


Deti Yunita*

Affiliation: Department of Physics Education, Faculty of Science and Technology,
Universitas Islam Negeri Sunan Kalijaga, Yogyakarta, Indonesia 

ORCID ID: [0009-0006-7155-3982](https://orcid.org/0009-0006-7155-3982)

Development and Validation of an Integration–Interconnection-Based Physics Module on Light for Junior High School Students

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*Corresponding Author:

Author: Deti Yunita

Email: yunitadety37@gmail.com

ORCID ID: [0009-0006-7155-3982](https://orcid.org/0009-0006-7155-3982)



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EN Abstract

Background: The separation between science and religion in Indonesian education often leads to fragmented knowledge and limited value integration. In physics, especially on the topic of light, teaching materials rarely include Qur’anic perspectives. This study developed and validated a physics module based on the integration–interconnection paradigm using the complementation model.

Methods: A Research and Development (R&D) approach with a 3-D model (Define, Design, Develop) was applied. Validation involved content, media, integration–interconnection experts, and practicing teachers. Student responses were obtained from limited and extensive trials, with data analyzed using descriptive statistics.

Results: The module was rated very good by content experts (92.33%), media experts (90.90%), integration–interconnection experts (84.17%), and teachers (97.33%), with an overall score of 92.27%. Student responses in both trials also indicated high acceptance, confirming the module’s classroom applicability.

Conclusions: The module effectively bridges scientific and Qur’anic perspectives while supporting active learning. It is feasible as an alternative teaching material for junior high schools and can serve as a replicable prototype for integrating cultural and spiritual values into physics learning. Future studies should expand this approach to other physics topics.

EN Keywords

Physics Module; Integration–Interconnection; Complementation Model; Light; Junior High School.

ID Abstrak

Latar Belakang: Dikotomi ilmu dan agama dalam pendidikan Indonesia sering menimbulkan pengetahuan terfragmentasi serta kurangnya integrasi nilai. Dalam pembelajaran fisika, khususnya materi cahaya, bahan ajar jarang mengaitkan konsep dengan perspektif Al-Qur’an. Penelitian ini mengembangkan dan memvalidasi modul fisika berbasis paradigma integrasi–interkoneksi dengan model komplementasi.

Metode: Penelitian menggunakan metode Research and Development (R&D) dengan model 3-D (Define, Design, Develop). Validasi dilakukan oleh ahli materi, media, integrasi–interkoneksi, serta guru IPA. Respon siswa diperoleh melalui uji coba terbatas dan luas, dianalisis dengan statistik deskriptif.

Hasil: Modul memperoleh penilaian sangat baik dari ahli materi (92,33%), media (90,90%), integrasi–interkoneksi (84,17%), dan guru (97,33%), dengan skor keseluruhan 92,27%. Respon siswa pada kedua uji coba juga tinggi, menunjukkan penerimaan positif dan kelayakan implementasi.

Kesimpulan: Modul ini efektif menjembatani perspektif sains dan Al-Qur’an sekaligus mendukung pembelajaran aktif. Produk layak digunakan sebagai bahan ajar alternatif dan dapat direplikasi guru fisika untuk mengintegrasikan nilai budaya serta spiritual. Penelitian selanjutnya disarankan memperluas pendekatan ini ke topik fisika lain.

ID Kata Kunci

Modul Fisika; Integrasi–Interkoneksi; Model Komplementasi; Cahaya; SMP/MTs.

1. INTRODUCTION

Education in the 21st century is increasingly challenged to balance cognitive, affective, and moral dimensions in fostering human development. While science, technology, engineering, and mathematics (STEM) education has gained prominence worldwide, many critiques highlight that science education often remains secular and disconnected from ethical or spiritual considerations (Bybee, 2020; Lederman & Lederman, 2022). This separation can lead to fragmented worldviews, where learners master scientific facts but fail to integrate them into broader moral or philosophical frameworks. Internationally, there has been a growing call for “holistic science education” that integrates scientific knowledge with cultural, ethical, and even religious dimensions (Osborne, 2021; Taylor, 2022). Such integration is expected to foster not only scientific literacy but also value-oriented competencies necessary for addressing global challenges.

