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The integration of the epistemologies of science and Islam in the development of a curriculum system for modern Islamic boarding schools in Indonesia

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ABSTRACT

Background: The dichotomy between religious studies and science remains a major issue in the Islamic education system, particularly in modern Islamic boarding schools, necessitating an epistemological integration model capable of uniting revelation, reason, and empiricism within a single scientific framework.

Purpose: This study aims to analyze the epistemological integration of science and Islam in the development of the curriculum system for modern Islamic boarding schools in Indonesia, using a case study of Trensains Muhammadiyah Sragen.

Method: This study employs a qualitative approach with an intrinsic case study design. Data were collected through in-depth interviews, participant observation, and document analysis, and were subsequently analyzed using the Miles, Huberman, and Saldaña interactive model.

Findings: The results indicate that epistemological integration is substantively achieved through the reconstruction of the relationship between revelation, reason, and empiricism within the framework of tawhid. This integration is manifested in an integrated curriculum as well as learning practices based on *ayat kauniyah*, inquiry-based learning, and scientific research by students. The findings also indicate that this integration contributes to the development of students' holistic competencies, encompassing critical thinking skills, scientific understanding, and spiritual awareness. However, implementation still faces challenges regarding teacher competencies and the availability of integrative teaching materials. The novelty of this study lies in the formulation of an operational epistemological integration model within the curriculum system and pedagogical practices of modern Islamic boarding schools.

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INTRODUCTION

Advances in science and technology in the era of globalization have brought significant changes to various aspects of life, including the education system. This

transformation requires educational institutions to produce graduates who are not only intellectually competent but also possess strong moral and spiritual integrity. In the context of Islamic education in Indonesia, these challenges have become increasingly complex due to the epistemological dichotomy between religious knowledge and general knowledge that remains deeply rooted in educational practice (Azra, 2019; Zarkasyi, 2020).

This dichotomy is essentially a historical product of the interaction between the classical Islamic scholarly tradition and the influence of the modern Western educational system introduced during the colonial era. Western educational systems tend to emphasize positivistic and empiricist approaches, which separate the metaphysical dimension from knowledge. Meanwhile, the Islamic scholarly tradition, both ontologically and epistemologically, places revelation as the primary source of knowledge that is inseparable from reason and empirical experience (Al-Attas, 1995; Nasr, 2006). The tension between these two paradigms has resulted in a fragmentation of scholarship, leading to graduates who tend to be polarized between intellectual intelligence and spiritual awareness.

In the Indonesian context, pesantren as the oldest Islamic educational institutions play a strategic role in bridging this gap. However, traditional pesantren generally still focus on teaching classical Islamic sciences, while mastery of science and technology remains relatively limited (Dhofier, 2011). Conversely, modern formal educational institutions often excel in scientific mastery but fail to provide sufficient attention to the deep cultivation of spirituality and Islamic values (Madjid, 2008). This situation underscores the urgency of developing an integrative educational model capable of accommodating both dimensions in a balanced manner.

Efforts to integrate science into Islamic education have long been a concern for contemporary Muslim thinkers. Ismail Raji al-Faruqi (1982) proposed the concept of the Islamization of knowledge as a response to the dominance of the secular Western paradigm. Meanwhile, Syed Muhammad Naquib al-Attas (1995) emphasized the importance of de-Westernizing knowledge through the purification of key concepts in Islamic epistemology. On the other hand, a more moderate approach was developed by Amin Abdullah (2012) through the concept of integration-interconnection, which seeks to foster constructive dialogue among various disciplines without eliminating their distinct characteristics.

Nevertheless, the implementation of the concept of scientific integration in educational practice still faces various obstacles. Many educational institutions claim to implement integration, yet in practice, this is limited to the inclusion of Quranic verses in learning materials without any profound epistemological reconstruction (Kuntowijoyo, 2006; Irawan, D., & Putra, R. S. 2022). This indicates that the integration carried out remains symbolic and has not yet touched upon fundamental aspects within the structure of science.

In recent decades, a phenomenon of modern science-based Islamic boarding schools has emerged, aiming to address this issue. One prominent example is Trensains Muhammadiyah Sragen. This pesantren champions the concept of integrating science and Islam by using the Qur'an as the foundation for the development of knowledge, particularly in understanding natural phenomena (*ayat kauniyah*). This model is worth examining because it not only integrates the curriculum administratively but also seeks to build a new scientific paradigm among the students (Sudrajat, A. 2018; Pathin, T. D., & Hanif, M. 2026).

