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THE IMPACT OF EXPERIMENTAL RESEARCH-BASED LEARNING MODULES ON STUDENTS' AFFECTIVE DOMAIN: A STUDY ON RELIGIOUS MODERATION IN CHEMISTRY EDUCATION

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ABSTRACT

Islamic Religious Colleges (PTKI) 's key mission is to promote religious moderation for students. This aspect is currently missing in the Chemical Education Studies Program curriculum. To address this, we constructed a teaching module that applied the 4S-TMD method (Selection, structuring, characterization, and didactical reduction). This work is based on experimental data of using waste palm coconut shells as activated carbon for methylene blue dye adsorption, which formed two modules: Inorganic Chemistry II (Module A) and Instrumental Analysis Chemistry (Module B). The selection phase was designed with graduate learning outcomes (GLO), learning content, and indicators of religious moderation in module design. The item content validity index (I-CVI), measuring content validity, reached an excellent average of 0.98. During the structuring phase, laboratory experimental results were mapped conceptually. Module A performed excellently, with a validity of 85%, whereas Module B was below 80%. After the refinement steps, both modules reached 100% validity. The measure of the value of religious moderation of GLO indicates >60% for 10 variables, whereas the self-assessment of the nine values of religious moderation of students shows very good (above 20%). This is the first study applying religious moderation to chemistry education and showed that the 4S-TMD method of implementing the 4S-TS method was effective (4.9/5.0 for eligibility). Sow enjoyably integrates chemistry and science education with similar values, which can take place using their type.

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INTRODUCTION

The Indonesian economy relies heavily on Agriculture. Its palm coconut plantation subsector, located on Sumatra Island, remains one of the largest contributors to palm coconut production. In 2020, Aceh produced 1,027.298 tons of palm coconuts [1]. Coconut yields 6.5% of palm coal waste per ton of production [2]. This waste problem will be a waste problem for our environment if it is not used wisely. Based on the previous study, oil palm shell combustion has been known to cause several ash-related issues, such as slagging, fouling, and corrosion, impacting the amount of ash deposit and thereby reducing the heat transfer [3].

This waste management will affect the circular bioeconomy with proper treatment in management strategies, including “reducing,” “reuse,” and “recycling” [4]. Lignocellulose biomass is the most significant component of agricultural biomass as it consists of cellulose, hemicellulose, and lignin, and oil palm shell is one of the lignocellulose biomass. Lignocellulosic biomass can be converted into a wide range of products for domestic and commercial purposes. Compost, bio-coal, biochar, bio-bricks, biohydrogen, biomethane, bioethanol, biobutanol, organic acids, and bioelectricity are [5], [6]. The carbon content of oil palm biomass averages from 42.7% to 57.9%, with 3.5-27% fixed carbon, and it is a potential carbon material source [6]. So it can be processed into biochar or activated carbon.

The composition measurement of carbon from experimental research can be included in the inorganic chemistry teaching module, including carbon sources, synthesis, and characteristics. Not only did the students have to understand the carbon material theory, but the lecture had to challenge a graduate learning outcome on environmental issues that students have to cure. The results are consistent with GLO (S6), which was compulsory by the Department of Chemistry for all students and graduates. From the previous description and experience of learning inorganic chemistry II and instrumental analysis chemistry, they could convert oil palm shell waste into activated carbon for dye removal. The adsorption behavior of activated carbon in decolorizing wastewater can also be integrated into learning comprehension in the instrumental analysis chemistry teaching module. Hence, oil palm shell waste can be used as teaching materials, in the scope of chemistry learning.

The porous structure of activated carbon materials has been emphasized, with specific pore volumes between 0.26 cm^3/g and 8.43 cm^3/g, which makes it a more appropriate adsorbent of methylene blue dye as used in the textile industry, in comparison to the other carbon materials that were tested 8 [10]. As such, this research underlines the great potential of palm shell residues in waste management and the development of renewable resources. QS offers similar guidance in response to such efforts. The closing 190 and 191 of Surah Al-Imran - Indeed, in the creation of the heavens and the earth and the alternation of night and day are signs for those of understanding. Through chemical education, students are urged to develop environmental and societal awareness, assessed by the religious moderation values in GLO.

It promotes renewable resource utilization and highlights integration challenges in educational practices, specifically in the chemical education domain, where waste management is an integral part of the iterative industry process [11]. This results in minimizing the negative effects of palm shell waste and allowing a related approach to establish self-evaluation tools centered around GLO in Inorganic Chemistry II and Instrumental Analysis Chemistry courses. This action is consistent with the Director General's Decree No. 7272 of 2019 from Islamic Education, which points to the guide of its implementation of religious moderation in Islamic education. As a result, Islamic Religious Colleges (PTKI) graduates will be more than capable of upholding Pancasila and UUD 1945 and unlocking and spreading tolerance, inclusivity, and moderate Islamic beliefs. Incorporating ethics in technical education reflects this emphasis on socially conscious and compassionate graduates. This integration is explored through case studies and models of upstanding ethics in ways that show social responsibility and reflection.

The Ministry of Religious Affairs of the Republic of Indonesia has recently made tolerance the latest topic in its efforts to reform religious moderation guidelines for lecturers and students. Even in specialized training for instructional staff, it is recommended that values of religious moderation also be integrated into the educational process. However, the above application has not been properly evaluated, so the study of the integration of religious moderation values has not been the main priority in the learning agenda at PTKI. More broadly, not exclusively from religious issues, incidents of social division result from environmental things like mismanaged agricultural byproducts. The most recent study conducted a validity test on the survey instrument a validity test on the survey instrument. It examines the Technology Pedagogical Content Knowledge (TPACK) approach in the context of religious moderation, which lecturers use to promote religious moderation in character development courses [12].

Laboratory learning is traditionally aligned with students' learning objectives. Some studied constructs like cooperation, communication, interest, enjoyment, and engagement are typically measured [13]. Although limited studies, such as focus group discussions adapted into a lesson plan (RPS), have been conducted related to lecturer perceptions on the revival of this religious moderation value in the curriculum of science subjects in higher education [14]. On the other hand, no research has specifically addressed the development of measures to determine graduates' learning outcomes (attitudinal aspect) in religious moderation. Consequently, they do not have any teaching modules containing religious moderation values in the learning instruction.

