriculum analysis, and product specification. In the needs analysis phase, it was found that teaching materials in the form of value-laden questions on the acid-base material were not available at MAS Darul Ulum Banda Aceh. Developing teaching material was based on the results of oral interviews with the chemistry teacher and several students at the school. The chemistry teacher at MAS Darul Ulum Banda Aceh stated that the chemistry questions in textbooks and worksheets, especially those on acid-base material, were not integrated with religious values. The survey results also showed that there had been no development of Higher Order Thinking Skills (HOTs)-based chemistry questions that are integrated with religious values.

The curriculum analysis stage involves selecting standard competency 3.10, which explains the concept of acids and bases, their strength, and the equilibrium of their ionization in a solution. This competency standard can be made into a higher-order thinking Skills question with the criteria: analyzing (C4) and evaluating (C5). In this research, the Indicators of Compromise will be formulated from Competency Standard 3.10.

In the material analysis stage, the learning material to be determined is acid-base. Based

on interviews with chemistry teachers at MAS Darul Ulum, it was found that the acid-base material could have been more optimal in terms of its integration with religious values in its questions.

In the product specification stage, the researcher formulated learning indicators based on the initial analysis results: needs analysis, Standard Competency (SC) analysis, and material analysis. The formulation of these learning indicators serves as a reference in developing HOTs-based chemistry questions that are integrated with religious values on the acid-base material. These learning indicators are tailored to the competency standards in the 2013 curriculum. The results of the learning objective specifications can be seen in Table 1.

Table 1. Formulation of Learning Indicators

Competency Standard (CS)		Learning Indicators	
3.10	Understanding the concept of acids and bases, their strength, and the equilibrium of their ionization in a solution.	3.10.1	Analyzing the concepts of Arrhenius, Bronsted-Lowry, and Lewis's acids and bases.
		3.10.2	Explaining the functions, properties, and indicators of acids and bases.
		3.10.3	Explaining the concepts of *pH*, *pOH*, and pK_w.
		3.10.4	Analyzing the impact caused by acid-base.
		3.10.5	Conducting an experiment on acid and base solutions using several indicators.

The next stage carried out by the researcher is the design stage. In this stage, the researcher creates an initial design of the chemistry questions in the HOTs category, which are integrated with religious values and will be developed based on the analysis stage.

The question framework was designed by following the references of the core competencies and Basic Competencies (BC) in the 2013 curriculum. The indicators designed in the HOTS question framework follow the HOTs criteria, which are analyzing (C4), evaluating (C5), and creating (C6). The question framework includes the cognitive level and religious values present in each item that will be developed. The cognitive level in the designed HOTs question indicators is analyzing (C4) and evaluating (C5). The religious values present in the question indicators are the relationship between humans and God (obedience and gratitude), the relationship between humans (mutual assistance), and the relationship between humans and nature (environmental awareness).

The HOTS chemistry questions are arranged based on the question framework. The type and form of the test questions are adjusted to the acid-base material. The test questions developed are multiple-choice questions appropriate for the characteristics of HOTS questions. This is because multiple-choice questions have several advantages; one is that they can measure students' cognitive levels from memory to evaluation (Kusaeri et al., 2019). The chemistry questions integrated with religious values are arranged into 20 questions.

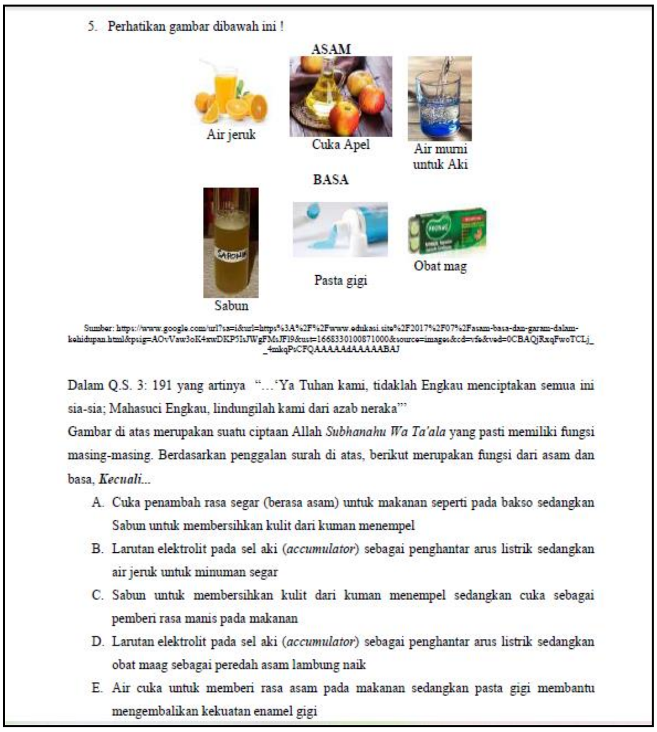
The product that has been designed in the design stage is then subjected to guidance from the supervisor. The result of the guidance is then revised until the questions are deemed suitable for validation. Hence, this stage involves many revisions, followed by the development stage.