The integration of the epistemologies of science and Islam within the context of Trensains Muhammadiyah Sragen has implications not only for curriculum design but also for the perspective on science itself. From this perspective, science is no longer understood as a neutral and value-free entity but rather as a means to comprehend the signs of God's greatness. Thus, the science learning process becomes part of a spiritual activity aimed at strengthening monotheism (Bagir, 2019).

Furthermore, this integrative approach also has strong relevance to the demands of 21st-century education, which emphasizes the importance of critical, creative, collaborative, and communicative thinking skills. The integration of science and Islam enables the development of these competencies within a framework of religious values, thereby producing graduates who are not only academically excellent but also possess strong character (OECD, 2021; World Bank, 2020).

A number of previous studies have discussed the integration of science and Islam primarily at conceptual, philosophical, or normative levels. Foundational thinkers such as Syed Muhammad Naquib al-Attas and Ismail Raji al-Faruqi laid the philosophical groundwork for the Islamization of knowledge by emphasizing the epistemological position of revelation in relation to reason and empiricism. Meanwhile, Amin Abdullah introduced the integration–interconnection paradigm to encourage interdisciplinary dialogue within Islamic higher education. These works provide a strong theoretical foundation for understanding the relationship between science and Islam, yet they predominantly remain at the level of epistemological discourse and conceptual reconstruction.

In the Indonesian context, scholars such as Kuntowijoyo, Zuhairini Dhofier, and Azyumardi Azra have examined the historical dynamics of pesantren and highlighted the urgency of overcoming the dichotomy between religious and general sciences. More recent discussions by Harahap, S., & Pohan, N. J. (2025) propose models of knowledge integration in Islamic education; however, these studies largely emphasize theoretical formulations rather than empirical examinations of how such integration is enacted in real educational settings.

Several studies have begun to explore modern pesantren that emphasize science learning, including works by Pathin, T. D., & Hanif, M. (2026) and Prayogo, M. S., & Tharaba,

M. F. (2025), which describe institutional transformation (Rofiqi, et.al., 2026) and curriculum development (Abidin, et.al., 2022) in science-oriented pesantren. Nevertheless, these studies tend to focus on managerial, structural, or policy aspects without deeply analyzing how the epistemological relationship between revelation, reason, and empiricism is operationally reconstructed within classroom practices and learning processes.

This condition reveals a significant research gap. While discourse on the integration of science and Islam is rich at philosophical and conceptual levels, empirical case studies that investigate how epistemological integration is systematically translated into curriculum structures and pedagogical practices within pesantren settings remain scarce. Consequently, there is limited understanding of how integration moves beyond normative claims and becomes an operational educational reality.

This study is based on the assumption that effective integration requires transformation not only at the curriculum level but also at epistemological and pedagogical levels. Reconstruction of perspectives on knowledge, learning methods, and the purpose of education is necessary for integration to function substantively rather than symbolically. In this regard, Trensains Muhammadiyah Sragen is viewed as an educational laboratory that offers an alternative model for the development of modern pesantren curricula in Indonesia.

Therefore, this study positions itself to address this gap by providing an in-depth intrinsic case study of how epistemological integration is concretely constructed within the curriculum system and enacted through learning activities at Trensains Muhammadiyah Sragen. The novelty of this study lies in the formulation of an operational epistemological integration model that demonstrates how the relationship between revelation, reason, and empiricism is not only articulated philosophically but also embedded structurally in the curriculum and pedagogically in classroom learning practices.

Based on this research gap, the study seeks to analyze how the epistemological relationship between revelation, reason, and empiricism is systematically constructed within the curriculum structure at Trensains Muhammadiyah Sragen, how this integration is operationalized in classroom learning practices through inquiry-based, problem-based, and research-based learning approaches, how it influences students' cognitive and spiritual development, and what challenges are encountered in sustaining its implementation within the pesantren curriculum system. These guiding questions ensure coherence between the study objectives, research design, data analysis, and the presentation of findings, as each of these aspects is directly addressed in the Results and Discussion sections.

METHODS

This study employs a qualitative approach with an intrinsic case study design to obtain an in-depth understanding of how the epistemological integration between revelation,

reason, and empiricism is constructed within the curriculum structure and enacted in classroom learning practices at Trensains Muhammadiyah Sragen. An intrinsic case study was deliberately selected because the objective of this research is not to generalize findings to all pesantren, but to thoroughly understand a unique and information-rich case that explicitly positions itself as a science-based pesantren grounded in the values of tawhid. This design enables the researcher to explore the complexity of epistemological integration as a lived educational practice within its real context, in line with the characteristics of intrinsic case study research (Creswell, 2018; Yin, 2018).