In Indonesia, the urgency of integrative education is strongly emphasized by the National Education System Law (Undang-Undang Nomor 20 Tahun 2003), which mandates education to cultivate intellectual capacity alongside religious devotion, ethical character, and civic responsibility. The integration of knowledge and faith has long been a distinctive discourse in Indonesian Islamic higher education, particularly through the paradigm of “integrasi–interkoneksi” (integration–interconnection), which advocates a dialogical relationship between science and religion (Hamami, 2006; Kartanegara, 2005). More recent work has further formalized this paradigm, demonstrating that dialogical approaches to curriculum design can overcome superficiality and instead cultivate ethical reasoning alongside scientific understanding (Hamami, 2022). However, despite strong policy directions, the practical implementation of such integration in schools remains limited, especially at the junior high school level where learning materials are predominantly secular and subject-focused. Recent reviews confirm that integrative approaches in secondary science education remain scarce, with most empirical studies still concentrated in higher education or limited pilot projects (Suwarma & Astutik, 2023; Alkahf & Rahman, 2024).

Physics, as a core subject in junior high schools, presents both opportunities and challenges for such integration. The topic of light, for example, is central to optics and everyday phenomena, making it highly relevant for learners. Beyond its scientific importance, light carries profound symbolic meanings across cultures and religions, including explicit references in the Qur’an. This dual significance provides fertile ground for integrative teaching. Yet, in practice, most physics modules and textbooks treat light exclusively as a scientific phenomenon, without acknowledging or embedding spiritual perspectives. Interviews with teachers in several junior high schools confirm that one major barrier is the lack of instructional resources that operationalize the integration–interconnection paradigm in accessible and pedagogically sound ways.

The integration–interconnection paradigm itself has been elaborated by scholars of Islamic education as an effort to overcome the dichotomy between “secular” and “religious” sciences (Hamami, 2006). Within this paradigm, the complementation model offers a practical strategy, wherein science and religion mutually reinforce and enrich each other while preserving their distinct identities. Rather than collapsing into a single body of knowledge, both domains interact dialogically to produce more comprehensive understanding. Such an approach is consistent with contemporary educational theories advocating interdisciplinary and values-based learning (Darling-Hammond et al., 2020). In physics education, applying the complementation model means situating physical concepts, such as the properties of light, within a framework that also acknowledges Qur’anic perspectives and moral reflections.

Several studies have explored integrative approaches to science education in Indonesia. Fauzi (2012) developed integrated learning materials for senior high school physics, while Komalasari (2009) applied interconnection models in mathematics. More recently, research in STEM integration has emphasized contextualized learning that connects science to local values and societal needs (Winarno et al., 2021; Setiawan & Koestiari, 2023). However, these studies often focus on either higher education or broad thematic approaches, with

limited emphasis on junior high physics modules specifically designed around the complementation model. Furthermore, systematic validation involving experts and empirical evaluation of student responses remain scarce, leaving a significant gap in both theory and practice.

Internationally, module-based learning has been widely recognized for enhancing self-directed learning, providing structured yet flexible pathways for students to engage with content (Seaman et al., 2019; Braun & Clarke, 2021). Modules allow learners to proceed independently while still guided by clear objectives, activities, and assessments. When combined with integrative approaches, modules can function not only as learning tools but also as vehicles for embedding values and interdisciplinary connections. Nevertheless, research on integrative module development—especially combining science with religious insights—remains underrepresented in global literature, despite its relevance to culturally diverse education systems. Similar gaps have been highlighted in recent international studies, which call for module-based designs that integrate ethics, culture, and disciplinary knowledge to address diverse classroom contexts (Nugroho et al., 2023; Fernández & Tan, 2024).

Against this backdrop, the present study was designed to address both theoretical and practical gaps. It develops a physics module on the topic of light for junior high school students, grounded in the integration–interconnection paradigm through the complementation model. Unlike previous studies that remained conceptual or limited to higher education contexts, this research emphasizes product development, expert validation, and student evaluation. By systematically assessing both quality and learner responses, the study provides empirical evidence of the feasibility and acceptance of integrative modules in secondary education.