The product that has been developed resulted in 20 questions. Each question aspect has been integrated with religious values. The table below shows the religious values present in each question item.

Table 2. Religious Values in Question Items

No	Religious Values (Connect with)	The Aspects	Questions Number
1	Divinity (Allah)	Gratitude	1, 4, 5, 6, 7, 8, 9, 10,12, 16, 19
		Obedience	11, 18, 20
2	Humans	Mutual Assistance	2, 3
3	Environment	Environment Awareness	13, 14, 15, 17

The results of developing questions for each aspect can be seen in Figure 2.


5. Perhatikan gambar dibawah ini !

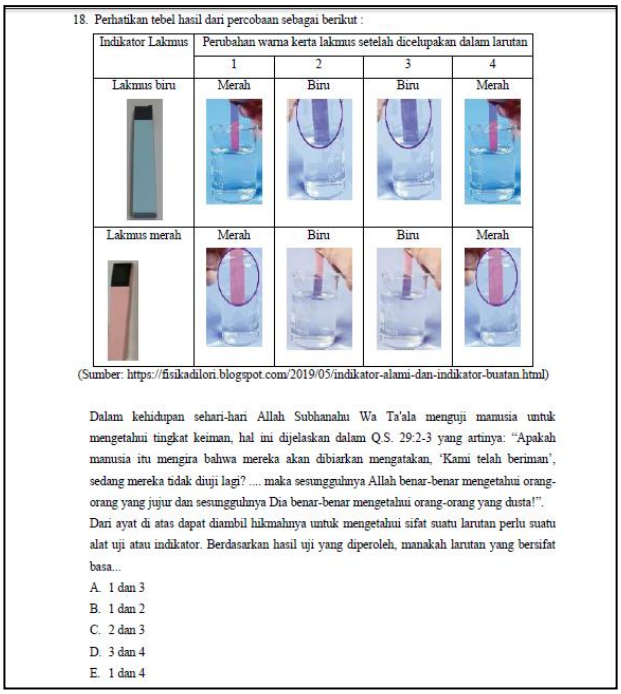
Sumber: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.edukasi.site%2F2017%2F07%2Fasam-basa-dan-garam-dalam-kehidupan.html&psig=AOvVaw3oK4xwDKP5IsJWgFMsJFl9&ust=1668330100871000&source=images&cd=vfe&ved=0CBAQjRxqFwoTCLj__4mkqPsCFQAAAAAdAAAAABAJ

Dalam Q.S. 3: 191 yang artinya "…'Ya Tuhan kami, tidaklah Engkau menciptakan semua ini sia-sia; Mahasuci Engkau, lindungilah kami dari azab neraka'"
Gambar di atas merupakan suatu ciptaan Allah *Subhanahu Wa Ta'ala* yang pasti memiliki fungsi masing-masing. Berdasarkan penggalan surah di atas, berikut merupakan fungsi dari asam dan basa, *Kecuali...*

A. Cuka penambah rasa segar (berasa asam) untuk makanan seperti pada bakso sedangkan Sabun untuk membersihkan kulit dari kuman menempel
B. Larutan elektrolit pada sel aki (*accumulator*) sebagai penghantar arus listrik sedangkan air jeruk untuk minuman segar
C. Sabun untuk membersihkan kulit dari kuman menempel sedangkan cuka sebagai pemberi rasa manis pada makanan
D. Larutan elektrolit pada sel aki (*accumulator*) sebagai penghantar arus listrik sedangkan obat maag sebagai peredah asam lambung naik
E. Air cuka untuk memberi rasa asam pada makanan sedangkan pasta gigi membantu mengembalikan kekuatan enamel gigi

Figure 2. Question with the Stimulus Gratitude

The indicator for the question in Figure 2. is to explain the function of acid-base based on the provided image. The question stimulus contains the value of gratitude. In the Qur'an, Surah Ali-Imran: 191, it is explained that *Allah Subhanahu wa Ta'ala* created everything with a purpose, and similarly, the image in the question must have its function.