The research site was determined through purposive sampling based on three criteria: the institution explicitly declares the integration of science and Islam as its educational vision, it implements a science-oriented curriculum within a pesantren system, and it has established learning practices that connect Qur'anic reflection (*ayat kauniyah*) with scientific inquiry. Based on these criteria, Trensains Muhammadiyah Sragen was considered an appropriate and information-rich site for investigating epistemological integration in practice.

Research informants were also selected using purposive sampling with clear criteria to ensure the relevance and richness of the data. Informants consisted of the pesantren leadership who design and oversee the curriculum system, teachers of science and religious subjects who directly implement integrative learning, and students who experience the learning process. In total, 15 participants were involved, comprising three members of the leadership team, six teachers (three science teachers and three religious studies teachers), and six students from different grade levels. These participants were selected because they represent key actors in curriculum formulation, pedagogical implementation, and learning experience. Data collection continued until thematic saturation was reached, indicated by the repetition of patterns and the absence of new emerging themes (Guest et al., 2020).

Data were collected over a period of three months through semi-structured in-depth interviews, participatory classroom observations, and document analysis. The interviews lasted between 45 and 90 minutes and explored participants' perspectives on the meaning, process, and challenges of epistemological integration. Participatory observations were conducted in twelve learning sessions across science and religious classes to directly examine how integration occurred during teaching and learning activities. Field notes were systematically recorded to capture teacher–student interactions, learning sequences, and the use of Qur'anic references in scientific discussions. Document analysis included the review of curricula, syllabi, lesson plans, teaching materials, and student research reports to identify how epistemological integration is structurally embedded in educational documents.

Data analysis followed the interactive model involving data reduction, data display, and conclusion drawing and verification (Miles et al., 2014). In addition, this study applied an epistemological analytical approach to specifically examine how revelation, reason, and empiricism are positioned and related within the curriculum and learning practices. This was operationalized by coding the data into three analytical categories: references to Qur'anic or revelatory foundations, manifestations of rational-conceptual explanation, and forms of empirical inquiry or experimentation. The interaction among these three categories became the primary analytical lens for interpreting how epistemological integration functioned in practice.

To ensure trustworthiness, triangulation was conducted across data sources, data collection methods, and time of observation. Member checking was implemented by returning interview summaries and preliminary interpretations to several participants to confirm the accuracy of the researcher's understanding. Credibility, transferability, dependability, and confirmability were addressed following the framework proposed by Lincoln and Guba (1985). The entire research process adhered to ethical standards, including informed consent, confidentiality of participants, and voluntary participation

RESULT AND DISCUSSION

Result

An Epistemological Integration Model in the Curriculum Structure

The figure 1 represents an actual learning pattern repeatedly observed in classrooms at Trensains Muhammadiyah Sragen and confirmed through interviews and curriculum documents. The integration of revelation, reason, and empiricism is implemented as a fixed sequence of learning activities embedded in lesson design rather than as a symbolic addition to science content.

