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A Web-Based Educational Innovation for Quran-Astronomy Integration: Design, Development, and Implications for 21st-Century Learning

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Abstract: *Contemporary education in the twenty-first century necessitates a comprehensive, integrative, and technology-enhanced approach to learning in order to cultivate individuals who are not only intellectually competent but also grounded in values and equipped with higher-order thinking skills. Within the domain of Islamic education, the harmonization of naqli (revealed) and aqli (rational) knowledge-particularly through the integration of Quranic discourse with contemporary astronomical science-remains a pedagogical challenge that calls for structured, interactive, and accessible learning platforms. In response to this need, the present study seeks to design and develop an integrated web-based educational platform that systematically links Quranic verses related to cosmic phenomena with established concepts in modern astronomy as a medium for twenty-first-century learning. The development process is underpinned by the ADDIE instructional design framework, encompassing the phases of needs analysis, instructional and system design, content development, implementation, and evaluation. The platform adopts an integrative pedagogical orientation, emphasizing tafsir 'ilmi, comparative epistemological perspectives between Islamic scholarship and scientific inquiry, as well as the incorporation of multimedia and interactive features to facilitate meaningful and engaging learning experiences. Methodologically, the study employs a mixed-methods design, integrating content analysis, observational techniques, and survey-based instruments to assess both usability and instructional effectiveness. The findings reveal that the developed platform demonstrates considerable potential as an effective educational tool in enhancing learners' comprehension of Quranic astronomy and in fostering a deeper appreciation of the relationship between revelation and scientific knowledge. The inclusion of interactive functionalities, visual representations of cosmic phenomena, and a well-structured content organization significantly contributes to increased learner engagement, motivation, and autonomy in learning. From a pedagogical standpoint, the platform supports the cultivation of essential twenty-first-century competencies, including critical thinking, self-directed learning, and interdisciplinary integration of knowledge domains. In summary, this study underscores the potential of digital technology as an effective medium for enriching contemporary Islamic education through the integration of Quranic and astronomical knowledge. This approach is well aligned with the shifting paradigms of twenty-first-century education and supports the cultivation of well-rounded individuals who embody both intellectual depth and spiritual integrity.*

Keywords: Islamic Education Technology; Web-Based Learning Platform; Naqli–Aqli Knowledge Integration

1. Introduction

The rapid evolution of digital technologies has fundamentally reshaped the landscape of contemporary education, particularly within the framework of 21st-century learning. Current pedagogical paradigms emphasize not only disciplinary knowledge acquisition but also higher-order competencies such as critical thinking, digital literacy, collaboration, and self-regulated learning (Voogt et al., 2013; OECD, 2023). In this context, the integration of educational technology has emerged as a critical enabler of meaningful learning, particularly when supported by coherent instructional design models that align content, pedagogy, and technological affordances. Recent studies have reaffirmed that technology-enhanced learning environments, when grounded in sound pedagogical principles, can significantly improve learners' conceptual understanding and engagement (Bond et al., 2023; Schindler et al., 2017). Furthermore, advances in multimedia learning research highlight the importance of interactive and visual representations in facilitating the comprehension of complex scientific concepts, especially in STEM-related domains (Mayer, 2014).

Within Islamic educational discourse, the integration of *naqli* (revealed knowledge) and *aqli* (rational or empirical knowledge) remains a central epistemological concern. Contemporary scholarship increasingly revisits the classical Islamic intellectual tradition, which historically upheld the complementarity of revelation and reason rather than a dichotomous relationship (Hashim & Rossidy, 2000; Al-Attas, 1993). From an Islamic epistemological perspective, the Qur'an consistently encourages reflection upon the natural world as *ayat kawniyyah* (cosmic signs), thereby positioning scientific inquiry as an extension of spiritual and intellectual engagement (Guessoum, 2011). However, despite these theoretical foundations, modern educational systems often perpetuate a fragmentation between religious and scientific knowledge, resulting in a compartmentalized understanding that limits interdisciplinary integration and holistic worldview development (Zul et al., 2026).