Specifically, the objectives of this research are twofold: (1) to develop and validate an integration–interconnection-based physics module on light using the complementation model, as assessed by experts in content, media, integration, and pedagogy; and (2) to examine junior high school students' responses to the developed module in both limited and extended

trials. Through these aims, the study seeks to contribute to the broader discourse on integrative science education and provide a practical model for embedding values into physics learning. At the same time, it addresses the contemporary emphasis on scientific literacy not only as mastery of concepts but also as the capacity to act as a competent outsider who makes value-oriented judgments in science-related issues (Osborne, 2024).

2. LITERATURE REVIEW

2.1. Theoretical Foundation

Instructional Modules in Science Education

Instructional modules are widely recognized as effective tools for facilitating self-directed and student-centered learning. A module is typically defined as a structured, stand-alone unit of study containing objectives, learning materials, activities, and assessments that enable students to learn independently (Seaman et al., 2019). In the context of physics education, modules can enhance conceptual understanding by providing students with opportunities to explore phenomena systematically while fostering autonomy and responsibility for learning (Darling-Hammond et al., 2020). Compared to traditional textbooks, modules are more flexible and can be designed to incorporate specific pedagogical strategies, such as contextual learning or inquiry-based approaches (Arends, 2021).

Integration–Interconnection Paradigm

The integration–interconnection paradigm is a framework rooted in the philosophy of Islamic higher education in Indonesia but increasingly relevant to broader discussions on interdisciplinary learning. It seeks to bridge the gap between “secular” sciences and religious knowledge by promoting dialogue and mutual reinforcement between the two domains (Hamami, 2006). Rather than merging science and religion into a single indistinguishable body of knowledge, integration–interconnection emphasizes interdependence and complementarity, allowing each discipline to enrich the other's perspective. This paradigm aligns with contemporary calls for holistic science education that incorporates ethical and cultural dimensions (Taylor, 2022; Aditomo & Kessels, 2023).

The Complementation Model

Among the models within the integration–interconnection paradigm, the complementation model is particularly suited for practical application in classrooms. It posits that science and religion operate in distinct yet interconnected domains, complementing rather than contradicting each other. In physics education, this model allows teachers to present scientific explanations of natural phenomena while simultaneously drawing on Qur’anic references or moral reflections that reinforce students’ spiritual awareness. Such an approach not only fosters scientific literacy but also develops affective and ethical competencies, preparing students to become holistic learners (Kartanegara, 2005; Setiawan & Koestiari, 2023).

Light in Physics and Religion

The topic of light occupies a central position in both physics and religious symbolism. Scientifically, light is essential in optics, explaining phenomena such as reflection, refraction, and image formation (Halliday & Resnick, 2018). Pedagogically, light is often introduced at the junior high school level because of its observable and relatable applications in daily life. Religiously, light holds significant metaphors and explicit references in the Qur’an, where it is associated with guidance, knowledge, and divine presence (Rahman, 2007). The dual scientific and spiritual significance of light makes it an ideal topic for applying the complementation model in integrative physics education.

2.2. Previous Studies

Several studies have addressed the integration of science and religion in education, though most remain at the conceptual level. Fauzi (2012) developed integrated learning materials for senior high school physics, reporting positive outcomes but limited scope of validation. Komalasari (2009) explored interconnection models in mathematics, demonstrating feasibility but without addressing empirical responses from students. At the international level, researchers have investigated interdisciplinary approaches connecting science education with cultural or ethical frameworks (Osborne, 2021; Lederman & Lederman, 2022). These works highlight the importance of embedding values into STEM

education but do not directly engage with religious perspectives.

In terms of module development, Seaman et al. (2019) emphasized that instructional modules provide flexibility and autonomy, while Winarno et al. (2021) showed that contextualized modules in STEM can improve engagement and achievement. Recent studies in Indonesia have also begun to link STEM education with local wisdom and cultural identity (Setiawan & Koestiari, 2023). However, empirical studies that combine systematic module development, integration with religious texts, and validation by experts and students remain scarce.

