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Integrating Environmental Stewardship and Christian Values in Chemistry: Module Development for Junior High School Special Science Learners

CAJUCOM, Elsa; MARZAN, Joey-Nell T.

(1) 0000-0001-9121-866X; Saint Louis University. Baguio City, Philippines. 2245532@slu.edu.ph
(2) 0009-0002-2579-1841; Saint Louis University. Baguio City, Philippines. jntmarzan@slu.edu.ph

ABSTRACT

This study developed and validated Environment and Christian Values-Oriented Chemistry Modules (ECCM) to enrich science instruction for Junior High School Special Science Program learners. Anchored on the ADDIE instructional design model, the modules integrated key chemistry concepts with environmental stewardship and Christian values, promoting holistic learning that combines cognitive growth with ethical responsibility. A panel of five chemistry experts evaluated the ECCM using the Department of Education's Quality Assurance Tool and a functionality assessment instrument. Findings revealed consistently "Very Satisfactory" ratings across all dimensions of evaluation, with mean scores ranging from 3.8 to 4.0, affirming the modules' strong acceptability, usability, and accuracy. These results indicate that the ECCM are scientifically sound, developmentally appropriate, and pedagogically effective in fostering higher-order thinking, contextual understanding, and values integration. By embedding real-world environmental issues alongside biblical teachings, the ECCM created meaningful opportunities for learners to connect chemistry to daily life, sustainability, and moral reflection. This approach addresses gaps in traditional, content-heavy chemistry instruction and responds to the urgent call for contextualized, values-based science education in the Philippines. The study offers a novel framework for integrating environmental principles and Christian values into chemistry education, offering a replicable model for faith-based and values-driven instruction that can be expanded across other science disciplines.

RESUMO

Este estudo desenvolveu e validou Módulos de Química Orientados para o Meio Ambiente e Valores Cristãos (ECCM) para enriquecer o ensino de ciências para alunos do Programa Especial de Ciências do Ensino Fundamental. Ancorados no modelo de design instrucional ADDIE, os módulos integraram conceitos-chave de química com a gestão ambiental e valores cristãos, promovendo uma aprendizagem holística que combina crescimento cognitivo com responsabilidade ética. Um painel de cinco especialistas em química avaliou o ECCM usando a Ferramenta de Garantia de Qualidade do Departamento de Educação e um instrumento de avaliação de funcionalidade. Os resultados revelaram classificações consistentemente "Muito Satisfatório" em todas as dimensões da avaliação, com pontuações médias variando de 3,8 a 4,0, confirmando a forte aceitabilidade, usabilidade e precisão dos módulos. Esses resultados indicam que os ECCM são cientificamente sólidos, adequados ao desenvolvimento e pedagogicamente eficazes no fomento do pensamento de ordem superior, da compreensão contextual e da integração de valores. Ao incorporar questões ambientais do mundo real aos ensinamentos bíblicos, o ECCM criou oportunidades significativas para os alunos conectarem a química à vida cotidiana, à sustentabilidade e à reflexão moral. Esta abordagem aborda lacunas no ensino tradicional de química, com conteúdo rico, e responde ao apelo urgente por uma educação científica contextualizada e baseada em valores nas Filipinas. O estudo oferece uma nova estrutura para integrar princípios ambientais e valores cristãos ao ensino de química, oferecendo um modelo replicável para um ensino baseado na fé e em valores, que pode ser expandido para outras disciplinas científicas.

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Keywords:
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Comentado [o11]: This was comprehensively discussed. However, it is overly dense and procedural, with certain phrases more appropriate for the Methodology section than the abstract. For instance, the listing of instructional principles ("Everything must go somewhere," etc.) and Christian values, while important to the paper, clutters the flow and would be better summarized rather than enumerated in full. The same applies to the breakdown of evaluation dimensions (e.g., "content validity, format, presentation, accuracy, functionality"), which, while accurate, could be streamlined or collapsed under broader descriptors like "acceptability and usability" for conciseness. Additionally, there is a lack of numerical or statistical data that might demonstrate the magnitude of results (e.g., mean scores, descriptive ratings). Including even one or two quantitative indicators would strengthen the abstract's empirical value.
Another issue is the absence of clear articulation of the study's contribution or novelty. While the integration of environmental and Christian values is implied as significant, this contribution could be more directly framed in the abstract's final lines (e.g., "This study offers a novel values-integrated framework for Chemistry education in faith-based contexts").
Lastly, the concluding sentence could be improved by transforming it from a suggestion ("The study suggests…") into a more assertive implication statement, which reflects confidence in the study's potential applications and next steps.

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Introduction

Science education is essential in equipping learners to respond to the pressing challenges of the 21st century, such as climate change, environmental degradation, and public health issues. Globally, education systems are called not only to develop cognitive skills but also to instill values and dispositions that promote responsible citizenship and sustainable living (Chowdhury et al., 2020). In the Philippines, this concern is particularly urgent. Results from international assessments like PISA 2022 ranked the country 78th out of 80 in science, with more than 77% of Filipino students performing at low levels (OECD, 2023). National data, such as the National Achievement Test (NAT), show similar outcomes, reflecting weaknesses in scientific reasoning, conceptual understanding, and problem-solving (Behiga, 2022). These learning gaps pose risks to the nation's ability to achieve Sustainable Development Goal (SDG) #4 on quality education and SDG #13 on climate action.