Astronomy (*ʿilm al-falak*) represents a particularly significant domain for exploring the integration of Qur'anic knowledge and scientific inquiry. Numerous Qur'anic verses reference celestial phenomena, including the motion of the sun and moon, the structure of the cosmos, and the precision of cosmic order. Recent scholarship in Islamic science and Qur'anic cosmology emphasizes the need for a methodologically rigorous approach that balances scriptural interpretation (*tafsir*) with contemporary astrophysical knowledge (Guessoum, 2011; Saliba, 2007). At the same time, the legacy of Islamic astronomy underscores its historical importance within Muslim civilization as a field that bridged observation, mathematics, and theological reflection. Despite this rich intellectual heritage, current digital educational resources tend to adopt either a predominantly theological orientation with limited scientific depth or a purely scientific perspective lacking exegetical grounding. This dichotomy highlights a critical gap in the design of integrated educational platforms.

In parallel, recent advancements in digital pedagogy highlight that the effectiveness of web-based learning environments is contingent upon well-structured instructional design, active user engagement, and alignment with clearly defined learning objectives (Bond et al., 2023; Redecker & Punie, 2017). However, the limited availability of pedagogically coherent platforms that meaningfully integrate Qur'anic exegesis with contemporary scientific knowledge continues to present a significant gap in current educational practice. Addressing this gap is particularly critical within the context of 21st-century education, where interdisciplinary learning and epistemological integration are increasingly emphasized as essential components of holistic knowledge development.

In response to these challenges, this study proposes the design and development of a web-based educational innovation, *QuranAstro*, which systematically integrates Qur'anic exegesis (*tafsir 'ilmi*) with modern astronomical knowledge. Grounded in principles of instructional design, multimedia learning, and Islamic epistemology, the platform aims to facilitate meaningful learning experiences that promote critical reflection, conceptual understanding, and the harmonization of revelation and scientific inquiry. By situating the integration of Qur'an and astronomy within a digitally mediated learning environment, this study contributes to the advancement of holistic education aligned with the demands of 21st-century learning.

2. Research Objectives

Grounded in the identified educational and technological gaps, this study aims to achieve the following objectives:

- **To establish the pedagogical and epistemological need** for an integrated Quran–astronomy educational platform that bridges revealed knowledge (*naqli*) and rational-scientific knowledge (*aqli*) within a digital learning environment.
- **To design and develop the QuranAstro web-based platform** using a systematic instructional design framework, ensuring pedagogical coherence, structured content architecture, and the effective integration of multimedia and interactive features.
- **To evaluate the developed platform** in terms of usability, functionality, and educational effectiveness, particularly in enhancing users' conceptual understanding, learning engagement, and interdisciplinary appreciation of Quranic astronomy.

3. Literature Review

3.1 Integration of Qur'an and Astronomy: Epistemological and Methodological Perspectives

The integration of Qur'anic knowledge and scientific inquiry has increasingly attracted scholarly attention within contemporary Islamic intellectual discourse. Central to this discussion is the Qur'anic encouragement of *tafakkur* (reflective thinking) upon natural phenomena as *ayat kawniyyah* (cosmic signs), which positions the study of the natural world as both an intellectual and spiritual endeavor. Recent studies in Islamic epistemology reaffirm that the relationship between *naqli* (revealed knowledge) and *aqli* (rational knowledge) is inherently complementary rather than dichotomous, thus providing a foundational framework for interdisciplinary integration (Hashim & Rossidy, 2000; Majid & Khairudin, 2023).

Contemporary scholarship has further examined the methodological implications of *tafsir 'ilmi* (scientific exegesis), particularly in relation to modern scientific developments. While such approaches offer opportunities for meaningful engagement between scripture and science, recent studies caution against reductionist or "scientific miracle" narratives that risk oversimplifying both the Qur'anic text and scientific knowledge (Guessoum, 2011; Sardar, 2022). Instead, scholars advocate for a balanced epistemological approach that maintains theological integrity while embracing empirical inquiry. This perspective is increasingly reflected in Scopus-indexed discussions on Islam and science, which emphasize critical engagement, contextual interpretation, and interdisciplinary dialogue (Zul et al., 2026).