2.3. Critical Synthesis

The reviewed literature indicates several key insights. First, instructional modules are effective vehicles for fostering independent learning and aligning pedagogy with student-centered approaches. Second, the integration–interconnection paradigm provides a robust theoretical basis for bridging science and religion, with the complementation model offering a practical strategy for implementation. Third, while light is an ideal topic for such integration, existing studies have not fully utilized its dual scientific and religious significance.

The research gap lies in the lack of empirically validated instructional modules at the junior high school level that systematically apply the integration–interconnection paradigm, a concern also echoed in recent international scholarship on values-based and holistic science learning (Fernández & Tan, 2024). Most prior works are either conceptual, focus on higher education, or lack comprehensive validation involving experts and student responses. This study addresses the gap by developing and validating a physics module on light based on the complementation model, thereby contributing both theoretically and practically to the discourse on integrative science education.

3. METHODS

The methodological framework of this study was carefully designed to ensure that the development and validation of the physics module were conducted systematically, transparently, and in alignment with international standards of educational research.

Because the study aimed not only to produce an instructional product but also to guarantee its quality through expert assessment and empirical trials, a research design capable of combining product development with rigorous evaluation was required. The chosen methodology emphasized both the technical accuracy of the instructional content and the practical feasibility of its classroom implementation, while ensuring that ethical considerations were embedded throughout the research process.

3.1. Research Design

This study adopted a Research and Development (R&D) methodology, which is widely recognized as appropriate for producing instructional innovations that require systematic design, expert validation, and empirical testing prior to dissemination (Gall, Gall, & Borg, 2007). The specific model employed was the 3-D model—Define, Design, and Develop—adapted from Thiagarajan’s original 4-D model (Thiagarajan, Semmel, & Semmel, 1974). The Disseminate stage was excluded because the objective of this study was limited to developing the product, validating its quality, and assessing its feasibility rather than implementing it at scale. The 3-D model was chosen for its iterative structure, which allows continuous refinement of the module at each stage of development. This aligns with best practices in instructional design research, whereby products undergo repeated evaluation until they achieve acceptable levels of validity and practicality (Plomp & Nieveen, 2013).

3.2. Participants

The research was conducted in junior high schools (SMP/MTs) in Kemranjen, Central Java, Indonesia, focusing on eighth-grade students directly engaged with the physics curriculum on the topic of light. A purposive sampling technique was applied to select participants most relevant to the objectives of the study, namely those who would represent typical end-users of the module. Two participant groups were involved: experts and students.

In the validation phase, three categories of experts were invited: a physics education lecturer who evaluated content accuracy and curriculum alignment, an educational technology specialist who assessed design and presentation, and an Islamic studies scholar who examined the

appropriateness of the integration–interconnection dimension. Additionally, two practicing science teachers, each with more than five years of classroom experience, participated as field experts to ensure the module’s applicability in authentic instructional contexts. For empirical testing, students were divided into two groups. A limited trial was conducted with fifteen students to identify immediate weaknesses and gather initial feedback, while an extensive field trial involved sixty students to obtain more representative evidence regarding usability, acceptance, and effectiveness. The involvement of both experts and students ensured a multi-perspective evaluation, consistent with methodological standards for R&D in education (Nieveen & Folmer, 2013).

3.3. Instruments

Multiple instruments were designed and reviewed to collect reliable data. Expert validation sheets assessed the accuracy of physics content, logical sequencing of topics, appropriateness of illustrations, clarity of language, and the relevance of integrated Qur’anic verses. These sheets used a four-point Likert scale ranging from “very poor” to “very good.” Teacher evaluation sheets focused on classroom practicality, instructional clarity, time efficiency, and curriculum compatibility. Student response questionnaires were administered after both limited and extensive trials to capture learners’ perceptions of clarity, attractiveness, motivational appeal, and overall usefulness; responses were measured on a Likert scale to enable statistical analysis. To complement these quantitative measures, classroom observation guidelines were used by the researcher to document student engagement, interaction patterns, and challenges encountered during module use. All instruments underwent face and content validation by senior researchers to enhance clarity and minimise measurement bias, and triangulation across instruments was applied to increase the robustness of the findings.