18. Perhatikan tebel hasil dari percobaan sebagai berikut :

Indikator Lakmus	Perubahan warna kerta lakmus setelah dicelupakan dalam larutan			
	1	2	3	4
Lakmus biru	Merah	Biru	Biru	Merah
Lakmus merah	Merah	Biru	Biru	Merah

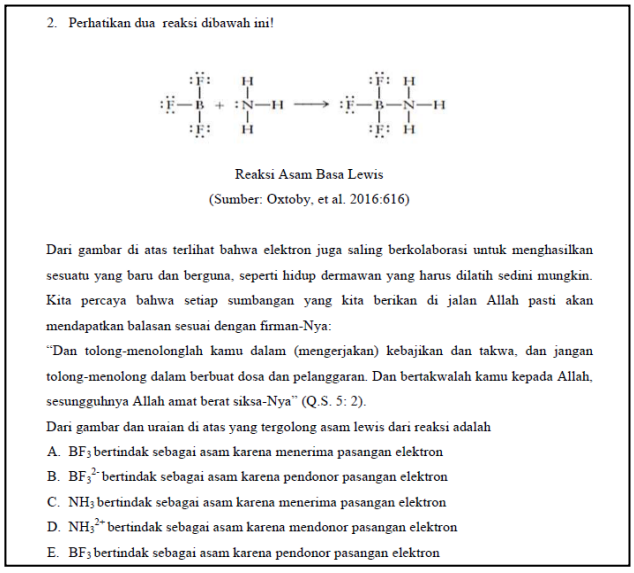
(Sumber: https://fisikadilori.blogspot.com/2019/05/indikator-alami-dan-indikator-buatan.html)

Dalam kehidupan sehari-hari Allah Subhanahu Wa Ta'ala menguji manusia untuk mengetahui tingkat keiman, hal ini dijelaskan dalam Q.S. 29:2-3 yang artinya: "Apakah manusia itu mengira bahwa mereka akan dibiarkan mengatakan, 'Kami telah beriman', sedang mereka tidak diuji lagi? .... maka sesungguhnya Allah benar-benar mengetahui orang-orang yang jujur dan sesungguhnya Dia benar-benar mengetahui orang-orang yang dusta!". Dari ayat di atas dapat diambil hikmahnya untuk mengetahui sifat suatu larutan perlu suatu alat uji atau indikator. Berdasarkan hasil uji yang diperoleh, manakah larutan yang bersifat basa...

A. 1 dan 3
B. 1 dan 2
C. 2 dan 3
D. 3 dan 4
E. 1 dan 4

Figure 3. Question with the Stimulus Obedience

The indicator for the question in Figure 3. is to analyze acidic and basic solutions based on indicators. The question stimulus contains the value of obedience in the Quran, which explains testing a Muslim's faith. Concerning the question, a solution is said to be acidic and needs to be tested with an indicator to prevent mistakes. Based on intellectual stimulus, an event or phenomenon for the question, a student asks to take a lesson from the event that knowing something is true or wrong needs testing. Phenomena are the source of knowledge and understanding (Kikas, 2004; Jenkin & Howard, 2019; Andrade et al., 2020).



2. Perhatikan dua reaksi dibawah ini!

Reaksi Asam Basa Lewis

(Sumber: Oxtoby, et al. 2016:616)

Dari gambar di atas terlihat bahwa elektron juga saling berkolaborasi untuk menghasilkan sesuatu yang baru dan berguna, seperti hidup dermawan yang harus dilatih sedini mungkin. Kita percaya bahwa setiap sumbangan yang kita berikan di jalan Allah pasti akan mendapatkan balasan sesuai dengan firman-Nya:

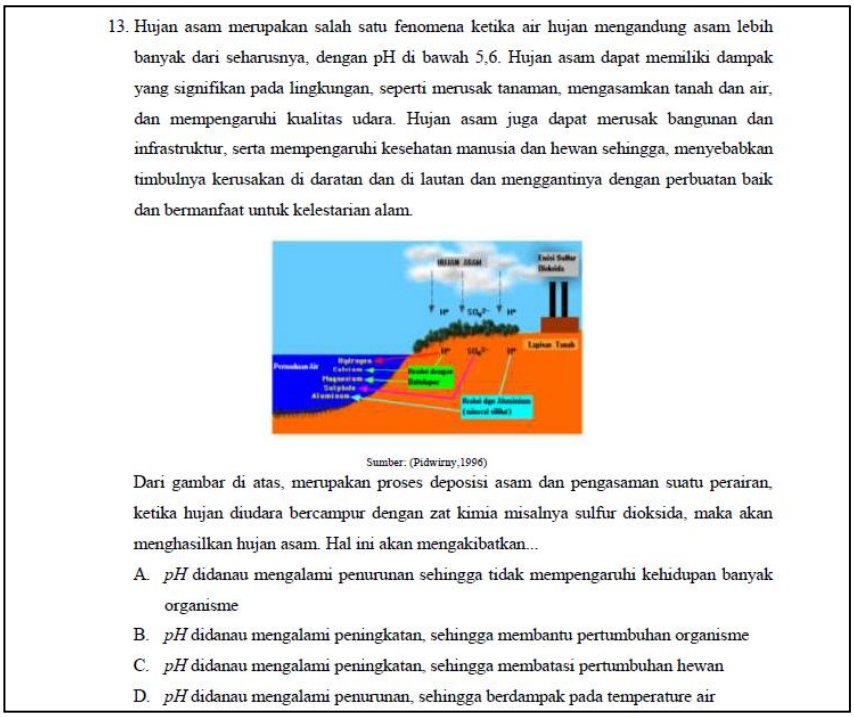
"Dan tolong-menolonglah kamu dalam (mengerjakan) kebajikan dan takwa, dan jangan tolong-menolong dalam berbuat dosa dan pelanggaran. Dan bertakwalah kamu kepada Allah, sesungguhnya Allah amat berat siksa-Nya" (Q.S. 5: 2).

Dari gambar dan uraian di atas yang tergolong asam lewis dari reaksi adalah

A. BF_3 bertindak sebagai asam karena menerima pasangan elektron
B. BF_3^{2-} bertindak sebagai asam karena pendonor pasangan elektron
C. NH_3 bertindak sebagai asam karena menerima pasangan elektron
D. NH_3^{2+} bertindak sebagai asam karena mendonor pasangan elektron
E. BF_3 bertindak sebagai asam karena pendonor pasangan elektron

Figure 4. Question with the Stimulus Mutual Assistance

The indicator of the question in Figure 4. is to analyze the concept of acid-base theory from Lewis structure. The question stimulus includes the value of mutual assistance, as shown in the Lewis acid-base reaction. NH_3 is analogous to donating a pair of electrons to BF_3 to become stable, and this electron donation is reflected in (Q.S. Al-Baqarah:245). Analogies can help the student to connect chemistry concept to familiar things in daily life activity (Keri & Elbatarny, 2021; Gürses et al., 2022).



13. Hujan asam merupakan salah satu fenomena ketika air hujan mengandung asam lebih banyak dari seharusnya, dengan pH di bawah 5,6. Hujan asam dapat memiliki dampak yang signifikan pada lingkungan, seperti merusak tanaman, mengasamkan tanah dan air, dan mempengaruhi kualitas udara. Hujan asam juga dapat merusak bangunan dan infrastruktur, serta mempengaruhi kesehatan manusia dan hewan sehingga, menyebabkan timbulnya kerusakan di daratan dan di lautan dan menggantinya dengan perbuatan baik dan bermanfaat untuk kelestarian alam.

Sumber: (Pidwirny,1996)

Dari gambar di atas, merupakan proses deposisi asam dan pengasaman suatu perairan, ketika hujan diudara bercampur dengan zat kimia misalnya sulfur dioksida, maka akan menghasilkan hujan asam. Hal ini akan mengakibatkan...