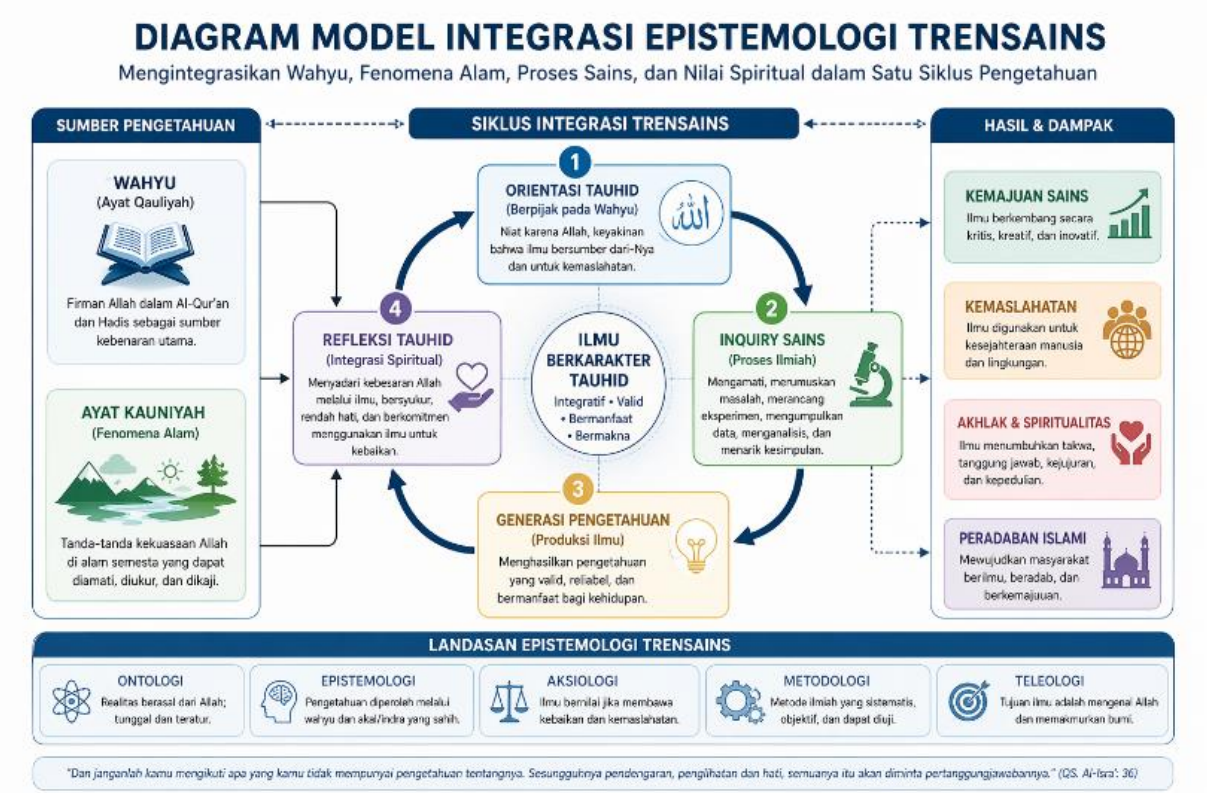
Classroom observations show that lessons consistently begin from Qur'anic verses related to natural phenomena (*ayat kauniyah*). These verses function as the epistemological entry point that stimulates questions before scientific theory is introduced. As one administrator explained,

> "We do not merely attach verses to science material. The verse is where students start thinking. From there, questions emerge before the theory is introduced" (Interview, Administrator, 2025).

A science teacher confirmed this pattern: "*Before opening the textbook, students read the verse first. I ask them what phenomenon is mentioned there, and that question leads the lesson"* (Interview, Teacher, 2025). Students also recognized this structure: "Usually we start with a verse, discuss its meaning, and only after that go into science" (Interview, Student A, 2025).

Figure 1.

Epistemological Integration Model in the Curriculum Structure



From this starting point, inquiry and experimentation grow naturally from the discussion of the verse. After identifying the phenomenon described in the verse, students are directed to observe, test, or experiment. A teacher described, "*After discussing verses about motion, students conducted experiments measuring speed. I told them: now let us observe how Allah's law works"* (Interview, Teacher, 2025). A student reflected, *"The experiment feels like continuing the verse we discussed. It is like proving what we read"* (Interview, Student B, 2025). This shows how empiricism is not introduced independently but emerges from reflection on revelation.

Scientific reasoning then becomes central as students analyze results using formulas and concepts. A religious studies teacher emphasized, *"Students must understand the formulas and concepts. Reason is used fully, but they are reminded that these laws are part of Allah's creation"* (Interview, Teacher, 2025). A student noted, *"We calculate and discuss the theory, but the teacher always connects it back to what the verse meant"* (Interview, Student C, 2025). Here, reason acts as a bridge linking revelation and empirical findings.

Each lesson concludes with reflection that reinforces tawhid awareness. An administrator stated, "Learning is not complete when students understand the concept. It is complete when they realize the meaning behind it" (Interview, Administrator, 2025). A student shared, *"At the end, we are always asked what lesson about faith we get from the*

topic" (Interview, Student D, 2025). This reflective closure is a consistent component of the learning sequence.

Curriculum documents and lesson plans at Trensains Muhammadiyah Sragen explicitly require this order verse, inquiry, conceptual explanation, and reflection, demonstrating that the model is structurally embedded rather than dependent on individual teacher preference. A curriculum document states, "Each science topic must begin from *ayat kauniyah*, proceed through inquiry, be explained conceptually, and end with reflective internalization of tawhid values" (Document Analysis, 2025).

Teachers observed concrete impacts on students. One teacher explained, *"Students can explain science clearly and also express its religious meaning"* (Interview, Teacher, 2025). A student added, "Science lessons make me admire Allah's creation. It feels meaningful, not only for exams" (Interview, Student E, 2025).