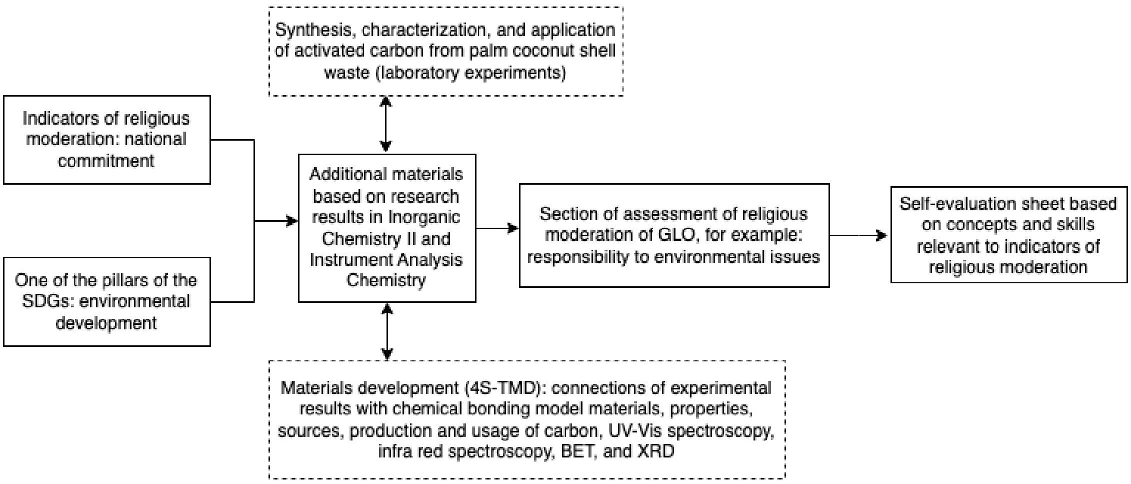


Figure 1. Research rationale

Religious attitude, honesty, discipline, and responsibility in the lectures in the attitude assessment section of the Learning Plan (RPS) But for the contents do not refer to the descriptors of religious moderation as specified by the Director General of Islamic Education Decree No. 102 of 2019 concerning PTKI's Religious Standards. Hence, integrating such environmental management subjects in the material's study, for example, oil palm shell waste management, commonly found in their habitat, can produce graduates with moderate concern towards environmental issues [15], [16]. The research rationale will present the interconnection between those issues in this study (see Figure 1).

As presented in Figure 1, this research encompasses two core purposes relevant to the rationale. First, explain the construction of integrated teaching materials and the study findings on oil palm shell waste as activated carbon. Next, to determine and describe the perspectives of student moderation, the integrated learning material consists of moderation attitude measurement sheets and the results of palm coconut shell waste utilization as activated carbon. The second objective aims to fulfill the need for instrument development to measure graduate learning outcomes in religious moderation.

METHODS

1. Research Design and Framework

This study adopted the Research and Development (R&D) approach in conjunction with the Four-Step Teaching Material Development (4S-TMD) model to design chemistry learning modules that integrate scientific concepts with religious moderation values [17]. The modules were specifically developed for Inorganic Chemistry II and Instrumental Analysis Chemistry courses, emphasizing carbon group elements and UV-Vis spectrophotometry. These topics were chosen due to their real-life applications and suitability for embedding religious moderation principles, aligning with the broader educational goal of fostering ethical awareness alongside academic knowledge.

The development process followed the 4S-TMD framework, which includes four distinct phases. The Selection phase focused on identifying chemistry topics relevant to the curriculum and capable of promoting religious moderation values. This ensured that the chosen content was academically appropriate and value-driven. In the Structuring phase, theoretical knowledge and experimental activities were systematically integrated to create a cohesive learning experience, linking scientific concepts with practical applications while embedding ethical values. During the Characterization phase, the modules underwent validation and refinement to confirm their clarity, relevance, and alignment with learning objectives, ensuring they effectively resonated with students. Finally, the Didactical Reduction phase involved simplifying complex topics to enhance student comprehension, ensuring the delivery of the material remained engaging and accessible while retaining its ethical underpinnings [17].

This methodical process, illustrated in Figure 2, reflects a structured approach to curriculum development. Combining chemistry education with religious values, the study aims to produce graduates with technical expertise and a strong ethical foundation, fostering a holistic educational experience.

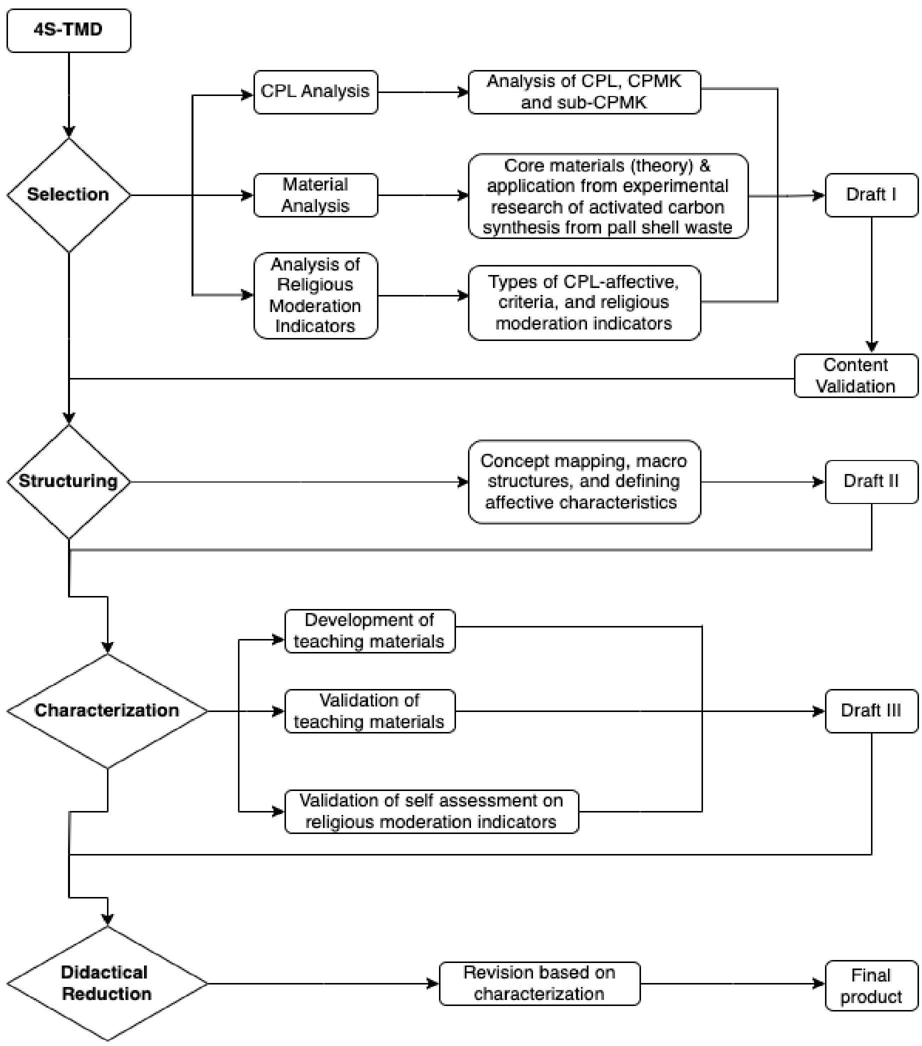


Figure 2. Research flow

2. Sample Selection

The study employed purposive sampling to ensure the selected samples were directly relevant to the research objectives. For the experimental research, palm coconut shells were chosen as the primary material, sourced from the Nagan Raya district in Aceh, due to their availability and suitability as activated carbon in the experiments. This material was pivotal in demonstrating the practical application of chemistry concepts in real-life scenarios, specifically in waste management and environmental sustainability.

For the development of teaching materials, the sample comprised students enrolled in the Chemistry Education program. A total of 18 students were selected from the Inorganic Chemistry II course, focusing on the chemistry of carbon group elements, and 27 students were chosen from the

Instrumental Analysis Chemistry course, which emphasized quantitative analysis using UV-Vis spectrophotometry. These courses were strategically selected as they offered significant opportunities to integrate scientific concepts with religious moderation values.

By targeting these specific groups, the study ensured the developed modules aligned with the learning objectives of both the courses and the broader goal of fostering ethical awareness among students. This selection strategy allowed the study to test the feasibility and effectiveness of the modules in diverse academic contexts, ensuring robust and meaningful outcomes.

3. Development Process

The development of the teaching modules adhered to the 4S-TMD process, encompassing four sequential stages: Selection, Structuring, Characterization, and Didactical Reduction [17].