A. *pH* didanau mengalami penurunan sehingga tidak mempengaruhi kehidupan banyak organisme
B. *pH* didanau mengalami peningkatan, sehingga membantu pertumbuhan organisme
C. *pH* didanau mengalami peningkatan, sehingga membatasi pertumbuhan hewan
D. *pH* didanau mengalami penurunan, sehingga berdampak pada temperature air

Figure 5. Question with the Stimulus Environment Awareness

The indicator for the question in Figure 5. is to analyze the impact of acid rain on aquatic ecosystems based on research data. The question stimulus contains the value of environmental awareness. In verse 41 of Surah Ar-Rum, Allah affirms that various damage on land and sea result from human actions, including acid rain. Acid rain is harmful and become a global problem because it annoys the ecology (Mohajan, 2018). Therefore, it is essential to understand acid rain's causes, prevention, and impacts. Green chemistry is a form of concern for chemists to prevent environmental damage. Developing student worksheets based on green chemistry on acids and bases (Ulandari & Mitarlis, 2021) is one of the right ways to get students to care about their environment.

Based on the validation results of the feasibility assessment of the chemistry questions integrated with religious values for the acid-base material by two subject matter experts, an average percentage of 0.9 was obtained using Aiken's scale, which is classified as very valid. From these results, the chemistry questions integrated with religious values in the acid-base material developed in this study are highly viable to be tested on students as research subjects and used in the learning evaluation process. The percentage of the assessment results for each aspect evaluated by the two validators can be seen in Figure 6.

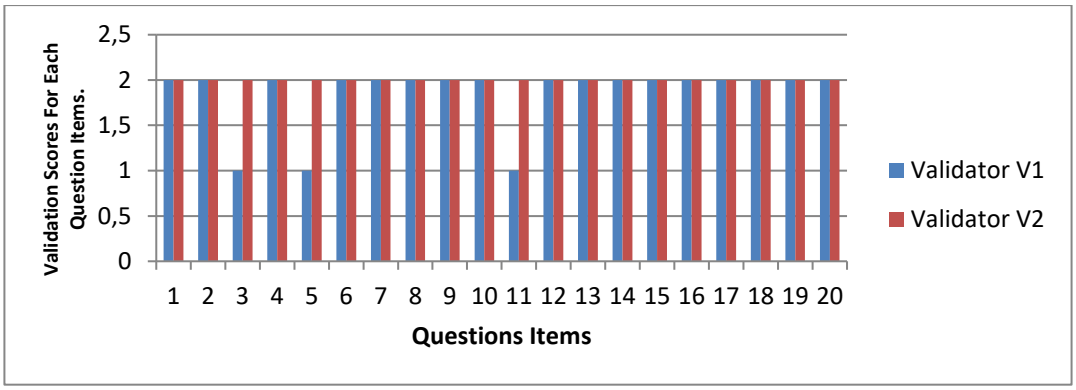


Figure 6. The Feasibility Graph of Chemistry Questions Integrated with Religious Values by Two Validators.

Next, a reliability test was conducted by the IRA. Based on Figure 6, there are 17 questions rated the same by two validators. The reliability index is 0.85 based on the IRA. A test is considered reliable if the observation score is highly correlated with the actual score (Retnawati, 2016).

Responses from students and chemistry teachers toward chemistry questions integrated with religious values in the acid-base topic

After the implementation stage, a score of 89.2% was obtained for student responses, classified as very good. The result of responses indicates that the students gave positive feedback on the chemistry questions integrated with religious values. Students feel that chemistry questions integrated with religious values in the acid-base material are more relevant to their daily lives and provide additional motivation because they are learning academic material and broader and more important values. The result of the teacher response questionnaire showed an average percentage of 95.5%, indicating that the test instrument is classified as a very good and meaningful question. The result of teacher responses is also in line with the statement by Sari and Suprihatin (2018) that a study is considered appropriate for use if the percentage obtained from each respondent's assessment falls within the range of 81-100% and 61-80% with the categories of very appropriate and appropriate, respectively. The more connections between concepts (chemistry and religious value), the more meaningful and significant they are stored in long-term memory (Winarni & Syahrial, 2022). The results of student and teacher responses can be seen in Figure 7.