Within the domain of astronomy (*'ilm al-falak*), recent research highlights its historical significance within the Islamic intellectual tradition as well as its continued relevance in contemporary scientific discourse. Studies have demonstrated that Qur'anic references to celestial bodies-such as the sun, moon, stars, and cosmic order, provide rich entry points for

integrating scriptural reflection with astrophysical concepts (Mohammaddin et al., 2023). However, existing literature remains largely theoretical and text-oriented, focusing on hermeneutical analysis rather than pedagogical application. Empirical studies that translate Qur'an-astronomy integration into educational practice, particularly through digital platforms, remain limited.

Moreover, recent discourse in Islamic epistemology calls for the development of integrative knowledge frameworks that move beyond fragmented disciplinary approaches toward a holistic worldview rooted in *tawhidic* principles (Majid & Khairudin, 2023; Hashim & Rossidy, 2000). Despite these theoretical advancements, there remains a significant gap in the implementation of such frameworks within technology-enhanced learning environments. This gap underscores the need for innovative educational models that systematically integrate Qur'anic exegesis, contemporary astronomy, and pedagogically sound digital design.

3.2 Web-Based Knowledge Systems and Digital Learning Environments

The rapid expansion of digital technologies has significantly transformed educational practices, particularly through the proliferation of web-based learning environments. Recent research highlights that digital platforms can support flexible, self-directed, and personalized learning experiences when designed with strong pedagogical foundations and user-centered principles (Bond et al., 2023; OECD, 2023). In this regard, web-based systems are no longer viewed merely as repositories of information but as dynamic environments that facilitate active knowledge construction and engagement.

A growing body of literature emphasizes the role of multimedia and interactivity in enhancing learning outcomes, particularly in science education. Visualizations, simulations, and interactive elements have been shown to significantly improve learners' conceptual understanding of abstract and complex phenomena by reducing cognitive load and supporting mental model development (Mayer, 2014; Schindler et al., 2017). This is especially relevant in astronomy education, where many concepts, such as cosmic scale, orbital motion, and celestial mechanics, are not directly observable and therefore require representational support.

In addition, contemporary digital competence frameworks stress the importance of instructional design, usability, and user experience (UX) in ensuring the effectiveness of web-based learning platforms. The European Digital Competence Framework for Educators (DigCompEdu), for instance, highlights the need for structured content organization, intuitive navigation, and interactive engagement to support meaningful learning (Redecker & Punie, 2017). Platforms that lack these features often fail to achieve their pedagogical potential, functioning instead as static and fragmented information sources.

Comparative analyses of existing educational websites, particularly within religious and scientific domains, reveal a persistent dichotomy. Many platforms prioritize narrative or textual exposition without sufficient interactivity, while others present scientific content in a decontextualized manner without epistemological grounding. This fragmentation reflects a broader challenge in digital education: the lack of integrated platforms that combine disciplinary knowledge, pedagogical structure, and user-centered design.

In response to these gaps, the development of QuranAstro represents an effort to conceptualize and implement a web-based educational innovation that integrates Qur'anic exegesis with contemporary astronomical knowledge. By incorporating principles of instructional design,

multimedia learning, and Islamic epistemology, the platform seeks to provide a coherent and engaging digital learning environment aligned with the demands of 21st-century education.

4. Research Methodology

This study adopts a Design and Development Research (DDR) approach to systematically design, develop, and evaluate a web-based educational platform integrating Qur'anic exegesis and astronomy. DDR is particularly appropriate for studies that aim to produce educational innovations while simultaneously examining their pedagogical effectiveness in real-world contexts (Richey & Klein, 2007). In addition, this study is underpinned by an Islamic epistemological framework, which emphasizes the integration of *naqli* (revealed knowledge) and *aqli* (rational-scientific knowledge) as a foundation for holistic knowledge construction (Hashim & Rossidy, 2000; Majid & Khairudin, 2023).