4. Selection Phase

During the Selection phase, chemistry topics were chosen based on their alignment with the curriculum and ability to incorporate religious moderation values. This step ensured the inclusion of relevant content that bridged scientific concepts with ethical considerations. The initial module draft, Draft I, underwent content validation to ensure its quality and relevance. Validation was performed using the Content Validity Ratio (CVR), Item-Content Validity Index (I-CVI), and Scale-Content Validity Index (S-CVI).

The formulas used for these validations are as follows:

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \qquad (1)$$

Where n_e is the number of experts rated the item as essential, and N is the total number of experts, CVR ranges from -1 to 1. A positive value indicates that the item is considered essential by the experts. I-CVI is used to measure the content validity at the individual item level based on the percentage of experts who rated the item as relevant.

$$\text{I} - \text{CVI} = \frac{\text{Number of experts who gave a score of 3 or 4}}{\text{total number of experts}} \qquad (2)$$

S-CVI is the average of all the individual I-CVIs or the proportion of items meeting certain I-CVI criteria.

$$\text{S} - \text{CVI} = \frac{\text{Number of items with accepted I} - \text{CVI}}{\text{total number of experts}} \qquad (3)$$

A high I-CVI indicates that the item is considered relevant/essential by most experts. A high S-CVI indicates the overall instrument has content validity [19].

The teaching materials and the instrument for measuring religious moderation attitudes were validated in the Characterization stage. Validation was done using a Likert scale and calculated using the following equation:

$$P = \frac{F}{N} \times 100\% \qquad (4)$$

These indices quantify the essentiality of each item (CVR), the relevance of individual items (I-CVI), and the overall content validity of the instrument (S-CVI). By employing these metrics, the phase ensured the module content was educationally and contextually appropriate.

5. Structuring Phase

The learning materials were meticulously organized in the Structuring phase to establish a cohesive connection between theoretical chemistry concepts and experimental activities. This stage emphasized using multiple representations from practical experiments, bridging the gap between scientific theory and its real-world applications. By integrating representations from experimental findings, the learning modules ensured a robust link between chemistry education and the values of religious moderation, thereby fostering a comprehensive learning experience for students [18].

This phase highlighted the synergy between hands-on activities and ethical considerations, demonstrating how experimental evidence can reinforce scientific understanding and moral principles. Through this structured approach, the modules promoted an active and reflective learning process aligned with the broader educational goals of integrating scientific inquiry with societal values.

6. Characterization Phase

In the Characterization phase, the teaching modules and instruments designed to measure students' attitudes toward religious moderation were rigorously validated using a Likert scale. The validity percentages of the module items were calculated using the following equation:

$$P = \frac{F}{N} \times 100\% \quad (4)$$

Where P represents the validity percentage, F is the number of experts who rated an item as valid or relevant, and N is the total number of experts who evaluated the item.

Table 1. Validity Categories in the Characterization Stage

Category	Percentage Range (%)	Description
Highly Valid	90 - 100	The item is highly valid and accepted without revision.
Valid	75 – 89.9	The item is valid but may require minor revisions.
Moderately Valid	60 – 74.9	The item is moderately valid, requiring revisions to improve relevance.
Poorly Valid	40 – 59.9	The item is poorly valid and needs significant revisions or consideration for removal.
Not Valid	< 40	The item is not valid and is recommended for removal or drastic modification.

The results of these calculations were interpreted using the criteria outlined in Table 1, which categorizes validity percentages into ranges such as "Highly Valid," "Valid," and "Moderately Valid," among others. This systematic validation ensured that the modules met both educational objectives and the integration of religious moderation values [19].

Through this phase, any necessary revisions were identified and implemented, enhancing the quality and relevance of the modules. The detailed validation process, supported by expert evaluations and structured methodologies, underscored the robustness of the Characterization phase in aligning the modules with graduate learning outcomes and the broader educational goals of fostering religious moderation.

7. Didactical Reduction Phase

The Didactical Reduction phase focused on simplifying complex chemistry concepts to enhance student comprehension while ensuring that religious moderation values were meaningfully embedded within the material. A self-assessment questionnaire was administered to evaluate the impact of these materials on students' attitudes toward religious moderation. The calculation of the self-assessment results was conducted using the formula:

$$P = \frac{F}{N} \times 100\% \text{..(5)}$$

Where P represents the percentage of a specific attitude category, F is the number of respondents selecting a criterion, and N is the total number of respondents.

The self-assessment results were interpreted using the categories outlined in Table 2, which range from "Very Good/Strongly Agree" to "Very Poor/Strongly Disagree." This ensured a nuanced understanding of students' perspectives and the alignment of their attitudes with the intended graduate learning outcomes [20].

Table 2. Categories for Interpreting Self-Assessment Questionnaire Results

Category	Percentage Range (%)	Interpretation 1	Interpretation 2
Very Good/Strongly Agree	85 - 100	Very Good	Strongly Agree
Good/Agree	70 – 84.9	Good	Agree
Fair/Neutral	55 - 69.9	Fair	Neutral
Poor/Disagree	40-54.9	Poor	Disagree
Very Poor/Strongly Disagree	< 40%	Very Poor	Strongly Disagree

This phase ensured the teaching materials were accessible to students while the religious moderation values were seamlessly integrated into their learning process. By combining simplified scientific content with a focus on ethical and spiritual principles, this phase underscored the holistic educational approach central to the module development process.

8. Evaluation and Feasibility Testing

The Evaluation and Feasibility Testing phase assessed the practicality and effectiveness of the developed modules. Feasibility testing was conducted using the formula:

$$Avarage\ Score = \frac{\sum_{i=1}^{n} X_i}{n} \text{........................(6)}$$

Where $\sum_{i=1}^{n} X_i$ It is the sum of all expert scores for a particular aspect and represents the total number of experts who evaluated the material.

The average scores were then categorized according to Table 3, which interprets the results. These categories range from "Very Feasible," indicating that the material requires minimal revision, to "Not Feasible," suggesting significant reworking is necessary [20].

This phase ensured the modules met educational standards and effectively integrated the intended religious moderation values. By rigorously evaluating the feasibility and alignment with learning objectives, this step confirmed the readiness of the modules for practical application in educational settings.

Table 3. Categories for Interpreting Feasibility Test Results

Category	Average Score Range	Description
Very Feasible	4.5 – 5.0	The teaching materials are very feasible to use, requiring almost no revisions.
Feasible	3.5 – 4.4	The teaching materials are feasible to use but may require minor revisions.
Moderately Feasible	2.5 – 3.4	The teaching materials are moderately feasible, but significant revisions or improvements are needed.
Infeasible	1.5 – 2.4	The teaching materials are not feasible, requiring major revisions or a complete overhaul.
Not Feasible	1.0 – 1.4	The teaching materials are not feasible and are recommended for rejection or complete reworking.

RESULTS AND DISCUSSION

Using the 4S-TMD method, the research's findings will be presented in four steps: selection, structuring, characterization, and didactic reduction. Overall, the data that will be presented consists of the results of GLO analysis from Inorganic Chemistry II and Instrumental Analysis Chemistry courses, information on literature-based material analysis, and research on palm shell waste-based active carbon production for blue methylene adsorption. A self-assessment questionnaire was drafted to gauge students' perception of the availability of values of religious moderation towards the subject of study in the reference materials based on the materials provided.