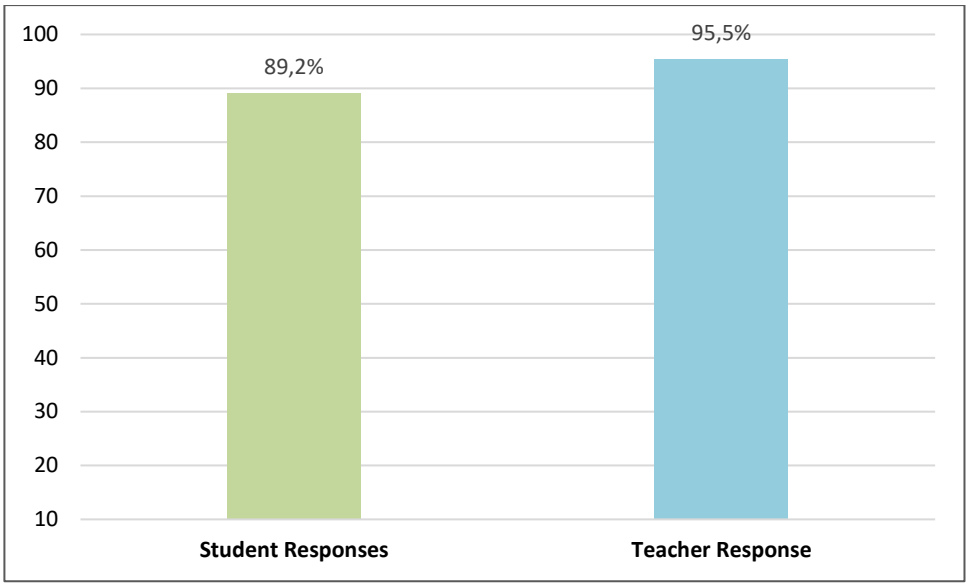


Figure 7. Student and Teacher Responses

Students' response to the chemistry questions integrated with religious values was positive, with an average percentage score of 89.2% (excellent), and teachers' response was positive, with an average percentage score of 95.5% (excellent). Based on the result of the study, most of the students and teachers expressed their agreement on chemistry questions integrated with religious values in the acid-base topic as follows:

1. Chemistry questions integrated with religious values (obedience, gratitude, care for the environment, help) made me more interested in studying chemistry, especially acid-base material.
2. The linkage of acid-base material questions with religious values (obedience, gratitude, care for the environment, help) adds to religious understanding about the greatness of Allah *Subhanahu Wa Ta'ala* and all of His creation
3. The chemistry questions integrated with religious values (obedience, gratitude, caring for the environment, helping each other) convinced me that the Al-Quran is the source of all knowledge.
4. I learned much about the relationship between chemistry and the Koran after working on chemistry questions integrated with religious values (obedience, gratitude, care for the environment, and help).
5. After I worked on chemistry questions integrated with religious values (obedience, gratitude, care for the environment, please help), I became more obedient to all of Allah SWT's commands and kept away from all His prohibitions
6. After I worked on chemistry questions integrated with religious values (obedience, gratitude, care for the environment, please help) motivated me to be more enthusiastic about learning
7. The information contained in the chemistry questions integrates religious values (obedience, gratitude, care for the environment, help) and adds to my knowledge of religious values in acid-base material

8. The information contained in the chemistry questions integrates religious values (obedience, gratitude, care for the environment, please help) and adds to my knowledge of religious values in acid-base material
9. Using chemistry questions integrated with religious values (obedience, gratitude, caring for the environment, helping) changed my mindset that religious studies and science lessons are equally important to study seriously.

These responses showed that most students and chemistry teachers agree that the questions based on religious values can increase the quality of chemistry learning achievement. The statement goes hand in hand with learning the outcome of chemistry education in the latest education curriculum in Indonesia, for the first is increasing devotion to the one and only God after studying chemistry.

Conclusion

Out of the 20 chemistry questions integrated with religious values that were developed, 16 of them have high validity and reliability. The validity of the chemistry questions integrated with religious values that have been developed, based on the content and language using Aiken's index, is 1, which falls under the criteria of very high and suitable for use as an evaluation test for acid-base material learning. The students' responses to the integrated chemistry questions with religious values that have been developed showed a positive response, with an average percentage of 89.2%, and the teachers' responses were also positive, with an average percentage of 95.5%.

Credit Authorship Contribution Statement

Sri Winarni: Conceptualization, Methodology; Writing-review and editing; Formal analysis; Supervision. **Riska Putri**: Methodology; Writing – original draft; Formal analysis; Visualization. **Erlidawati**: Conceptualization, Methodology; Supervision.

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