3.4. Data Collection Procedures

Data collection followed the three stages of the R&D model. In the Define stage, curricular requirements were identified by analysing the national curriculum for junior high school physics with a focus on light, and teacher interviews were conducted to explore learning

obstacles and typical student engagement with physics materials. These insights informed the scope and objectives of the module.

In the Design stage, a draft version of the module was prepared. Learning objectives were articulated as competency-based indicators; content on reflection, refraction, and optical instruments was developed; and Qur’anic verses that metaphorically or explicitly reference light were integrated alongside illustrations, worked examples, and practice exercises to support diverse learning styles. The draft underwent internal review prior to expert validation. For clarity and transparency, the module design elements—including learning objectives, main physics topics, Qur’anic references, and sample activities—were summarized in a tabular format (see Table X). This table provides a concise overview of the module’s structure and enhances the potential for replication in similar educational contexts.

Table 1. Summary of the Module Design Elements/Ringkasan Elemen Desain Modul

Learning Objectives/ Tujuan Pembelajaran	Physics Content/ Materi Fisika	Qur’anic Integration/ Integrasi Al-Qur’an	Sample Activities/ Contoh Aktivitas
Students identify the laws of reflection and apply them to everyday phenomena. Siswa mengidentifikasi hukum pemantulan cahaya dan menerapkannya pada fenomena sehari-hari.	Reflection of light on mirrors (plane, concave, convex). Pemantulan cahaya pada cermin (datar, cekung, cembung).	“Allah is the Light of the heavens and the earth...” (QS. An-Nur: 35) as a metaphor for guidance and clarity. “Allah adalah cahaya langit dan bumi...” (QS. An-Nur: 35) sebagai metafora petunjuk dan kejelasan.	Experiment using plane and concave mirrors to observe reflection angles; group discussion linking clarity of reflection with clarity of guidance. Eksperimen menggunakan cermin datar dan cekung untuk mengamati sudut pantul; diskusi kelompok mengaitkan kejernihan pantulan dengan kejernihan petunjuk.
Students explain refraction and analyze its applications	Refraction of light in air–water and glass–air media;	Qur’anic verse on the creation of water as a medium for	Hands-on activity: inserting a stick in water to observe

in natural and technological contexts. Siswa menjelaskan pembiasan cahaya dan menganalisis penerapannya dalam konteks alam dan teknologi.	lenses. Pembiasan cahaya pada medium udara–air dan kaca–udara; lensa.	life (QS. Al-Anbiya: 30). Ayat Al-Qur’an tentang penciptaan air sebagai media kehidupan (QS. Al-Anbiya: 30).	apparent bending; discussion on how “distortion” can be compared to misperceptions without guidance. Aktivitas praktis: memasukkan batang ke dalam air untuk mengamati pembengkokan semu; diskusi tentang bagaimana “distorsi” dapat dibandingkan dengan kesalahan paman tanpa petunjuk.
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Students describe the function of optical instruments. Siswa mendeskripsikan fungsi alat optik.	Simple optical instruments (magnifying glass, camera, human eye). Alat optik sederhana (kaca pembesar, kamera, mata manusia).	Verses about the gift of vision and senses (QS. An-Nahl: 78). Ayat tentang anugerah penglihatan dan pancaindra (QS. An-Nahl: 78).	Activity using magnifying glasses and cameras; reflective writing on senses as both scientific phenomena and divine gifts. Aktivitas menggunakan kaca pembesar dan kamera; menulis refleksi tentang pancaindra sebagai fenomena ilmiah sekaligus anugerah Ilahi.
Students connect the scientific concept of light with symbolic meanings in Islam. Siswa menghubungkan konsep ilmiah cahaya dengan makna	Synthesis of reflection, refraction, and optical instruments. Sintesis pemantulan, pembiasan, dan alat optik.	Integrating metaphors of “light” in the Qur’an with scientific explanations. Mengintegrasikan metafora “cahaya” dalam Al-Qur’an dengan penjelasan ilmiah.	Group presentation: “Light in Science and Religion”; drawing conceptual maps linking physics principles with Qur’anic insights. Presentasi

simbolik dalam Islam.

kelompok: "Cahaya dalam Sains dan Agama"; membuat peta konsep yang menghubungkan prinsip fisika dengan wawasan Qur'ani.