Among the sciences, chemistry stands out as a discipline where students face significant struggles. The K–12 generalist teaching model has reduced subject-specific expertise, while limited laboratory facilities hinder opportunities for hands-on learning (Orbe et al., 2018; Mecampong, 2017). Many teachers still rely heavily on traditional lectures, resulting in weak engagement, poor retention, and difficulty connecting chemistry concepts to real-world issues (Komathy et al., 2021). This often leaves students viewing chemistry as abstract and irrelevant to daily life, reducing motivation and hindering deeper understanding. Addressing this challenge requires approaches that are not only rigorous but also contextual, values-oriented, and personally meaningful.

One promising approach is the integration of environmental education (EE) into chemistry instruction. Environmental principles such as resource limitations, interdependence, and ecological balance provide meaningful anchors that link scientific concepts to sustainable practices (Galang et al., 2003). Research showed that embedding EE in chemistry enhances students' critical thinking, problem-solving, and conservation-oriented behavior (Sudarmin et al., 2018; Rahmawati et al., 2023). In the Philippine context, Malaluan et al. (2023) emphasized that integrating environmental principles into science curricula fosters both awareness and action. This approach shifts chemistry from abstract theories to socially relevant knowledge that prepares learners to act as responsible stewards of the environment.

Alongside environmental literacy, values formation is a crucial component of holistic education, particularly in faith-based schools. Religion is recognized in the Philippine education system as a foundation for moral development, with Catholic education highlighting stewardship of creation, ethical responsibility, and service to others (Francis, 2015). However, much of the existing research on values integration in chemistry comes from Islamic contexts (Kumala et al., 2022; Putri et al., 2023; Mawarnis et al., 2023), where the incorporation of

Comentado [o12]: Consider ending the introduction with a clear statement of the research gap and research objectives (currently this is placed in a later paragraph).

Comentado [o13]: The introduction is impressively detailed and well-structured. However, a few areas still warrant refinement. First, brevity and thematic focus could be improved. The introduction is excessively long (over 3,000 words), which may overwhelm readers and dilute the key messages. Several paragraphs reiterate similar points, e.g., the importance of modular instruction, the alignment with SDGs, and the value of contextualized materials. A tighter synthesis and clearer section transitions would help maintain coherence and impact. Second, the theoretical foundation for integrating Christian values remains more descriptive than analytical. While religious texts and examples are provided, educational theories of values formation (e.g., Lickona's character education, Kohlberg's moral development) are missing. Including such frameworks would elevate the intellectual weight of the study's moral dimension. Lastly, research gaps could be highlighted more clearly and earlier. While the gap is addressed toward the end, a more assertive statement, e.g., "To date, no study in the Philippine setting has developed and validated chemistry modules that integrate both environmental education and Christian values…",would clarify the study's originality.

Qur'anic verses has been shown to deepen learning engagement. These findings demonstrate that science and faith can complement each other, enriching both cognitive and affective learning.

Grounding Christian integration in educational theory strengthens its relevance.) character education model emphasizes moral knowing, feeling, and action, which align well with chemistry lessons that encourage reflection and application. Kohlberg's (1976) stages of moral development show how learners move from rule-based reasoning toward principled ethical judgment, which can be nurtured through inquiry-based tasks embedded with values. Similarly, Dewey's experiential learning framework highlights that values are best developed when learners encounter real-world problems and reflect on their consequences. Applying these theories positions Christian integration not just as descriptive practice but as a structured educational strategy for moral development.

Modular instruction has also gained importance in science education, particularly in resource-limited and disrupted learning environments. Modules encourage independent, inquiry-driven, and contextualized learning, enabling students to engage with complex concepts at their own pace while applying knowledge to practice (Setiabudi et al., 2019; Bonitez, 2021). Both local and international research confirms that well-designed chemistry modules enhance student performance, motivation, and critical thinking (Medina & Baraquia, 2023; Ee et al., 2022). Digital modules, such as those developed through platforms like NODMA, further demonstrate the potential of technology-enhanced learning (Mamintal, 2024).

The ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—offers a structured framework for creating effective instructional materials (Yeh & Tseng, 2019). Its iterative process ensures that modules respond to learner needs, align with curriculum standards, and adapt to diverse learning contexts. For chemistry education, ADDIE enables careful sequencing of concepts, the integration of cross-cutting values, and the rigorous validation of materials before classroom use.

Although studies on modular instruction, environmental integration, and values education are increasing, a clear gap remains. In the Philippine setting, no prior research has developed and validated chemistry modules that deliberately integrate both environmental education and Christian values for Junior High School Special Science Program learners. Earlier works have focused either on sustainability or on religious values separately, but not on their integration within chemistry instruction. Addressing this gap is crucial, as combining these approaches can strengthen both the cognitive and moral dimensions of learning, empowering students to think critically and act responsibly.

This study responded by developing and validating Environment and Christian Values-Oriented Chemistry Modules (ECCM) using the ADDIE model. Specifically, it aimed to: (1)

explore the feasibility of integrating environmental principles and Christian values into chemistry instruction, (2) determine the instructional characteristics of the ECCM, and (3) validate the modules in terms of acceptability and usability. By filling this research gap, the study contributes an innovative framework for holistic chemistry education, one that integrates scientific knowledge with ethical and spiritual development, offering a replicable model for values-driven instruction in the Philippines and beyond.

Methodology

This study used a Research and Development (R&D) design guided by the ADDIE instructional model—Analysis, Design, Development, Implementation, and Evaluation—to develop and validate the Environment and Christian Values-Oriented Chemistry Modules (ECCM) for Junior High School Special Science Program (SSP) learners. It was carried out during School Year 2024–2025 at Saint Mary's University Junior High School, a private CICM Catholic school in the Philippines. The research focused on Phase I of the R&D process, which centered on expert validation. While this phase ensured a thorough initial evaluation, it did not include pilot classroom testing, which is recognized as a limitation. Future stages of the study will address this by implementing the ECCM in real classroom settings and collecting student feedback to improve its applicability and generalizability. This design ensured a systematic and iterative process to produce quality instructional materials aligned with curricular and values-based learning outcomes (Allonar et al., 2024).