Across observations, interviews, and documents, the figure accurately represents a repeated pedagogical cycle. Revelation, reason, and empiricism operate as one continuous epistemological process in classroom practice rather than as separate domains.

Implementation of Integration in the Learning Process

Figure 2.

Group Experimental Activity Using Verse-Based Inquiry Worksheet

In classroom practice at Trensains Muhammadiyah Sragen, epistemological integration is not only visible in curriculum documents but becomes operational through inquiry-based learning, problem-based learning, and research-based learning that follow a consistent sequence: Qur'anic orientation, scientific exploration, empirical verification, conceptual reasoning, and reflective internalization of tawhid values.

Observation notes show that inquiry-based learning begins when the teacher presents a Qur'anic verse related to a natural phenomenon and asks students to generate investigable questions from it. In one observed physics lesson on motion, students first read verses about order and measure in creation, then formulated questions about how speed can be measured. They designed simple experiments using measuring tools, recorded data, and discussed patterns they found. The teacher stated, *"After students read the verse, I ask them what phenomenon can be investigated. Their questions become the basis of the experiment"* (Interview, Teacher, 2025). A student confirmed, *"We don't start from formulas. We start from the verse and then try to find the scientific explanation"* (Interview, Student A, 2025). Field notes documented students working in small groups with worksheets that explicitly linked the verse, the question, the experiment, and the conclusion.

Problem-based learning appears when teachers introduce real-life problems connected to both scientific concepts and Qur'anic meaning. During an astronomy topic, students were asked to explain the regularity of planetary motion as described in verses about celestial order. They discussed why such regularity is important for life on earth, searched for scientific explanations, and presented solutions in groups. The teacher explained, *"Students are given a problem that connects the verse with a scientific issue. They must solve it using both understanding of the text and scientific reasoning"* (Interview, Teacher, 2025). Observation records noted active debate among students, concept mapping on the board, and explicit references back to the verse during argumentation. A student reflected, *"Discussing the problem makes us see that the verse is not symbolic; it relates to real scientific facts"* (Interview, Student B, 2025).

Research-based learning is implemented through mini research projects where students investigate phenomena mentioned in *ayat kauniyah*. In a biology project, students examined plant growth in different conditions after reading verses about vegetation and life. They designed procedures, collected data over several days, analyzed results, and wrote short reports that included both scientific findings and reflective insights. The teacher noted, "Students conduct small research projects. They learn the research process while realizing the meaning of the verse they started from" (Interview, Teacher, 2025). Documentation of student reports shows sections titled: verse reference, research question, method, findings, and reflection. A student stated, *"Writing the report makes us connect the experiment with what the Qur'an says about nature"* (Interview, Student C, 2025).

Across these activities, teachers consistently position themselves as facilitators who connect scientific concepts with Islamic values without reducing either dimension. As one teacher summarized,

> "When we teach about the universe, we start with Qur'anic verses about creation, then move to physics or astronomy concepts. Students see a direct connection between revelation and science" (Interview, Teacher, 2025).

Students perceive this as a distinctive learning experience: "*Learning science here isn't just about formulas; it helps us understand the greatness of Allah, so it feels more meaningful"* (Interview, Student D, 2025).

Classroom observations, learning worksheets, student research reports, and interview data together show that inquiry, problem-solving, and research activities are structured to operationalize the relationship between revelation, reason, and empiricism. Integration is therefore enacted through concrete pedagogical routines that repeatedly guide students from verse, to investigation, to reasoning, and finally to reflective awareness.

The Impact and Challenges of Epistemological Integration

Findings at Trensains Muhammadiyah Sragen show that the integration of revelation, reason, and empiricism produces observable effects on both students' cognitive performance and spiritual disposition. These impacts were consistently identified across interviews, classroom observations, and student learning documents.

From a cognitive perspective, students demonstrate stronger analytical reasoning when explaining scientific concepts because they are accustomed to moving from questions generated by *ayat kauniyah* to investigation, analysis, and conceptual explanation. Observation notes recorded students debating experimental results using formulas while still referring back to the initial verse that framed the inquiry. A teacher explained, *"Students are not only able to explain scientific concepts but also connect them to the values of faith. This is what we see as the primary outcome of the integration"* (Interview, Teacher, 2025). Student worksheets and reports also show structured reasoning that links the research question, empirical data, conceptual explanation, and reflective meaning.