Ringkasan elemen desain modul, meliputi tujuan pembelajaran, materi fisika, integrasi Al-Qur'an, dan contoh aktivitas.

In the Develop stage, the module was subjected to systematic expert validation using the predefined sheets, and feedback was analysed to guide revisions. Following revision, the module was implemented in a limited trial with fifteen students to gather initial responses; observations during this trial informed further refinements. Subsequently, an extensive field trial with sixty students was conducted under teacher-led instruction with comparable time-on-task, generating broader data on usability and acceptance. Each revision cycle was documented, and the process continued iteratively until the module achieved validation scores classified as "very good."

3.5. Data Analysis

Data obtained from expert validations, teacher evaluations, and student responses were analysed using descriptive statistical techniques. The **ideality percentage** for each instrument was calculated using the following formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

where P is the ideality percentage, $\sum x$ is the total score obtained, and $\sum x_i$ is the maximum possible score. The resulting percentages were interpreted according to predefined categories: very good (81–100%), good (61–80%), fair (41–60%), poor (21–40%), and very poor (0–20%). These thresholds were applied consistently to expert validations, teacher evaluations, and student responses. Quantitative questionnaire results provided measures of acceptance, while qualitative classroom observations supplied supporting evidence regarding learner enthusiasm, participation, and comprehension. Where relevant, descriptive summary statistics

(e.g., means, standard deviations, and percentages) were reported to communicate precision and enable systematic comparison across validation aspects.

3.6. Ethical Considerations

The research complied fully with ethical principles in educational research. Permission to conduct the study was granted by the Faculty of Science and Technology, Universitas Islam Negeri Sunan Kalijaga, Yogyakarta, and by the principals of the participating junior high schools. Informed consent was obtained from teachers, while parental consent and student assent were secured from all student participants prior to data collection. Participation was voluntary; confidentiality was ensured through anonymisation of student responses; and no participant faced harm or academic disadvantage as a result of involvement. The study did not involve clinical or medical interventions, and therefore trial registration was not applicable. Artificial intelligence tools were employed exclusively for language editing of the manuscript; all aspects of conceptualisation, design, data collection, analysis, and interpretation were conducted by the researcher.

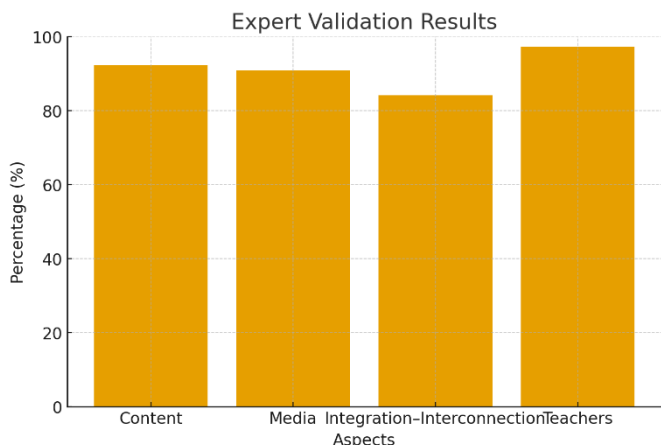
4. RESULTS AND DISCUSSION

Validation by experts

The physics module developed under the integration–interconnection paradigm was validated by experts in content, media, integration–interconnection, and pedagogy. The results showed that the content aspect achieved 92.33 percent, categorized as *very good*, indicating accuracy, coherence, and alignment with curriculum standards. Media validation yielded 90.90 percent, reflecting strong visual design and readability. The integration–interconnection component was rated at 84.17 percent, which, while still *very good*, was lower than other aspects, suggesting the need for deeper conceptual connections between physics and Qur'anic perspectives. Teacher validation obtained the highest score of 97.33 percent, confirming the module's practicality and classroom feasibility. Taken together, these evaluations produced an overall mean score of 92.27 percent, aligning with previous studies that also reported high practicality and usability of physics modules in Indonesian contexts (Yanti et

al., 2022). The relatively lower score on integration–interconnection reflects critiques that conceptual bridges between science and religion must be made explicit to avoid symbolic associations (Hamami, 2022). Future iterations may benefit from the inclusion of guiding questions that foreground epistemic links between Qur’anic metaphors of light and the physics of reflection and refraction.