Purposive sampling was utilized in the selection of five expert evaluators for the developed ECCM. This non-probability sampling technique was deemed appropriate as it ensured the inclusion of individuals possessing the specialized expertise necessary to provide credible and rigorous evaluations (Etikan et al., 2016). The panel of experts comprised the following: (1) a licensed professional teacher from the Department of Education holding a Master of Arts in Teaching (MAT) in Chemistry; (2) a science research specialist from the Department of Science and Technology (DOST), who is likewise a licensed professional teacher and registered chemical technician with a MAT in Chemistry; (3) a chemistry instructor from a higher education institution, also a licensed teacher with a MAT in Chemistry; (4) a licensed chemist with a MAT in Mathematics from the same institution; and (5) a junior high school teacher under the K–12 program, a licensed professional teacher with a MAT in Physics. Collectively, the panel's interdisciplinary qualifications in science education, chemistry, and pedagogy provided a breadth of perspectives that were both diverse and complementary, thereby ensuring that the ECCM was evaluated in terms of scientific accuracy, pedagogical soundness, and contextual relevance.

Two instruments were used in evaluating the ECCM. The first was the Quality Assurance Tool for New Print-Developed Learning Resources, developed by the Department of Education (DepEd) under the Learning Resource Management and Development System

Comentado [o14]: The methodology section demonstrates a robust and well-structured R&D framework grounded in the ADDIE instructional design model, but
- Clarify the number of evaluators consistently; some parts say "five," others say "at least three."
- Acknowledge the limitations of non-inclusion of pilot classroom testing more explicitly here, and not just in the conclusion.
- Add at least a brief comment on the validity/reliability of the Functionality Tool, or cite past studies that have used it successfully.
- Consider referencing potential future implementation or triangulation strategies (e.g., student interviews or FGDs) to address end-user perspectives.

Comentado [o15]: Although expert validation is appropriate for R&D Phase I, the lack of implementation or pilot test limits generalizability. This limitation should be acknowledged more explicitly.

Comentado [o16]: No mention of ethical procedures

(LRMDS). It covers five domains—content validity, format, presentation and organization, accuracy and up-to-datedness, and overall acceptability—across 28 indicators rated on a four-point Likert scale (1.00–1.49 = Not Satisfactory; 3.50–4.00 = Very Satisfactory). Although explicit reliability coefficients are not cited in DepEd documentation, the tool has been consistently applied in national validation processes, lending it content validity and practical reliability.

To complement this, the study also employed a Functionality Assessment Tool, developed by Butron (2018) and later adapted by Acanto (2024) for evaluating instructional materials in science education. This tool measures five key criteria focused on usability and adaptability: alignment with learners' abilities, ease of use in different learning settings, guidance in building conceptual understanding, flexibility for varying group sizes and timeframes, and support for performance-based tasks. It employs a five-point Likert scale (1 = lowest, 5 = highest). Previous studies have applied this tool, confirming its consistency and usefulness in validating instructional materials.

Both instruments were administered electronically to a panel of five purposively selected subject experts. These evaluators reviewed the ECCM modules and completed the instruments independently, providing both quantitative scores and qualitative insights, and combining a validated national tool and a context-specific functionality assessment allowed for a well-rounded evaluation of the instructional material's academic integrity, usability, and relevance to the intended learners.

This study employed the ADDIE Model—a systematic instructional design framework composed of five phases: Analyze, Design, Develop, Implement, and Evaluate—to guide the development and validation of the Environment and Christian Values-Oriented Chemistry Modules (ECCM) for Junior High School Special Science Program Learners. Each phase of the model was mapped to specific research objectives and implementation stages, ensuring a structured and research-based approach to instructional material development.

Analyze. In the Analyze phase, the study addressed Research Objective 1: To identify the feasibility of integrating environmental principles and Christian values in teaching chemistry to junior high school Special Science Program learners. This was carried out through Stage 1: Unpacking the approved syllabus or subject guide, which involved reviewing the existing Grade 7-10 Chemistry curriculum to determine potential entry points for integrating environmental education and Christian values. This process ensured that the ECCM was aligned with national curriculum standards while allowing for contextual enrichment rooted in ethics and environmental responsibility.

Design and Develop.

Following the analysis, the Design and Development phases were guided by Research Objective 2: To determine the instructional characteristics of the ECCM. The module's

instructional framework was created in Stage 2: Design of the AIMD Plan (Aligned Instructional Material Design Plan). This included formulating learning outcomes, content sequencing, integrating environmental and values-based themes, learner activities, and assessment methods. Stage 3: Implementing the AIMD Plan involved developing the ECCM based on the approved instructional design, ensuring coherence between content, values integration, and pedagogical strategies.

Implement and Evaluate

The Implement and Evaluate phases corresponded to Research Objective 3: To subject the ECCM to expert evaluation, acceptability, and functionality testing. In Stage 4: Implementation through content validation and acceptability assessment, the completed ECCM was evaluated by five (5) subject matter experts for content accuracy, instructional quality, and alignment with curriculum standards. Simultaneously, the module's acceptability was assessed by at least three potential users (teachers or educators), who evaluated the material's usability, relevance, and clarity in a classroom context. Both groups used structured evaluation tools—including the DepEd Quality Assurance Tool and a functionality checklist based on Butron (2018)—to provide quantitative ratings and qualitative feedback. All five experts independently reviewed the ECCM and submitted both quantitative ratings and qualitative feedback.