To operationalize the development process, this study employs the ADDIE instructional design model, comprising five iterative phases: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model remains widely recognized for its systematic, flexible, and iterative structure in developing digital learning environments (Branch & Dousay, 2022; Kurt, 2018). Its structured approach ensures alignment between learning objectives, content organization, technological affordances, and user engagement.

4.1 Analysis Phase

The analysis phase aimed to identify learners' needs, prior knowledge, and engagement patterns related to Qur'an–astronomy integration. Needs analysis is a critical component of instructional design, as it ensures alignment between learner characteristics, learning objectives, and technological solutions (Branch & Dousay, 2022).

Data were collected through structured questionnaires and document analysis. The questionnaire design followed contemporary methodological standards to ensure clarity, validity, and reliability (Taherdoost, 2022). Document analysis was conducted to examine existing learning resources, particularly the extent to which current materials present fragmented versus integrated approaches to Qur'anic and scientific knowledge.

The findings indicated that respondents generally demonstrated limited prior exposure to *tafsir 'ilmi* in astronomy, alongside a lack of access to structured and interactive learning platforms. These results support the need for a pedagogically grounded, multimedia-enhanced digital platform. Such findings are consistent with recent studies highlighting the importance of digital scaffolding in facilitating interdisciplinary and conceptually complex learning (OECD, 2023).

4.2 Design Phase

The design phase translated the identified needs into pedagogical and technical specifications. This phase was guided by user-centered design principles and structured digital architecture to enhance usability, accessibility, and learning efficiency (ISO, 2019).

The design framework incorporated the following components:

- Structured information architecture and taxonomy
- Intuitive navigation flow
- Thematic cosmic-based visual interface
- Clear distinction between Qur'anic exegesis and scientific explanation
- Integration of multimedia elements (e.g., diagrams, simulations, interactive components)

The design decisions were informed by contemporary multimedia learning theory, which emphasizes the alignment between visual and textual information to optimize cognitive processing (Mayer, 2014). Additionally, structured learning design models highlight the importance of scaffolding and sequencing in facilitating complex knowledge acquisition (van Merriënboer & Kirschner, 2017).

4.3 Development Phase

During the development phase, the QuranAstro platform was constructed using web-based technologies to ensure responsiveness, accessibility, and scalability. The development process integrated interdisciplinary content, including:

- Selected Qur'anic verses related to astronomical phenomena
- *Tafsir 'ilmi* interpretations grounded in established exegetical approaches
- Contemporary astronomical concepts and explanations
- Visual simulations of cosmic phenomena
- Interactive learning components and gamified elements

The integration of multimedia and interactive features was informed by empirical research demonstrating that simulations and gamification can significantly enhance learners' motivation, engagement, and conceptual understanding when aligned with instructional objectives (Clark & Mayer, 2023; OECD, 2023).

Furthermore, the development phase incorporated Islamic epistemological considerations by ensuring that scientific explanations were presented in harmony with Qur'anic interpretations, thereby avoiding reductionist or purely instrumental approaches to knowledge (Hashim & Rossidy, 2000; Majid & Khairudin, 2023).

4.4 Implementation Phase

The implementation phase involved pilot deployment of the QuranAstro platform among university students and lecturers with academic backgrounds in Islamic studies and science-related disciplines. Conducting pilot implementation in authentic educational contexts is a key characteristic of DDR, as it allows for contextual validation and iterative refinement (Richey & Klein, 2007).

Participants were provided with guided access to the platform and given sufficient time to explore its features, including multimedia content, interactive simulations, and structured learning modules. This approach ensured that users engaged meaningfully with the platform prior to evaluation.

4.5 Evaluation Phase

The evaluation phase employed a **mixed-methods approach** to assess usability, functionality, and educational effectiveness. Mixed-methods research is widely recommended in educational technology studies as it enables comprehensive analysis by integrating quantitative and qualitative data (Creswell & Plano Clark, 2018).

Data collection methods included:

- Structured questionnaires (quantitative)
- Observations (qualitative)
- Document analysis

Quantitative data were analyzed using descriptive statistics to measure usability, user satisfaction, and perceived learning effectiveness. Instrument reliability and internal consistency were assessed using established statistical procedures (Taherdoost, 2022). Qualitative data were analyzed thematically to capture users' experiences, perceptions, and suggestions for improvement.