The research report of the selected studies will be structured into four steps following the 4S-TMD method: Selection, Structuring, Characterization, and Didactic Reduction. These data to be presented generally include the results of GLO analysis from the Inorganic Chemistry II and Instrumental Analysis Chemistry courses, material analysis results based on literature studies, and research results on manufacturing active carbon from palm shell waste for the adsorption of blue methylene. Thus, a questionnaire of student self-assessment of the availability of religious moderation values in the subject area studied in the materials was prepared based on the content provided.

1. Selection

GLOs, SLOs, and LOs relevant to using palm coconut shell waste as active carbon for methylene-blue pollutant adsorption in water will be selected based on the Chemical Education Study Program curriculum requirements. The GLO part gives a decision framework for setting deciding standards for religious moderation values. Based on SLO and LOs, the assortment of materials was limited for teaching materials. Table 4 shows a description of selected GLOs.

Table 4. Selected GLOs for the background of religious moderation values

GLOs	Description
S2	To sustain human ideals while carrying out religious, moral, and ethical activities.
S6	Collaboration, being socially sensitive, and caring about society and the environment

The GLOs also align with national education goals as stated in Law Number 20 of 2003 of the Republic of Indonesia regarding the Purpose and Goals of National Education. National education aims to foster students' moral character and responsible citizenship [3]. The value of good morals is reflected in GLO S2, where the goal is to produce graduates who are religious and socialist. GLO S6 implies assessing the sense of responsibility due to its emphasis on nurturing caring and competent graduates who can deal with environmental challenges, which aligns with the objectives of the chemical education curriculum. The basics of measurement utilizing UV-visible spectrophotometry are among the topics covered in the Instrumental Analysis Chemistry teaching module. The properties of visible light are explored compared to those of electromagnetic waves. Moreover, students are asked to reflect on something that connects science with the Quran, namely Quran Surah Al-Mulk Verse 5 about electromagnetic radiation. In the advanced learning activity building on this experience, students are encouraged to work in groups and explore the connections between science and the Quran through Quranic interpretation activities. It will unavoidably indirectly propagate religious moderation values of deliberation.

Two GLOs were created in Endeavour, which is relevant to the research question, resulting in six sub-GLOs being generated: The GLOs are (1) knowledge of social consequences, (2) participate in sustained conversations about sustainability initiatives, (3) creativity of solutions, (4) commitment to the environment, (5) collaboration as a teammate, and (6) critical thinking skills. Then, from the six sub-GLOs, three to eight criteria for the attitude assessment were provided. Every criterion is added with one of the most relevant values of Religious Moderation.

A single sub-GLO is made up of two or more sub-GLO descriptions. The first sub-GLO's description is: "Students know about social issues that may be associated with that oil palm shell waste." The students are required to find materials related to the impacts of burning oil palm shell waste in the initial part of the learning. Next, for the discussion about sustainable initiatives sub-GLO, students are encouraged to participate in a discussion on research projects or technology development, like using palm kernel shell waste into activated carbon. This is not just a theory in the class but also practical sessions in the laboratory to determine the adsorption capacity of the oil palm shell waste-based activated carbon.
Then, in learning activities (theory and practice), students are asked to assess the values of religious moderation they show or develop from the speeches or group work using self-assessment sheets. In that evaluation, for instance, students are asked to evaluate their awareness of the social impacts of the practices of converting oil palm shell waste to activated carbon. However, through these activities, they also find out that some activities, such as burning activities, may disrupt the environmental and social balance. They are trained to instill the value of tawazun (balance), one of the core principles of religious moderation.

Furthermore, each course's content is analyzed according to the module requirements. As shown in Figure 3, the selection of the carbon application material is based on research conducted for the synthesis of activated carbon from palm coconut shell waste. The result of the research was then divided into two parts. The first part, the synthesis and characterization stage, was incorporated into the Inorganic Chemistry II teaching module. The second part (adsorption studies, UV-Vis spectrophotometry method) was incorporated in the seminar Instrumental Analysis Chemistry teaching module.

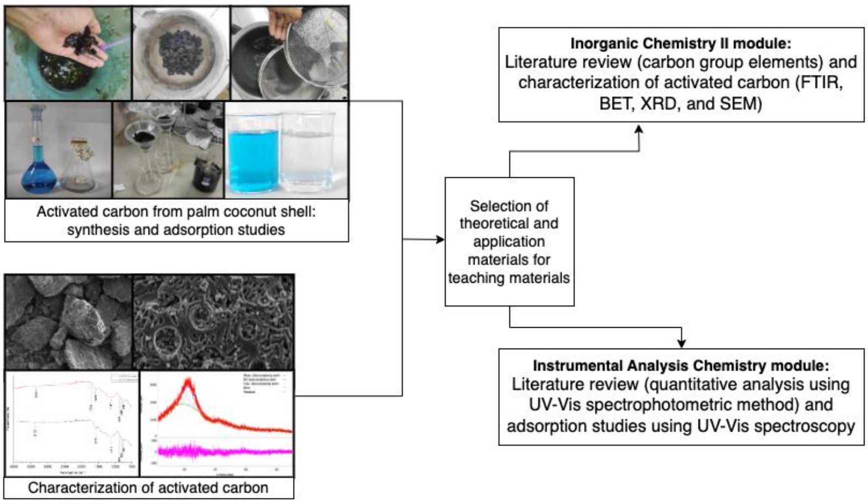


Figure 3. Material analysis based on laboratory experimental research

Among the learning topics in Inorganic Chemistry II, the carbon group element is the most related to synthesizing and characterizing activated carbon from palm oil shell waste adapted from the research [49]. Likewise, its application in removing dye pollutants from water significantly correlates with UV-visible spectrophotometry determination in Instrumental Analysis Chemistry. The research will thus provide a detailed view of the work steps, starting from selecting raw materials from biomass waste, properties of activated carbon, and techniques for removing dye pollutants in water. This relates directly to GLOs (S2 and S6), which seek To produce graduates who possess knowledge of environmental concerns and an understanding of waste ethics to address social concerns.

The draft I is content validated (CVR and CVI) by summarizing material from literary studies, laboratory research results, and religious moderation values. The contents are validated through ten assessment criteria, as shown in Figure 4. Ten aspects, P1-10 (described in Figure 4), were validated by three expert validators who mastered the implementation of the values of religious moderation in chemistry education. For example, the P4 with a low CVI indicates that at the beginning of the teaching module, it does not contain a specific topic describing the appropriate values of religious moderation based on the research findings presented in the module. The researcher believes that the values of religious moderation should only be presented when students self-evaluate. Therefore, the consensus of validators is that the basic content needs to be enhanced.