From an affective and spiritual perspective, students display heightened religious awareness when engaging with science learning. Several students expressed that science lessons feel meaningful because they reveal the signs of Allah in nature rather than functioning as abstract knowledge for examinations. One student noted, *"When we study science, we feel like we are reading the signs of Allah in the universe, not just memorizing formulas"* (Interview, Student, 2025). Teachers also observed that reflective sessions at the end of lessons often lead to deeper classroom discussions about faith, gratitude, and responsibility toward nature.

Despite these positive impacts, the study identified practical challenges in sustaining epistemological integration. The most significant challenge relates to teacher competence. Not all teachers possess equal mastery of both scientific content and Islamic epistemology,

which affects the consistency of integration in classroom practice. As one administrator stated, *"The biggest challenge is preparing teachers who truly understand both fields, science and Islam"* (Interview, Administrator, 2025). Classroom observations confirmed that the depth of integration varies depending on the teacher's background and confidence in connecting the two domains.

Another challenge concerns the limited availability of systematically integrated teaching materials. Although the curriculum requires verse-based inquiry and reflective closure, teachers often need to design their own worksheets and materials to align with this model. This creates variability in implementation and increases teacher workload. A teacher commented, *"Sometimes we have to prepare additional materials ourselves because textbooks do not provide this integrated structure"* (Interview, Teacher, 2025).

Overall, the evidence indicates that epistemological integration has been implemented in a substantive and practical manner, producing measurable cognitive and spiritual outcomes for students. At the same time, the sustainability of this model depends on strengthening teacher capacity and developing more standardized integrated learning resources to ensure consistent implementation across classrooms.

Discussion

Epistemological Integration in the Curriculum as a Substantive Model

The findings show that integration at Trensains Muhammadiyah Sragen is epistemologically substantive rather than symbolic. This confirms that the practice goes beyond the common pattern in many Islamic educational settings where Qur'anic verses are merely appended to science topics without reconstructing how knowledge is approached and generated (Kuntowijoyo, 2006). At Trensains, revelation functions as the epistemic entry point that shapes questioning, investigation, reasoning, and reflection within a single learning cycle.

Theoretically, this model resonates with the thought of Syed Muhammad Naquib al-Attas, who argues that knowledge must be grounded in tawhid as its ontological and epistemological foundation (Al-Attas, 1995). Positioning ayat kauniyah as the starting point of inquiry demonstrates how the Qur'an operates not only as a source of legitimacy but as a source of scientific inspiration. This orientation also reflects the Islamization of knowledge framework of Ismail Raji al-Faruqi (Al-Faruqi, 1982), but in a more operational form. While Al-Faruqi emphasizes conceptual reconstruction of disciplines, Trensains shows how this reconstruction is translated into curriculum structure and classroom routines (Sudrajat, A. 2018); Pathin, T. D., & Hanif, M. 2026).

This practice can further be understood through the integration–interconnection paradigm proposed by Amin Abdullah (Abdullah, 2012), where religion and science are

placed in constructive dialogue rather than fused indistinctly. The continued use of the scientific method alongside revelational orientation shows that empiricism and reason remain analytically functional while guided by a revelational framework of meaning.

Recent international scholarship strengthens the academic grounding of this model by showing that the meeting point between science and religion in classrooms is increasingly discussed as a pedagogical and epistemic issue rather than merely a philosophical one. Empirical evidence indicates that science–religion encounters can create overlapping epistemic spaces in learning when both domains are deliberately engaged through instructional design (Bowie et al., 2023). Similar findings in Islamic school contexts demonstrate that teachers who intentionally embed Islamic worldview into science lessons produce deeper conceptual and reflective understanding among students (Sahil et al., 2024).

Contemporary studies also argue that integration between religion and science contributes to the development of a more holistic scientific paradigm in Islamic education, where revelation and reason are positioned as complementary sources of knowledge rather than competing authorities (Erika et al., 2026). At the level of student development, integrating the nature of science with religious belief has been shown to strengthen both scientific comprehension and religious conviction simultaneously (Tursinawati et al., 2024). In addition, curriculum studies emphasize that systematic interconnection between Islam and science can function as a strategic foundation for strengthening Islamic education curricula in response to modern educational challenges (Febriyani et al., 2026).

These recent studies confirm that what occurs at Trensains is part of a broader emerging discourse in international scholarship, yet with a distinctive contribution: the integration is not only discussed theoretically or observed partially, but structurally embedded in the curriculum and pedagogically routinized in classroom practice. The Trensains model therefore bridges classical philosophical formulations of knowledge integration with contemporary pedagogical implementation, demonstrating a concrete shift from normative discourse toward operational epistemological practice in Islamic education.