The evaluation framework was guided by established principles of usability and digital learning effectiveness, including user engagement, content clarity, navigation efficiency, and pedagogical impact (OECD, 2023; Redecker & Punie, 2017). This comprehensive evaluation ensured that the platform was assessed not only in terms of technical performance but also its capacity to facilitate meaningful and integrated learning.

5. Findings and Discussion

5.1 Usability, Interface Design, and Cognitive Engagement

The findings demonstrate a high level of user satisfaction with respect to interface consistency, visual coherence, and navigational functionality. Specifically, 93.5% of respondents agreed that layout consistency was maintained across pages, 100% indicated that visual design supported their understanding of the content, and 96.8% confirmed that navigation elements functioned effectively. These results suggest that the platform achieved a high level of usability and interface clarity.

From a theoretical perspective, these findings are consistent with human-centered design principles, which emphasize that usability, consistency, and intuitive navigation are critical determinants of user engagement and learning effectiveness (ISO, 2019; Redecker & Punie, 2017). In line with multimedia learning theory, well-structured visual presentation plays a significant role in reducing extraneous cognitive load and directing learners' attention to relevant information, thereby facilitating meaningful learning processes (Mayer, 2014). Furthermore, recent research highlights that coherent interface design contributes not only to usability but also to sustained cognitive engagement in digital learning environments (Bond et al., 2023).

The high level of agreement among respondents indicates that QuranAstro successfully integrates aesthetic design with functional usability. This integration is particularly important in web-based educational systems, where poorly designed interfaces may hinder learning regardless of content quality. Therefore, the findings suggest that the platform's interface design has effectively supported both user interaction and cognitive processing.

5.2 Content Integration and Interdisciplinary Learning

The results further reveal strong positive perceptions regarding content clarity and interdisciplinary integration. A total of 87.1% of respondents reported that the content was clear and comprehensible, while 96.8% agreed that the selected Qur'anic verses were relevant to the astronomical topics presented. Notably, all respondents (100%) indicated that the integration of scientific explanations with Qur'anic content enhanced their learning experience. These findings provide empirical support for interdisciplinary learning theories, which posit that integrating knowledge across domains facilitates deeper conceptual understanding and knowledge transfer (van Merriënboer & Kirschner, 2017). The integration of *tafsir 'ilmi* with contemporary astronomy appears to have enabled learners to engage in generative cognitive processing, whereby new information is actively connected with prior knowledge (Mayer, 2014).

From an Islamic epistemological perspective, the findings also reinforce the concept of the complementarity between *naqli* and *aqli* knowledge. Recent scholarship emphasizes that meaningful integration of revelation and scientific inquiry can foster a holistic worldview grounded in *tawhidic* principles (Hashim & Rossidy, 2000; Majid & Khairudin, 2023). By structuring theological exposition and scientific explanation within a coherent digital taxonomy, the platform appears to have minimized epistemological confusion while promoting reflective engagement with both domains.

Moreover, contemporary studies in digital learning highlight that structured knowledge representation is essential for presenting complex scientific concepts effectively (OECD, 2023). The strong positive responses suggest that QuranAstro has successfully operationalized this principle, demonstrating that interdisciplinary integration can be effectively implemented within a digital learning environment when supported by sound instructional design.

5.3 User Satisfaction, Engagement, and Sustainability

User satisfaction and continued usage intention were also notably high, with 87.1% of respondents expressing full satisfaction and 96.8% indicating their intention to reuse the platform. These findings suggest that QuranAstro functions as a sustainable and user-centered digital learning environment rather than a static informational resource.

This outcome aligns with established models in educational technology, which identify perceived usefulness, ease of use, and content relevance as key determinants of technology adoption and sustained engagement (Almaiah et al., 2022). Additionally, recent research indicates that multimedia-rich and interactive environments significantly enhance learner motivation and long-term engagement, particularly when aligned with users' digital expectations (Bond et al., 2023; OECD, 2023).