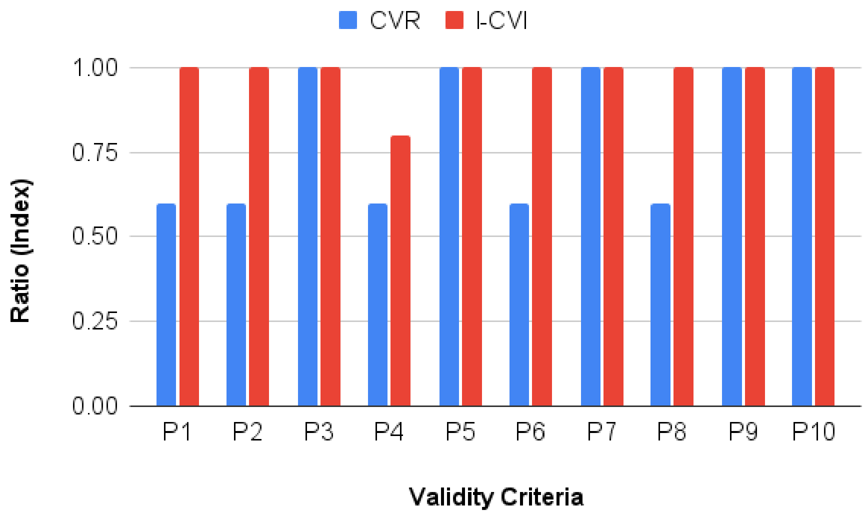


Figure 4. Content validity index (ratio) of material compilation

As demonstrated in Figure 4, all but the intervention scored high (0.6 or above) on the CVR, indicating that most of the expert panel collectively determined these criteria were essential. The high I-CVI of 0.8 or more of all the criteria indicates that most experts consider the item relevant. The S-CVI/Ave score of 0.98 and the S-CVI/UA value of 1.0 imply the instrument has excellent content validity [21], [22]. The S-VCI/Ave score within this range suggests that all variables at the article level are excellent; that is, the degree of religious moderation associated with GLOs is high. Such as P6 related to applying values of religious moderation in case studies or the impact of practices. Using research results on oil palm shell waste as activated carbon that adsorbs methylene blue dye in water, which is connected to the values of religious moderation (e.g., Judah, tawazun, tatawwur wa Iftikhar, etc.

2. Structuring

This step involves creating concept maps, formulating a macrostructure, and defining a perspective criterion. Instructional materials align with GLOs, SLOs, and LOs using conceptual mappings. The purpose of this map is to ensure that the scope of research integration results in the synthesis of activated carbon from palm coconut shell waste does not overlap with two courses, i.e., inorganic chemistry II and instrumental analysis chemistry. The approach to how research findings were incorporated in the concept map of the instrumentation analysis teaching module is shown in Figure 5. The findings of this research apply the theory of instrumental analysis—UV-Vis spectroscopy.

Macrostructure formulation constructs the base for creating diverse representations [23] that will be represented in teaching materials. Chemical material can be represented in three levels: macroscopic, submicroscopic, and symbolic (see Figure 6). Visually, the activated carbon can look the same as the carbon before activation. The submicroscopic image SEM shows the formation of the macrostructure on the carbon surface, confirming a correct activation of this carbon. Symbolically, as in real physical figures, BET test results show the pore volume difference in a carbon macrostructure before and after activation. These three representations are presented in the Inorganic Chemistry II teaching module for the subtopic carbon material characterization. So, in this section, the students can distinguish the nature of carbon before and after activation.

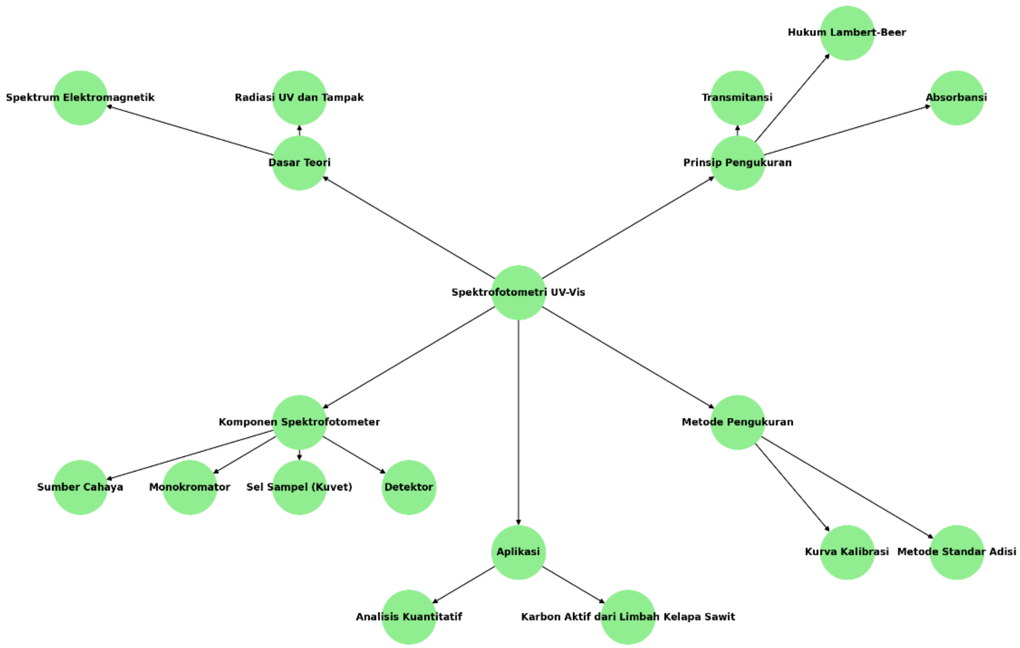
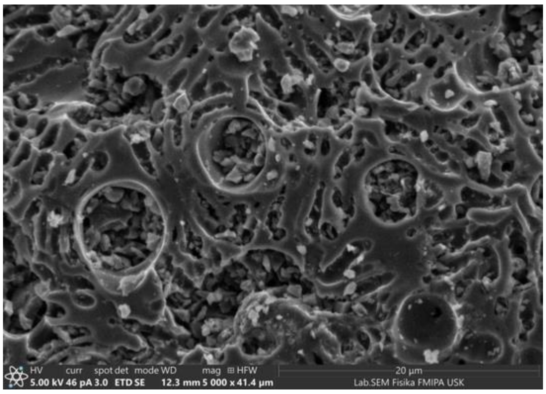
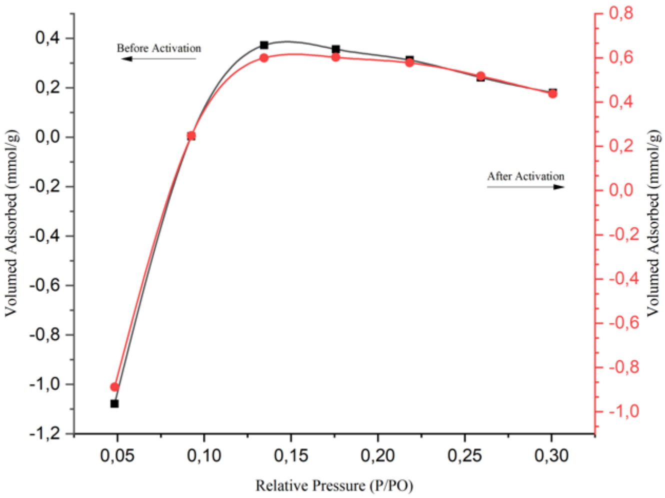


Figure 5. Concept mapping of instrumental analysis teaching module

Additional lab experimentation, such as examining SEM images of activated carbon [24], empowers students to delve into the material from the macroscopic down to the submicroscopic level. For instance, it is crucial that the material can show the carbon surface SEM image (properties of the carbon pores at the submicroscopic level) for the LOs to investigate the impact of carbon activation on the change in pore volume. The macroscopic scale phasor (Figure 6) is carbon (as granular material). To capture the properties of matter that facilitate its use, this macroscopic level needs to be complemented by submicroscopic and symbolic representations [25]. Furthermore, the BET surface area obtained from the isotherm (P/P0) against the adsorbed volume (cm^3/g) indicates the number of symbolic representations representing a change in porosity. Importantly, students are not just passive recipients of this information but active participants in the learning process. In particular, none of the SEM or BET measurements are appropriately taught during laboratory practicum. All the same, the measurement result is discussed from the perspective of carbon material characterization. Next, students learn to analyze the measurement results.



a. b.



c.