Figure 1. Expert Validation Results



Validation percentages for content, media, integration–interconnection, and teacher assessments, all rated in the “very good” category.

Table 2. Expert Validation Results

Aspect	Percentage	Category
Content	92.33%	Very Good
Media	90.90%	Very Good
Integration–Interconnection	84.17%	Very Good
Teachers (practicality)	97.33%	Very Good
Overall Mean	92.27%	Very Good

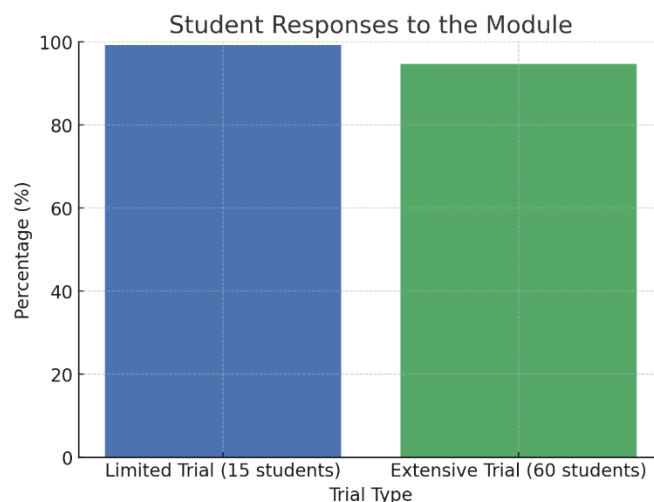
Scores from experts on content, media, integration–interconnection, and teacher evaluations, showing overall high validity of the module.

Sub-component analysis also revealed consistent results. Content feasibility, presentation design, integration of scientific and religious perspectives, and linguistic clarity were each rated above 89 percent, indicating that the module was reliable in all key dimensions. Nevertheless, integration–interconnection remained slightly weaker than the other components, echoing critiques in the literature that integrative approaches must be carefully conceptualized to avoid superficial associations (Kartanegara, 2005; Hamami, 2006).

Responses from students

Student responses reinforced the expert evaluations. In the limited trial with fifteen students, the overall response reached 99.28 percent, placing it in the “very good” category. In the extensive trial with sixty students, the score was slightly lower at 94.76 percent, though still within the “very good” category. The positive reception is consistent with evidence that well-structured e-modules and STEM-oriented modules enhance science literacy and motivation, including in Islamic-school settings (Prihatiningtyas et al., 2025; Ardianti et al., 2023).

Figure 2. Student Responses to the Module



Comparison of student responses in limited and extensive trials, both classified in the “very good” category

Students consistently reported that the module was clear, attractive, and easy to follow. The inclusion of Qur’anic verses was perceived not as a distraction but as an enrichment that increased the meaningfulness of learning. Illustrations and exercises were particularly valued for facilitating the understanding of complex optical concepts. Comparable findings were observed in a recent study of STEM Qur’an-based flipbook e-modules, which significantly enhanced science literacy among Islamic boarding school students, with learning outcomes improving from below 40 percent to above 80 percent (Prihatiningtyas et al., 2025).

Table 3. Summary of Student Responses

Trial Type	Percentage	Category
Limited Trial (15 students)	99.28%	Very Good
Extensive Trial (60 students)	94.76%	Very Good

Percentages from limited and extensive trials showing high acceptance of the module among students.

These findings align with studies that emphasize the effectiveness of modules in promoting self-directed and engaging learning. Seaman et al. (2019) and Darling-Hammond et al. (2020) demonstrated that well-structured modules provide clear pathways and autonomy for learners. The present study extends these insights by showing that integrative elements, when carefully embedded, can enhance the relevance and motivation of students, particularly in culturally and spiritually oriented educational settings.