Finally, in Stage 5: Analysis of the implementation results and revision, the data gathered from expert validators was analyzed to identify strengths and areas for improvement.

Because this phase focused solely on expert validation, results are limited to expert perspectives. Classroom implementation, student focus group discussions (FGDs), and surveys will be conducted in subsequent phases to triangulate results and incorporate learner voices.

The study complied with institutional ethical standards. Informed consent was obtained from all evaluators, participation was voluntary, and confidentiality of responses was ensured. No student participants were involved in this phase, minimizing risks.

Results and Discussion

The Feasibility of Integrating Environmental Principles and Christian Values in Teaching Chemistry

To examine the feasibility of integrating environmental principles and Christian values into chemistry instruction for junior high school learners, the elective subject *Selected Topics in Chemistry* was carefully reviewed. The process involved unpacking the prescribed learning competencies and aligning them with relevant environmental themes and Christian values. The results of this alignment are presented in the Aligned Instructional Material Design (AIMD) Plan, shown in Table 1.

Comentado [o17]: This section is generally comprehensive, well-organized, and intellectually coherent. However,
- deepen the discussion beyond descriptive confirmation. Ask not just *what* was found, but *why* it matters pedagogically or theoretically,
- bring in critical voices, what challenges might arise from merging theological and scientific narratives in public or pluralistic contexts?,
- acknowledge the absence of student-level data and propose how future work might triangulate findings using classroom trials or learner feedback,
- reframe parts of the validation narrative to focus less on affirmation and more on what these scores *mean* for values-based module design,
- strengthen the "discussion" elements, less paraphrasing of table content, more reflection on the implications for educational practice and research, and
- clarify the setting and nature of the expert evaluators, their religious affiliation or institutional background may have influenced acceptability ratings.

Comentado [o18]: Expand briefly on *how* the ECCM could be adapted to other subjects (e.g., Biology, Physics).

Table 1 outlines the Aligned Instructional Material Design (AIMD) Plan, which illustrates how environmental principles and Christian values can be woven into core chemistry topics such as Solutions, Acids and Bases, Chemical Equilibrium, and Redox Reactions. By mapping competencies, principles, and scriptural values, the plan shows that chemistry lessons can move beyond technical content and become enriched with ethical and spiritual perspectives.

Table 1

Aligned Instructional Material Design (AIMD) Plan

Content	**Learning Objectives**	**Subject Integration**		**Remarks**
		Environmental Principle	**Christian Values**	
Q1: SOLUTIONS	1.Explain solution properties, energy changes in dissolving, and factors affecting solubility; 2.Express solution concentration using mass per unit volume, % v/v, % m/m, molarity, molality, and mole fraction; 3. Distinguish and apply the properties of colligative properties of solutions.	Everything must go somewhere	Stewardship (Genesis 2:15))	Learners will propose sustainable practices in handling and disposing of solutions through a group presentation. They will also submit an individual reflection connecting the chemistry of solutions to the principle of stewardship based on Genesis 2:15.
Q2: ACIDS and BASES	4.distinguish the theories of acids and bases; 5.explain pH: acidity and basicity of solutions; 6.calculate the pH of solution given its hydrogen ion concentration or hydroxide ion concentration; 7.discuss practical applications of acids and bases.	Nature Knows Best	Balance and Discernment (Ecclesiastes 3:1)	Learners will create a real-life case analysis or infographic showing the role of acids and bases in environmental or household settings. They will reflect on responsible use and disposal, highlighting stewardship and respect for creation based on Genesis 2:15.
Q3: CHEMICAL EQUILIBRIUM	8.Analyze chemical equilibrium by explaining reaction mechanisms; 9.Apply Le Chatelier's principle; 10.Write equilibrium expressions and predict product formation using Kc.	Ours is a Finite Earth	Faith and Trust in God's Plan (Romans 8:28)	Learners will apply Le Chatelier's Principle and equilibrium expressions to real-world chemical processes, linking equilibrium to Earth's finite resources and sustainability. They will also reflect on how faith in God's plan (Romans 8:28) deepens their understanding of balance and harmony in nature.
Q4: REDOX	11. differentiate reduction and	Everything Changes	Restoration and	Learners will identify and differentiate redox reactions,

Content	Learning Objectives	Subject Integration		Remarks
		Environmental Principle	Christian Values	
REACTIONS	oxidation; reducing agent and oxidizing agent; 12. identify reactions as redox and nonredox; 13. writes and balances half-reactions.		Renewal (2 Corinthians 5:17)	balance half-reactions, and relate them to environmental processes like corrosion, combustion, and water treatment. A reflection task links chemical change to personal and spiritual renewal, inspired by 2 Corinthians 5:17.

The pedagogical significance of this approach lies in its ability to transform chemistry from abstract information into a medium for moral reflection and environmental responsibility. For instance, linking the principle "Everything must go somewhere" with the Christian value of Stewardship (Genesis 2:15) not only helps students understand solubility but also inspires them to apply that knowledge toward sustainable chemical practices. Likewise, pairing Chemical Equilibrium with the principle "Ours is a Finite Earth" and the Christian theme of Faith and Trust in God's Plan (Romans 8:28) invites learners to reflect on balance in both scientific and spiritual terms, encouraging critical thinking and ethical discernment. Such connections embody Lickona's (1991) framework of character education—developing moral knowing, moral feeling, and moral action through meaningful, contextualized science learning.

At the same time, challenges are unavoidable. The integration of Christian values fits naturally within Catholic schools, where faith formation is central, but it may face resistance in secular or pluralistic contexts. In such settings, the theological framing may need to be reframed by emphasizing universal ethical themes like responsibility, justice, and sustainability. This reflects the broader debate on blending religious and scientific perspectives in education (Rahmawati et al., 2023).