Figure 6. Multiple representations of a. macroscopic level; b. submicroscopic level; and c. symbolic level

To determine the adsorption capacity of activated carbon toward methylene blue, students add a certain amount of activated carbon to a methylene blue solution of a known concentration. The filtrate concentration was measured by UV-Vis spectrophotometry after 30 minutes of stirring. Visually, the solution color after adsorption appears more diluted than the original solution. This practical application of their learning demonstrates the real-world relevance of their studies. The adsorption process is described symbolically with concentration (in ppm), adsorption capacity (in mg/g), and removal percentage.

The assessment of the affected is further determined by self-assessment descriptions, whose descriptions become the initial steps in determining the affected assessment criteria relevant to appropriate religious moderation values. In the selection section, it was previously stated that six derivatives of GLOs attitude were used to develop the self-assessment questionnaire.

Table 5. Examples of Likert scale questions for self-assessment criteria

Derivative of GLO-attitude	Description of derivatives	Score	Types of Answer	Description of Questions
Awareness of environment	Students have a high awareness of environmental issues related to the use of oil palm shell waste as activated carbon.	1	Strongly disagree	I am deeply committed to environmental conservation and understand the importance of maintaining ecosystem balance, reducing plastic waste, addressing climate change, and supporting ecological restoration efforts. I have extensively studied oil palm shell waste as an adsorbent for water contaminants, which I want to incorporate aggressively into my conservation initiatives.
		2	Disagree	
		3	Neutral	
		4	Agree	
		5	Strongly agree	
Collaboration	Students show the capacity to collaborate effectively in groups, supporting one another and appreciating each member's contributions	1	I prefer to work independently and am less interested in team collaboration. I don't care about the contributions of other team members and want to concentrate on my work.	How effectively is your collaboration working synergistically inside a team, supporting one another and acknowledging each member's contributions?
		2	I like to work alone rather than in a team. I may participate in team conversations, but I am less active in encouraging or appreciating the contributions of other team members.	
		3	I can work well both independently and collaboratively, but I am not always active in supporting or appreciating the contributions of other team members. I understand the value of teamwork, but there is still room for growth.	
		4	I am usually involved in team collaboration and try to assist and appreciate the work of other team members. I believe teamwork is essential to success, and I endeavor to establish a positive work atmosphere for all team members.	
		5	I am an expert at working collaboratively within a team and always actively encourage and respect the efforts of all team members. I believe excellent teamwork yields better results than individuals working alone, and I endeavor to foster a pleasant collaborative environment in all projects.	

Based on Table 5, each derivative of the GLOs-attitude produces the description of an assessment of the attitude of religious moderation and its various scoring criteria. The first type provides students with the opportunity to assess their achieved attitudes, such as making judgments about the long statement (as in the first derivative) and expressing an opinion (as in the second derivative).

Although using a Likert scale in a questionnaire is supposed to induce respondents' skepticism, only helps, if statements or questions can be adjusted to the respondent's emotional stance and contextual conditions [26]. Respondents will thus respond more responsibly [27].

criterion is then split into five possible answers using the Likert scale (1–5). The Likert scale used has 2 types of answers, where the first varies from strongly disagree to agree strongly. The second type includes a description of the responses scored from one to five. It is easier for the students to evaluate their thoughts regarding their perspectives through self-evaluation instead of direct questions by using the Likert scale, with each score having a definition or description [28].

3. Characterization

After mapping the concepts with macro structures in the structuring stages, the teaching module is evaluated at the characterization stages. Three validators from different universities performed the validation. All three researchers are chemistry and science education researchers, two from Islamic religious college institutions already implementing rules that promote religious moderation in learning. However, a validator from outside PTKI was intentionally selected to allow researchers to evaluate how the module was understood by users who had first experienced moderating religion.

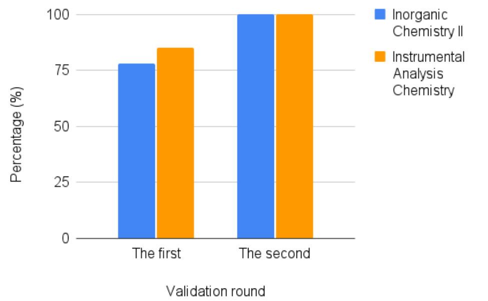


Figure 7. Validation of teaching modules

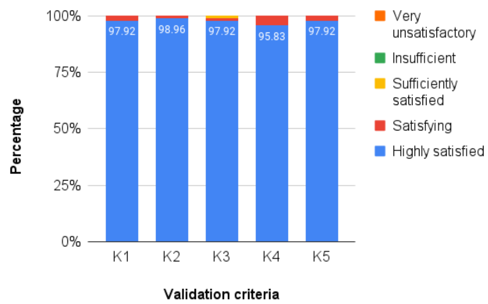


Figure 8. Validation of self-assessment sheet

As shown in Figure 7, validation is done twice; the second phase after the module is modified based on the feedback received by validators. To a large extent, valid decisions must have a basis in experience, knowledge, and intuition, as the standard of excellence is often expertise-based within the field of interest [29]. In a very valid category, both modules were given a full percentage. The validators gave numerous points of comment after validating three aspects: appearance, readability, and content. However, most validators primarily addressed the content piece. The experts advised, first, that researchers restrict study results included in the module to synthesis and characterization. On the other hand, the UV-Vis spectrophotometry data encouraging activated carbon adsorption capacity should be integrated into the instrumental analysis chemistry training module. Second, most experts recommend that any value of religious moderation recommended for the teaching module be explored and linked to research findings presented in the module.

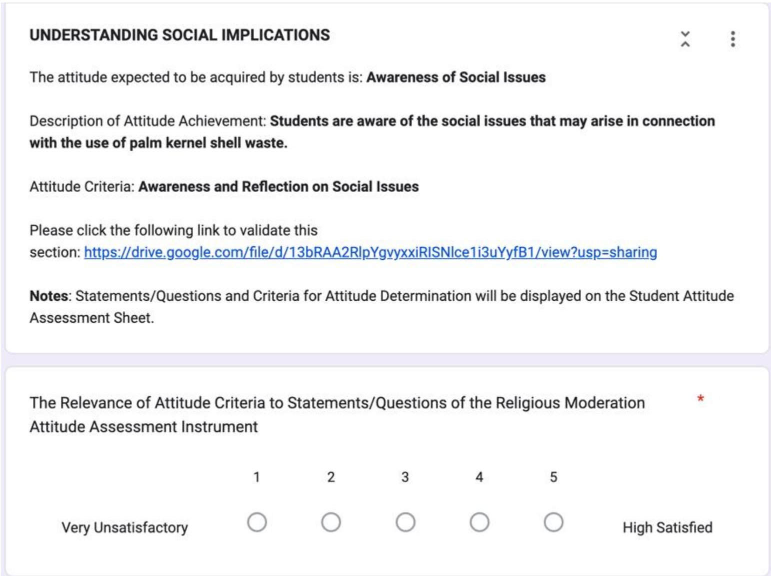


Figure 9. Design of validation instrument for students' self-assessment sheet

Additionally, 32 close-ended questions of the affective self-assessment sheet were validated. The instrument can assist in comparing students' perceptions and provide some insights into how they view their present and potential future transferrable skills [30]. Figure 8 shows that five aspects verify and validate every question (K1-K5). K1 shows how the perspective criteria align with the instrument's statement/question in assessing religious moderation values. K2 focuses on whether the behavior perspective aligns with and is consistent with the definitions of the criteria for addressing the response in determining effectiveness. Next, K3 denotes discernibility and linguistic correspondence, K4 for contextual correspondence, and K5 for reliability in emotional evaluation. K2 is highly useful for researchers because it allows the self-assessment sheet to be controlled only to expedite the full implementation of creative concepts instead of detailed execution. Reshuffling the statement/questions by K4 level does not measure more than one attitude and does not value religious moderation.