Pedagogical Implementation: Integration as a Learning Practice

The second finding shows that epistemological integration at Trensains Muhammadiyah Sragen moves beyond conceptual formulation and becomes visible in daily learning routines through inquiry-based learning, problem-based learning, and student research activities. Integration is therefore enacted operationally, not merely stated normatively in curriculum documents.

Beginning lessons from verses on the natural world reflects a constructivist orientation in which students build understanding through reflection, questioning, investigation, and experience rather than receiving information passively. In this sense, revelatory texts function

as cognitive triggers that lead students to explore empirical reality and formulate scientific explanations. This aligns with contemporary views of learning that emphasize knowledge construction through active engagement and meaning-making processes (OECD, 2021). Recent studies confirm that inquiry-based and problem-based approaches in integrated curricula significantly enhance students' epistemic cognition because students learn to connect sources of knowledge rather than treat them as separate domains (Yusriani, Y. 2025).

This practice is also consistent with the perspective of Seyyed Hossein Nasr, who argues that science in an Islamic worldview should not be detached from its spiritual dimension (Nasr, 2006). The learning pattern observed at Trensains shows that science education becomes a medium for tadabbur (contemplation) of nature, where empirical investigation deepens spiritual awareness rather than distancing students from it. Similar findings in international research indicate that integrating science with value-based education strengthens students' critical thinking and ethical reasoning alongside conceptual understanding (Chen & Tang, 2024; Sutiana, D., & Nugraha, M. S. 2025).

Field findings also reveal that the depth of integration varies according to teachers' competencies in relating scientific concepts to Islamic epistemology. This confirms that epistemological integration requires specific pedagogical and epistemic capacities. Studies emphasize that teachers' epistemological beliefs strongly influence how integration is enacted in classrooms and that integrative competence must be deliberately developed (Fauzi & Ramli, 2025; Schraw, G., & Olafson, L. 2002). Without adequate epistemological understanding, integration risks becoming symbolic rather than substantive (Harahap, S., & Pohan, N. J. 2025); Halstead, 2018).

Further support comes from research showing that bridging faith and science in STEM education positively shapes students' understanding and value formation (Ortiz-Revilla, J., et.al., 2020). Pedagogical strategies for integrating science and religion have also been discussed as relevant for multicultural and contemporary classrooms, where diverse epistemologies meet (El-Hani, C. N., & Mortimer, E. F. 2007). In addition, curriculum studies highlight that integration between science, religion, and sustainability values can strengthen the relevance of Islamic education in modern contexts (Rahayu & Kurniasih, 2023). Discussions on epistemic justice further underline the importance of recognizing Islamic epistemology as a legitimate source of knowledge in science classrooms (Syarip, S., et.al., 2026). Therefore, the effectiveness of epistemological integration depends not only on curriculum design but also on pedagogical quality and the teacher's capacity as the primary actor who translates epistemological principles into meaningful learning experiences.

Impacts and Challenges: Toward Holistic Islamic Education

The third finding indicates that epistemological integration at Trensains Muhammadiyah Sragen contributes positively to the development of students' holistic competencies, encompassing both cognitive and spiritual dimensions. Students demonstrate analytical reasoning when explaining scientific concepts while also showing reflective awareness of the spiritual meaning behind the knowledge they acquire. This condition reflects the ideal of Islamic education described by Azyumardi Azra (Azra, 2019), where intellectual growth and moral formation must develop in a balanced and integrated manner.

From a broader educational perspective, this model is consistent with the framework of 21st-century learning that emphasizes critical, creative, and reflective thinking skills (OECD, 2021; World Bank, 2020). What distinguishes the Trensains practice is its ability to embed these competencies within the values of tawhid. This is in line with recent findings showing that integrating science with values education strengthens students' critical thinking and ethical reasoning (Chen & Tang, 2024) and shapes students' spiritual disposition alongside conceptual mastery (Sutiana, D., & Nugraha, M. S. 2025). Inquiry-based and problem-based learning in integrated curricula are also shown to enhance students' epistemic cognition because learners connect multiple sources of knowledge rather than treating them as isolated domains (Yusriani, Y. 2025).