The feasibility shown in Table 1 aligns with previous studies. Malaluan et al. (2023) emphasized the need to embed environmental issues in science learning, while Sudarmin et al. (2018) and Rahmawati et al. (2023) demonstrated how integrating green chemistry and socio-scientific issues can foster conservation behaviors and critical thinking. The present study builds on these contributions by adding a Christian values dimension, offering a unique model for faith-based science education in the Philippine setting.

Importantly, the ECCM framework is adaptable beyond chemistry. In Biology, stewardship and renewal can be tied to ecology, genetics, and health topics. In Physics, themes of energy and sustainability can be paired with ethical discussions on consumption and fairness. In Earth Science, hazard preparedness and climate change can be taught alongside responsibility and care for creation. This makes the ECCM a versatile model for integrating values across science disciplines.

Hence, Table 1 demonstrates both the feasibility and significance of integrating environmental principles and Christian values into chemistry instruction. It provides a holistic framework that strengthens scientific literacy while also fostering moral and ethical growth. While further work is needed—particularly in gathering student-level data and addressing contextual challenges—the ECCM marks an important step toward values-driven, contextualized science education in the Philippines.

The Instructional Characteristics of the Environment and Christian Values-Oriented Chemistry Modules (ECCM)

Comentado [o19]: The paper lacks one of the most essential features of instructional material development research—visible representation of the developed product. I strongly recommend revision to include visual samples of the ECCM to improve credibility, clarity, and communicative power. Without them, the study risks being perceived as conceptually strong but empirically hollow in terms of design output.

Table 2 presents the instructional characteristics of the Environment and Christian Values-Oriented Chemistry Modules (ECCM), showing how each unit meaningfully connects chemistry concepts with environmental principles and Christian values. Beyond their descriptive features, these modules matter because they embody a pedagogical shift: chemistry is no longer taught solely as abstract knowledge, but as an avenue for moral reasoning, ethical decision-making, and environmental stewardship.

Table 2

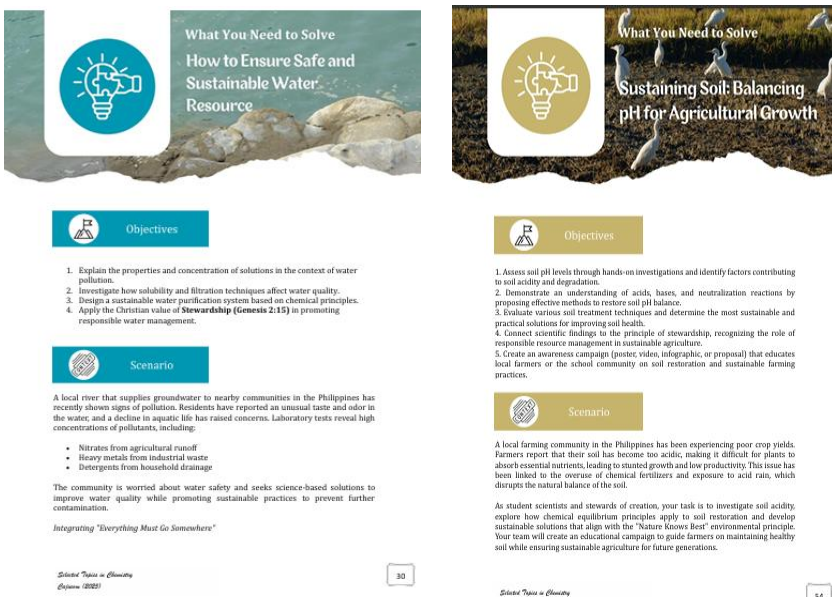
The Environment and Christian Values-Oriented Chemistry Modules (ECCM)

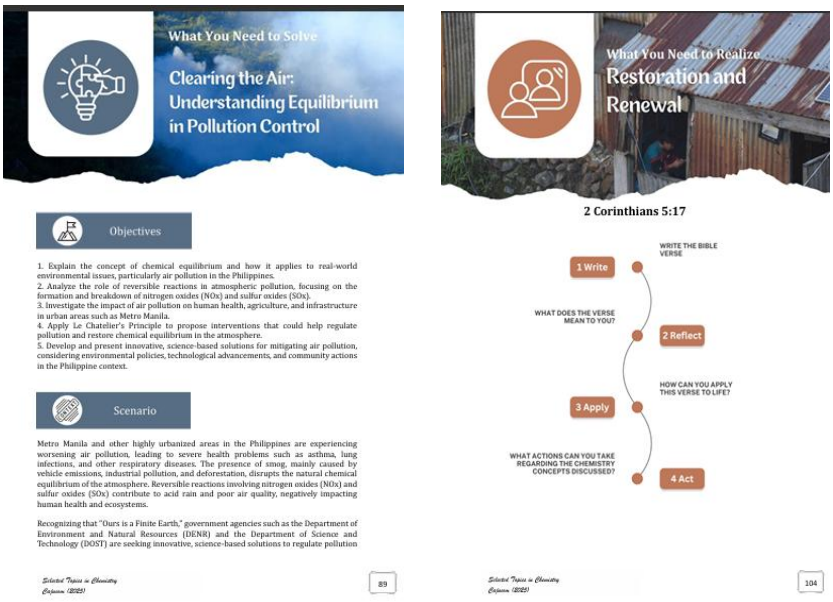
Module Title	Brief Description
Chemists have all the Solutions	This module examines solution properties, concentrations, and real-world applications through activities like water pollution analysis and filtration. Students explore the impact of solubility on water quality and apply the environmental principle "Everything Must Go Somewhere" to assess human influence on aquatic systems. Grounded in the Christian value of Stewardship (Genesis 2:15), the module fosters responsibility for sustainable chemical use and waste management.
Acids and Bases: The pH Power Behind Chemistry	This module examines the role of acids, bases, and pH in water quality, guided by the environmental principle "Nature Knows Best" and the Christian value of stewardship (Genesis 2:15). Students investigate the effects of acidic pollutants and apply neutralization as a remedial strategy. Through problem-based learning and a simulated water pollution scenario, they propose restoration solutions. The module culminates in a student-led awareness campaign—via poster, infographic, or video—integrating scientific insight with biblical values (Psalm 51:10; Ecclesiastes 3:1) to promote water conservation and responsible environmental stewardship.
Chemical Equilibrium: Balancing Reactions, Sustaining Life	This module examines chemical equilibrium in natural and industrial contexts, framed by the environmental principle "Ours is a Finite Earth." Students explore local issues such as soil degradation, agricultural sustainability, and air quality, applying Le Chatelier's Principle to predict