For example, as shown in Figure 9, one question/statement was shared with validators while analyzing the student attitude evaluation sheet, given the understanding of social implications. For each component, some instructions/guidelines describe the attitude that students are expected to develop, a description of the attainment of an attitude, and the criteria for attitude. All measures were above 95% in the validation results. Because of this, all criteria were rated as "very satisfied" and well deserved to move on to the next phase.

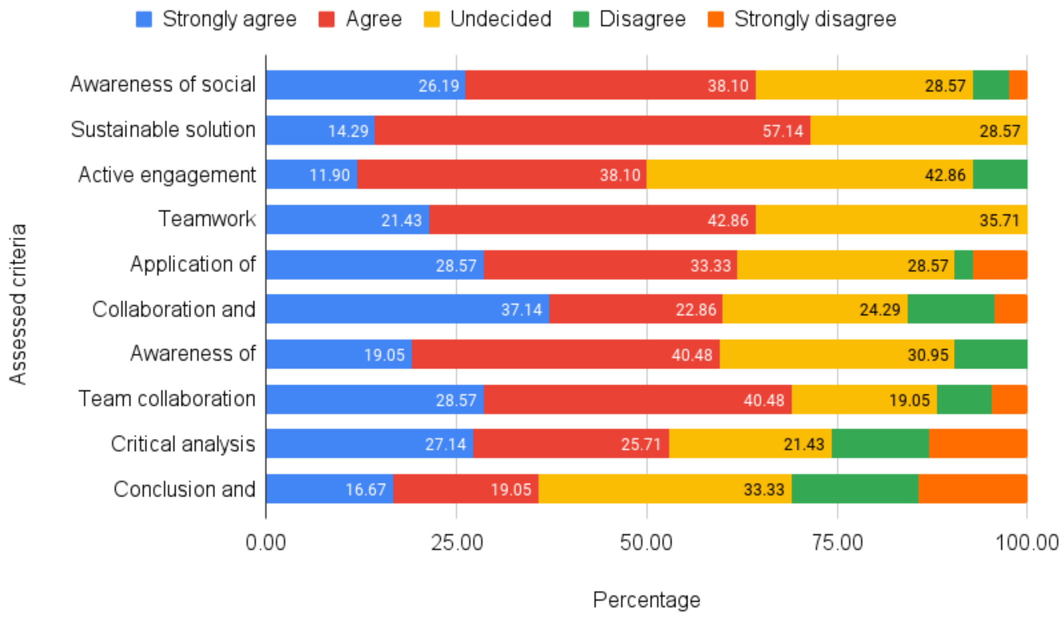
4. Didactical Reduction

The inorganic chemistry II and instrumental analysis teaching modules were employed in three meetings from each course. SLOs The number of Meetings has been adjusted. The first meeting will be for lectures about the basic knowledge of each subject. The second one will be a seminar to discuss how to solve environmental problems in groups of students using research topics that are part of the teaching module. As a result, the social impacts of the GLOs' derivatives were the only aspect of wedging religious moderation principles provided by the first meeting. Students presented and self-assessed their perspectives on religious moderation in the last meeting. The second and third meetings were more about interfering with the other parts of GLO, such as teamwork, critical thinking skills, and creative problem-solving. The results of the twenty-one students who self-assessed themselves showed indications of religious moderation, Figure 10.

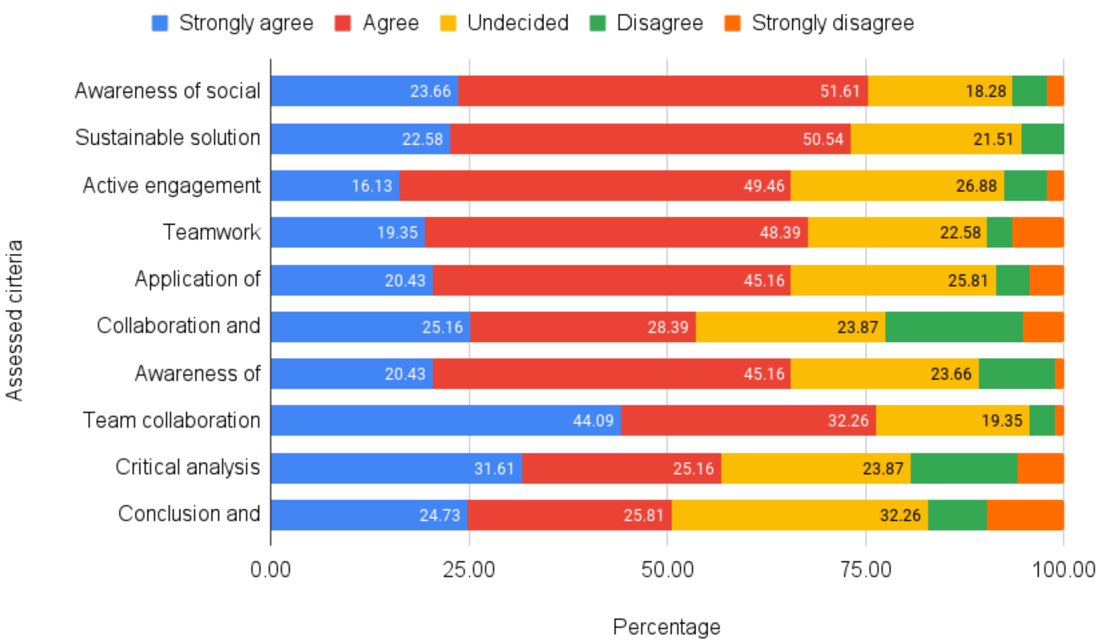
Overall, students strongly agreed with positive comments about their achievement of the religious moderation perspective, with an average of more than 50% (Figure 10) after learning modules from the previous stage. Students filled in a self-assessment estimate for each criterion, and teachers marked students' self-assessment estimates as "blindly" on the same scale [31]. The collaboration perspective had the highest achievements, ranging from 65% to 70%. The requirements of attitude in the summary and recommendations have quite low percentage, about 35% to 50%

In addition, the percentage of more than 20% fits the "disagree" and "strongly disagree" categories, showing a relatively low evaluation of the criteria of critical thinking. This further sounds the alarm over students' difficulties in merging critical thinking skills as signs of attitudes characterized by values blurred by religious moderatism. This statement also points out to researchers that this viewpoint is more challenging and needs detailed treatment to improve it, like providing students more experience in designing sustainable projects.

This involved a re-evaluation based on the values of religious moderation as relevant to each item on the self-assessment questionnaire presented to the student. Figure 9 shows that students' attitude toward religious moderation is very good, with 50-60% of each value being at a good- very good criterion. Figures 11a and b show that the performance is great when over 40% of the predictions are tolerance levels. Students must be tolerant and, at the same time, have good balance and a straightforward, firm attitude to minimize group division, especially on environmental issues. Between the two courses, the student struggled to maintain an exemplary attitude.