Interpretation of findings

Taken together, the validation and student response data confirm that the module effectively combined scientific rigor with integrative value-based learning. Expert and teacher assessments demonstrated its theoretical soundness and practical feasibility, while student responses highlighted its clarity and appeal. Previous studies on optics-focused modules have likewise shown that contextualisation—through local phenomena or digital enhancements—can significantly improve conceptual mastery (Fatimah et al., 2023), thereby triangulating the present findings on light and optical instruments and suggesting pathways to deepen conceptual engagement. The relatively lower score on integration–interconnection reflects the complexity of bridging scientific and spiritual perspectives. As Taylor (2022) argued, genuine holistic education requires critical engagement, not merely symbolic integration. Future versions of the module could incorporate reflective activities prompting students to make explicit conceptual links between Qur’anic verses and physical phenomena.

Implications for practice and research

The implications are significant. For curriculum developers, the validated module can serve as a prototype for embedding integrative approaches into science education. For teachers, it provides a practical resource that complements standard textbooks while offering added value in moral and cultural dimensions. For researchers, the study demonstrates the utility of the 3-D R&D model for producing contextually relevant and empirically tested instructional products. Beyond classroom practicality, integrative modules offer a vehicle for dialogue between scientific explanation and ethical–spiritual reflection, a

direction increasingly recognised in international frameworks on science education and citizenship. This perspective also aligns with recent arguments that science education should cultivate scientifically literate learners as “competent outsiders,” capable of evaluating scientific claims within social, ethical, and cultural contexts (Osborne, 2024).

Limitations and directions for future research

Despite strong outcomes, the study was limited to one topic—light—and conducted in a single school cluster. This limits the generalizability of the findings. Moreover, although the integration–interconnection component was validated as “very good,” it still lagged slightly behind other aspects, suggesting a need for deeper elaboration. Future research should extend this approach to other areas of physics such as mechanics or electricity, and conduct longitudinal studies to evaluate long-term impacts on achievement and attitudes. Comparative studies across cultural contexts would also help determine the broader applicability of this integrative model.

5. CONCLUSIONS

This study has demonstrated that a physics module developed under the integration–interconnection paradigm and designed using the 3-D R&D model meets high standards of validity and feasibility. Expert evaluations yielded an overall score of 92.27 percent, with all aspects rated in the “very good” category, while student responses reached 99.28 percent in the limited trial and 94.76 percent in the extensive trial. These findings confirm that the module integrates scientific accuracy, pedagogical clarity, and spiritual relevance, making it highly suitable for use in junior high school physics instruction.

Beyond empirical validation, the study contributes to the broader discourse on holistic education by showing that the complementation model can effectively bridge physics concepts with Qur’anic perspectives. The module not only supported the development of scientific literacy but also enriched learning with ethical and spiritual dimensions, thereby addressing the longstanding dichotomy between science and religion. This demonstrates that integrative approaches can enhance both the quality and the

meaningfulness of science education in culturally and spiritually grounded contexts.

Nevertheless, the study also revealed that the integration–interconnection dimension, though validated as “very good,” scored slightly lower than other aspects. This suggests the need for deeper conceptual development and more explicit reflective activities that directly link scientific and religious perspectives. Future research should extend this approach to other physics topics and contexts while exploring longitudinal impacts on students’ knowledge, critical thinking, and values. Cross-cultural studies may further provide insights into how integrative modules function in diverse educational systems and contribute to global conversations on holistic education.

6. ACKNOWLEDGMENTS

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7. AUTHOR CONTRIBUTIONS

The author was solely responsible for conceptualizing the study, designing the module, collecting and analyzing the data, and preparing the manuscript. Every stage of the research process, from the initial design through to the interpretation of findings and the writing of the article, was conducted under the author’s direction and supervision.

8. FUNDING

This research did not receive any external funding from government agencies, commercial entities, or non-profit organizations. The study was carried out independently with resources provided by the author’s academic institution.

9. CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the conduct of this study or

the preparation of this manuscript. The research was undertaken solely for academic and scientific purposes, with no financial or personal interests that could have influenced the outcomes.

10. DATA AVAILABILITY

The data that support the findings of this study are not publicly available because of institutional restrictions and the involvement of student participants. However, the data can be obtained from the corresponding author upon reasonable request.

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