	and influence equilibrium shifts. Integrating Christian values—Stewardship (Genesis 2:15), Wisdom (James 1:5), and Faith (Romans 8:28)—the module fosters responsible decision-making in resource use and pollution control. A culminating activity tasks students with analyzing local farming practices and proposing faith-informed strategies for sustainable productivity, positioning equilibrium as both a scientific and moral principle for balanced living.
Redox Reactions: The Chemistry of Giving and Taking	This module explores oxidation-reduction (redox) reactions in natural and industrial contexts, emphasizing electron transfer, half-reactions, and real-world applications such as corrosion, batteries, and environmental restoration. Anchored in the environmental principle "Nature Knows Best" and Christian values—Restoration (2 Corinthians 5:17), Cooperation (Galatians 6:2), and Transformation (Matthew 5:16)—it highlights cycles of renewal in both science and faith. As a culminating task, students examine a local redox-related issue and propose faith-driven, science-based solutions for sustainability.

Figure 1.

Sample pages from the Developed ECCM





As shown in Table 2 and illustrated in Figure 3, the ECCM integrates chemistry concepts with environmental principles and Christian values through carefully designed instructional materials. The modules highlight specific values in each topic—for example, stewardship in Solutions, balance and discernment in Acids and Bases, responsibility in Chemical Equilibrium, and renewal in Redox Reactions. This approach aligns with Lickona's (1991) framework of character education, which emphasizes moral knowing, moral feeling, and moral action alongside intellectual development. By framing chemistry within real-world issues such as water pollution, soil degradation, and energy use, the modules also reflect Rahmawati et al. (2023), who argued that socio-scientific issues promote critical thinking and ethical awareness. The inclusion of active learning tasks—such as case analyses, awareness campaigns, and sustainability proposals—makes learning experiential, echoing Dewey's principle that education must connect knowledge with lived contexts.

Still, challenges must be acknowledged. The theological framing of the modules fits naturally within Catholic institutions but may not transfer seamlessly into public or pluralistic schools. While environmental stewardship is broadly universal, explicitly Christian references (e.g., Genesis 2:15, Romans 8:28) could limit wider adoption. Contextual adaptation—such as presenting values in secular ethical terms—would therefore be necessary for broader use. This underscores the importance of further research on how learners interpret and reconcile the intersection of scientific and religious perspectives.

The ECCM also makes a novel contribution. Previous validated modules in the Philippines (e.g., Medina & Baraquia, 2023; Acanto, 2024) emphasized modularity, usability,

or contextualization, but none systematically connected Christian values with environmental education in chemistry. By doing so, ECCM introduces a distinct framework for values-driven science teaching. Its structure even demonstrates potential for cross-disciplinary application: in Biology, stewardship and renewal could frame discussions on ecology, genetics, and health; in Physics, responsibility and justice could guide lessons on energy use and sustainability; and in Earth Science, hazard preparedness and climate action could be interwoven with faith-based ethics of care for creation.

Thus, the instructional characteristics highlighted in Table 2 show that the ECCM is more than just a set of modules—it is a pedagogical model that blends scientific literacy with moral and spiritual growth. While expert evaluations confirm its acceptability, further studies must examine its effectiveness with students through classroom trials, group discussions, and surveys. This would help validate not only its content but also its potential to develop learners who are scientifically competent, environmentally responsible, and morally grounded.

Table 3, on the other hand, details the key instructional components embedded in each module.

Table 3

Instructional Characteristics of the Environment and Christian Values-Oriented Chemistry Modules

Module Components	Detailed Description
1. What You Need to Know	This component presents the essential chemistry concepts, principles, and skills learners must acquire in each module. It emphasizes the development of scientific understanding by helping students engage with foundational knowledge in chemistry, supporting both conceptual learning and practical application in various real-life contexts.
2. What You Need to Realize	This section fosters personal reflection and ethical insight by connecting chemistry content with Christian values. It encourages learners to recognize scientific knowledge's moral and spiritual significance, cultivating a more profound sense of purpose, responsibility, and stewardship in caring for God's creation through the lens of chemistry.
3. What You Need to Do	This part translates chemistry learning into meaningful action by guiding students through real-world, inquiry-driven tasks. It challenges students to address relevant environmental or societal issues through a chemistry-based, problem-solving approach. Learners strengthen their critical thinking, collaboration, and innovation skills by conducting investigations, proposing solutions, and presenting outcomes.

Figure 2.