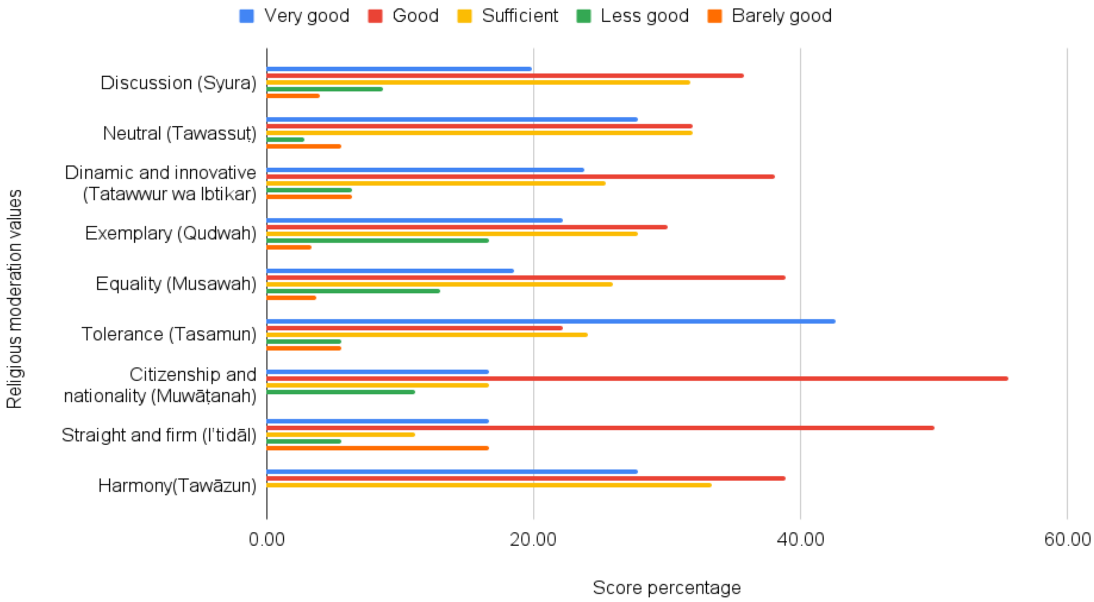


a.

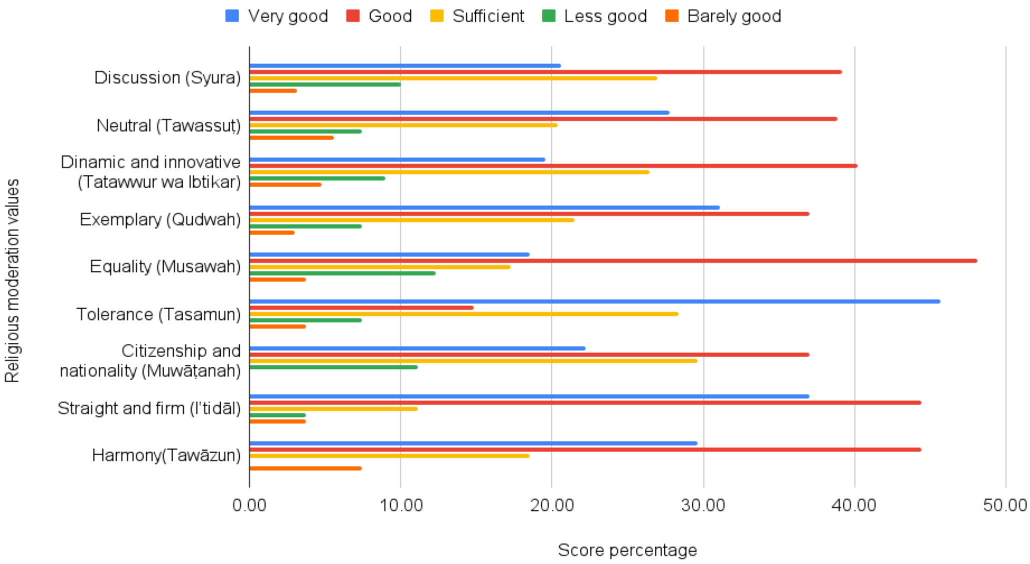


b.

Figure 10. Students' self-assessment at the session of a. Inorganic Chemistry II; b. Instrumental Analysis Chemistry



a.



b.

Figure 11. Students' self-assessment towards religious moderation values at the session of a. Inorganic Chemistry II; b. Instrumental Analysis Chemistry

An interesting discovery from The Inorganic Chemistry II course was the determination of nationality and patriotism, which exhibits good criteria greater than 50%. It indicates that students understand that, as citizens, they are responsible for responding to environmental problems. These values are very relevant to other religious moderation values, including discreteness, dynamism, and invention, as proven by the attitudes deemed important to teamwork, especially in the face of environmental challenges.

The moderation scores that still receive a quite large proportion (more than 10%) for the "less good" and "barely good" categories are representational (Judah), equality (musawah), citizenship and nationality (muwatanah), straight and firm (tidal). So this indicates that nationality seems to be considered a separate variable and does not hold much significance in the context of responsibility for environmental management — as part of chemistry education GLO. The value of equality also impacts students' inconsistency in implementing their chemical learning outcomes in reality or their attitude toward caring for living things.

Table 6. Eligibility test for learning modules and self-assessment sheet

Criteria	Average Score
Compatibility with curriculum	4.8
Utility	5.0
Clarity of learning materials and self-assessment sheet	4.8
Comprehensiveness of learning materials and self-assessment criteria	4.6
Relevance	5.0
Quality of visual and design	5.0
Total average	4.9

After that is the didactic reduction phase with an eligibility test against the learning module and self-assessment sheet, which refers to religious moderation values. Five experts assessed the eligibility test based on six criteria (Table 6).

The average of 4.8 in Table 6 also indicates that the input information and the measured religious moderation orientation are fully consistent with the curriculum. An average utility score of 5.0 shows that the details of the material are highly beneficial for students, and the self-assessment instrument is a measure of holding a religious moderation view. It is not difficult to call 4.8 a means of very transparent information and a simple question to answer in self-evaluation. The learning materials and self-assessment criteria received an average score of 4.6, suggesting that the material is nearly complete with minimal opportunities for improvement. Relevance criteria: A mean of 5.0 indicates that attitudes related to research and religious moderation are already very important for the competition and access students should have as graduates. The final criterion was the quality of visual and design, scoring 5.0, which provided evidence of high visual and design quality in teaching materials and other good self-assessment instruments.

CONCLUSION

Implementing the teaching module based on laboratory research stages, especially using palm shell waste into activated carbon for the adsorption of methylene blue dye in water, positively affects the didactical reduction stage. Evaluation results of religious moderation show that more than fifty percent of students agree with the religious moderation equality taught in Inorganic Chemistry II and Instrumental Analysis Chemistry lessons. For certain types of student responses, the results were somewhat more consistent, reflecting a lack of communication and collaboration, ethics in learning, and tolerance, all areas for additional educational growth.

Based on the self-evaluation results, 70% of students at least agreed with the application of religious moderation values although they had differences based on the score of criteria. The average eligibility test score was 4.9 out of 5.0, showing the very high validity of the module, its correspondence to the curriculum, and teaching quality.

This module is aligned with national curriculum standards, supporting a values-based approach to teaching chemistry. The results have broader implications for curriculum design, teacher preparation, and STEM education that embraces moral qualities in developing a more holistic and character-focused curriculum.

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