These findings also support the argument of Zainal Abidin Bagir (Bagir, 2019) that the integration of science and religion can address the crisis of meaning in modern education. International discussions describe such encounters as science–religion overlapping domains in classrooms when instructional design intentionally bridges both epistemic traditions (Bowie et al., 2023). Empirical evidence from Islamic school contexts further confirms that embedding Islamic worldview into science lessons produces deeper student understanding and reflection (Sahil et al., 2024).

At the pedagogical level, the effectiveness of this integration is strongly influenced by teachers' epistemological beliefs and their pedagogical practices (Schraw, G., & Olafson, L. 2002). Research highlights that integrative competence among teachers must be intentionally developed and assessed to ensure consistent classroom implementation (Fauzi & Ramli, 2025). This aligns with Abdullah and Al-Hafiz's (2022) proposal of an Islamic epistemic framework for science education that requires teachers to understand how revelation, reason, and empiricism interact within learning. Similar studies emphasize that bridging faith and science in STEM education contributes positively to students' value formation (Ortiz-Revilla, J., et.al. 2020) and is relevant in multicultural classroom contexts where diverse epistemologies meet (El-Hani, C. N., & Mortimer, E. F. 2007). The importance

of recognizing Islamic epistemology as a legitimate knowledge source in science classrooms is also discussed under the concept of epistemic justice (Syarip, S., et.al., 2026).

In terms of curriculum relevance, integration between science, religion, and sustainability values is increasingly discussed as a way to strengthen the responsiveness of Islamic education to contemporary challenges (Rahayu & Kurniasih, 2023; Febriyani et al., 2026). Conceptual studies also emphasize that integration contributes to the development of a holistic scientific paradigm in Islamic education where revelation and reason are complementary (Erika et al., 2026). Empirical classroom research at the elementary level further shows that integrating the nature of science with religion increases students' religious conviction alongside scientific understanding (Tursinawati et al., 2024).

At the same time, this study reveals structural challenges that affect sustainability. Limitations in human resources, particularly teachers who possess integrative epistemological competence, and the scarcity of systematically integrated teaching materials create variability in classroom implementation. These challenges are consistent with findings by Pathin, T. D., & Hanif, M. (2026) and Zarkasyi (2020), who argue that integration between science and Islam requires not only philosophical commitment but also institutional support systems to prevent it from remaining at the level of ideal discourse.

Therefore, although the integration model at Trensains demonstrates substantive success, its sustainability and potential replication depend on deliberate strengthening in teacher development, curriculum refinement, and the provision of integrated learning resources that ensure consistent implementation across learning practices.

CONCLUSION

This study finds that the integration of the epistemologies of science and Islam at Trensains Muhammadiyah Sragen is implemented in a substantive, operational, and systematic manner. Integration does not stop at the formal curriculum level but is embedded epistemologically through the reconstruction of the relationship between revelation, reason, and empiricism as a unified source of knowledge. In classroom practice, learning consistently begins from ayat kauniyah, develops through inquiry and experimentation, is explained through scientific reasoning, and ends with reflective internalization of tawhid values. This pattern shows that science is not positioned as a value-neutral discipline but as a means to understand the signs of God's greatness within a coherent epistemological framework.

Theoretically, this study contributes an operational model of epistemological integration that translates philosophical ideas about the Islamization of knowledge into concrete curriculum structures and pedagogical routines. Practically, the findings demonstrate that inquiry-based learning, problem-based learning, and research-based

learning can function as effective vehicles for integrating revelation, reason, and empiricism in classroom activities. This model offers an alternative reference for the development of modern pesantren curricula and provides a practical response to the long-standing dichotomy between religious and general sciences while remaining relevant to the demands of 21st-century education.

This study is limited to an intrinsic case at a single pesantren, which means the findings cannot be generalized to all Islamic educational institutions without further comparative research. In addition, variations in teacher competence and the limited availability of systematically integrated teaching materials indicate areas that require further development. Future research is recommended to examine similar integration models in different pesantren contexts, to develop standardized integrated teaching resources, and to investigate the long-term impact of epistemological integration on students' academic and spiritual trajectories.

DECLARATIONS

Author Contribution

Saputra, I. H., Conceptualization, methodology, data collection, data analysis, manuscript drafting; **Tobroni, T.,** Literature review, validation, supervision, manuscript review and editing; **Nurhakim, M.** Data interpretation, visualization, technical support, manuscript revision; **Karmiyati, D.,** Project administration, final approval of the manuscript.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Declaration of AI Use

The authors used artificial intelligence tools solely to assist with language editing and grammar improvement. All ideas, analyses, and conclusions presented in this manuscript remain the full responsibility of the authors.

Additional Information

Not applicable.

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