Sample module components from the Developed ECCM

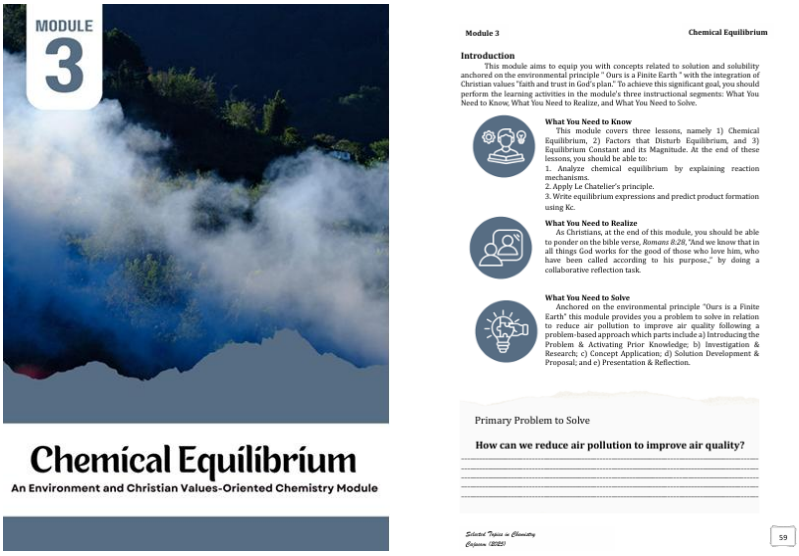


Table 3 and Figure 2 present the key instructional components of the Environment and Christian Values-Oriented Chemistry Modules (ECCM), each carefully designed to support holistic learning. *What You Need to Know* introduces essential chemistry concepts within real-life contexts, reflecting constructivist theory by ensuring that foundational knowledge is built meaningfully rather than in isolation. *What You Need to Realize* encourages ethical and spiritual reflection, enabling learners to connect scientific understanding with Christian values, which aligns with holistic and values-based education frameworks that integrate cognitive, affective, and moral development. *What You Need to Do* engages students in inquiry-based, real-world tasks that cultivate critical thinking, problem-solving, and decision-making skills. This is supported by studies such as Rahmawati et al. (2023), who emphasized the role of socio-scientific issues in fostering critical and ethical awareness, and Malaluan et al. (2023), who demonstrated the effectiveness of embedding environmental values in science instruction. Collectively, these components illustrate a balanced, values-driven approach to science education, where intellectual competence, ethical sensitivity, and spiritual growth are advanced in an integrated manner.

Experts' Evaluation of the Developed Environment and Christian Values-Oriented Chemistry Modules (ECCM) in terms of Acceptability

The experts' evaluation of the Environment and Christian Values-Oriented Chemistry Modules (ECCM) in terms of Acceptability is summarized in Table 4.

Table 4

Experts' Evaluation of the Developed Environment and Christian Values-Oriented Chemistry Modules (ECCM) along Acceptability

Module	Factor 1: Content	Description	Factor 2: Format	Description	Factor 3: Presentation and Organization	Description	Factor 4: Accuracy and Up-to-datedness of Information	Description
ECCM	20.6	P	67.2	P	17.6	P	24	P

Factor 1: Content	*21-28*	*Passed*	***P**-Passed*
Factor 2: Format	*54-72*	*Passed*	***F**-Failed*
Factor 3: Presentation and Organization	*15-20*	*Passed*	
Factor 4: Accuracy and Up-to-Datedness	*24-24*	*Passed*	

The expert evaluation of the Environment and Christian Values-Oriented Chemistry Modules (ECCM) yielded an overall rating of "Very Satisfactory" across content, format, presentation, and accuracy (Table 4). Beyond confirming technical adequacy, these findings carry pedagogical and theoretical significance. High scores in content demonstrate that values-based integration can be embedded within chemistry modules without compromising disciplinary rigor, supporting Dela Mines and Cajucom's (2022) argument that age-appropriate, cognitively aligned content strengthens conceptual learning. The ECCM's alignment with the ADDIE framework further reinforces Medina and Baraquia's (2023) claim that systematic design models yield materials that are both usable and relevant to curricular demands. In line with Lickona's (1991) character education framework and Rahmawati et al.'s (2023) socio-scientific approach, the results suggest that intellectual, moral, and environmental formation can be cultivated in tandem through well-designed instructional materials.

However, the results must be interpreted with caution. The theological framing of the ECCM aligns well with Catholic educational contexts but presents challenges in pluralistic or secular settings. While principles such as stewardship, justice, and responsibility have universal resonance, their explicit grounding in Christian scripture (e.g., Genesis 2:15; Romans 8:28) may limit applicability outside faith-based institutions. This tension reflects broader debates on the integration of religion and science in education, where perceived conflation of domains can hinder acceptance. Future adaptations might therefore consider rearticulating

Christian values in secular ethical terms to extend the modules' reach without diluting their moral orientation.

The evaluation results are also shaped by the context of the validators. Most experts were affiliated with Catholic institutions, which likely predisposed them to view the integration of faith and science positively. While their approval strengthens the modules' legitimacy within their intended setting, further validation from experts in secular or pluralistic institutions is needed to test adaptability across diverse educational environments. This limitation underscores the importance of situating evaluation findings within the sociocultural and institutional contexts of the reviewers.

Equally significant is the absence of student-level data. Although experts affirmed the ECCM's clarity, organization, and accuracy, the actual impact on learners remains untested. Prior studies (e.g., Salamat, 2024; Easa & Blonder, 2022) emphasized that readability, visual design, and safety measures must be assessed in real classroom contexts where student engagement and comprehension can be directly observed. Future research should therefore triangulate expert validation with classroom implementation, learner feedback, and focus group discussions to capture how students negotiate the integration of scientific and religious worldviews.

The factor-level ratings also yield insights for module refinement. Strong evaluations in accuracy and organization confirm that values-based design does not undermine scientific precision, echoing Mamintal (2024) and Dela Mines and Cajucom (2022). At the same time, slightly lower ratings in readability and safety guidance point to practical areas for improvement, aligning with Ee et al. (2022) and Salamat (2024), who highlighted the importance of accessible language and explicit safety instructions. These findings suggest that while the ECCM provides a robust framework for values-driven chemistry education, continuous iteration is necessary to enhance clarity, engagement, and classroom safety.

In sum, the expert evaluation affirms the ECCM's promise as a pedagogical model that integrates disciplinary knowledge with ethical and spiritual formation. Yet, its broader significance lies not only in validation but also in the critical questions it raises: How can faith-informed science instruction be inclusively adapted in secular settings? How do learners themselves perceive and experience this integration? And how might iterative revisions address concerns of readability, safety, and visual engagement? Addressing these questions through future empirical studies will be crucial for advancing the ECCM from a context-specific innovation to a model with broader implications for values-based science education in the Philippines and beyond.

Experts' Evaluation of the Developed Environment and Christian Values-Oriented Chemistry Modules (ECCM) in terms of Usability

The subject experts also assessed the Usability in terms of functionality of the Developed Environment and Christian Values-Oriented Chemistry Modules (ECCM), and their evaluations are presented in Table 5.

Table 5

Experts' Evaluation of the Developed Environment and Christian Values-Oriented Chemistry Modules (ECCM) in terms of Functionality

Functionality Evaluation Criteria	Mean	Descriptive Rating
1. The ECCM takes into account the attitudes and abilities of the students.	3.8	Very Functional
2. The ECCM is easy to use and transferable to the place of learning.	3.8	Very Functional
3. The ECCM will guide the students to the principles and concepts in Chemistry.	4	Very Functional
4. The ECCM is adaptable to any size of the learning group and differences in learning time.	3.8	Very Functional
5. The ECCM teaches and guides the students during actual performance of various learning.	3.8	Very Functional
	3.84	**Very Functional**

Legend: Very Functional (3.50 – 4.00); Functional (2.50 – 3.49); Less Functional (1.50 – 2.49); Not Functional (1.00 – 1.49)

As shown in Table 5, the ECCM modules received a "Very Functional" rating (M = 3.84), with high scores for clarity of instruction (4.0), consideration of student abilities (3.8), and ease of use (3.8). These results indicate strong potential to support differentiated instruction and adaptable classroom implementation, consistent with Easa and Blonder (2022), Medina and Baraquia (2023), and Ee et al. (2022). Beyond technical confirmation, the findings matter pedagogically because they demonstrate that values-based chemistry instruction can be delivered through practical, flexible tools without sacrificing usability.

However, functionality ratings reflect expert perceptions, many from Catholic institutions, which may predispose acceptance of the modules' theological framing. Whether similar judgments would hold in secular or pluralistic contexts remains uncertain. Moreover, the absence of student-level data means that clarity and adaptability, while affirmed by experts, still require validation through classroom trials and learner feedback. Thus, while the ECCM shows promise as a functional, values-driven resource, future work must test its effectiveness with diverse student populations to ensure both pedagogical impact and contextual relevance.

Overall, the ECCM modules were validated by experts as functional and well-designed instructional resources with strong potential for delivering values-based chemistry education, though their inclusivity and classroom impact remain to be established through future learner-focused studies.

Conclusion

This study successfully developed and expert-validated the Environment and Christian Values-Oriented Chemistry Modules (ECCM), which integrate core chemistry concepts with environmental principles and Christian values. Expert evaluations yielded consistently high ratings—"Very Satisfactory" for content (M = 20.6), format (M = 67.2), presentation and organization (M = 17.6), and accuracy (M = 24), and "Very Functional" with an overall mean of 3.84—confirming the modules' developmental appropriateness, scientific accuracy, and clear organization. These results suggest that the ECCM has strong potential to promote both cognitive and moral development through the integration of real-world environmental issues and Christian teachings, making it especially meaningful in faith-based educational contexts.

Nevertheless, the scope of the study was limited to expert validation, with no classroom implementation or student-level data to confirm learning outcomes. Some areas such as sentence conciseness, visual appeal, and safety guidance were identified for refinement. Moreover, the evaluators' predominantly Catholic institutional background may have influenced the positive assessments, raising questions about the modules' transferability to pluralistic or secular school settings.

To address these gaps, future research should pilot-test the modules in diverse classrooms, gather student feedback, and explore adaptations for broader contexts. Enhancing visual elements, clarifying language, and developing digital formats may further increase accessibility and learner engagement. The ECCM framework also shows promise for extension to other science subjects, advancing the broader project of values-integrated education.

Henceforth, the ECCM provides a validated model for embedding scientific literacy within a moral and spiritual framework. While expert reviews affirm its potential, systematic classroom-based research remains essential to establish its effectiveness, inclusivity, and adaptability beyond faith-based settings.

Comentado [o110]: This section demonstrates a clear summary of findings, appropriately framed limitations, and strong, forward-looking recommendations. It surpasses typical conclusions in many developmental research studies in its clarity and utility. However, to meet scholarly publication standards, it should be slightly refined to:
- quantify validation findings more precisely,
- acknowledge the interpretive limits of expert-only evaluation, and
- offer a brief critical caveat on transferability to broader (non-faith-based) settings.

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Comentado [o111]: Some DOIs or links appear incomplete or duplicated.

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