The high intention-to-reuse rate further indicates that the platform possesses characteristics associated with sustainable digital learning systems, including accessibility, structured content delivery, and meaningful interdisciplinary integration. These elements collectively contribute to a positive user experience, which is essential for the long-term viability of educational technologies.

5.4 Implications for 21st-Century Learning and Islamic Educational Paradigms

The findings also demonstrate that the QuranAstro platform supports key competencies associated with 21st-century learning. The integration of Qur'anic and scientific perspectives encourages critical thinking, analytical reasoning, and reflective inquiry. Additionally, the platform's structured navigation and self-paced learning features promote learner autonomy and self-directed learning, while multimedia integration enhances digital literacy.

These outcomes are consistent with contemporary educational frameworks, which emphasize the importance of developing higher-order cognitive skills, interdisciplinary competence, and digital fluency in modern learning environments (OECD, 2023; Voogt et al., 2013). Furthermore, complex learning models highlight that the integration of multiple knowledge domains is essential for fostering holistic understanding and transferable knowledge (van Merriënboer & Kirschner, 2017).

Importantly, from an Islamic epistemological standpoint, the integration of Qur'anic exegesis and modern astronomy contributes to the development of a balanced intellectual and spiritual worldview. Recent scholarship underscores that Islamic education should aim to harmonize

revelation and reason, thereby nurturing individuals who are both scientifically literate and spiritually grounded (Hashim & Rossidy, 2000; Majid & Khairudin, 2023).
In this context, QuranAstro represents a practical realization of integrative knowledge frameworks within a digital environment. It not only supports content acquisition but also fosters epistemological awareness and reflective engagement, aligning with both contemporary educational demands and the philosophical foundations of Islamic education.

5.5 Synthesis of Findings

Overall, the findings indicate that the systematic design and development of QuranAstro have resulted in a pedagogically coherent, user-centered, and cognitively effective digital learning platform. The integration of usability principles, multimedia learning strategies, and Islamic epistemological foundations has contributed to a learning environment that supports both conceptual understanding and holistic knowledge integration.

6. Conclusion

This study has demonstrated that the systematic design and development of an integrated Quran–astronomy educational website, guided by the ADDIE instructional design model, constitutes an effective and theoretically grounded approach for bridging *naqli* (revealed knowledge) and *aqli* (rational-scientific knowledge) within a contemporary digital learning environment. The empirical findings reveal high levels of usability, user satisfaction, and perceived educational effectiveness, indicating that the QuranAstro platform successfully meets both pedagogical and technological objectives.

Beyond its functional performance, the platform provides important insights into how digital innovation can be aligned with holistic Islamic educational philosophy. The structured integration of Qur'anic exegesis (*tafsir 'ilmi*) and modern astronomical knowledge, supported by multimedia design and user-centered architecture, facilitates not only conceptual understanding but also reflective inquiry and interdisciplinary engagement. This integrative approach contributes to the development of learners who are intellectually competent, spiritually grounded, and digitally literate, key attributes emphasized in 21st-century education.
From a theoretical standpoint, this study contributes to the growing body of literature on integrative knowledge by operationalizing the epistemological relationship between revelation and reason within a digital pedagogical framework. It demonstrates that the harmonization of religious and scientific knowledge can be effectively realized through systematic instructional design, thereby addressing longstanding challenges related to the fragmentation of knowledge in contemporary education.

In terms of practical implications, the findings underscore the transformative potential of well-designed web-based platforms in redefining the delivery of Islamic education. By shifting from static, text-based approaches to interactive and learner-centered environments, digital platforms such as QuranAstro can enhance engagement, accessibility, and knowledge integration. This positions such innovations as scalable models for contemporary educational practices that seek to integrate disciplinary and epistemological domains.

Nevertheless, this study is not without limitations. The scope of implementation was confined to a specific sample and context, which may limit the generalizability of the findings. Furthermore, the evaluation primarily focused on short-term user perceptions and usability measures, rather than long-term learning outcomes or deeper epistemological transformation.

Future research is therefore recommended to expand the scope of content and technological sophistication, including the incorporation of advanced simulations, adaptive learning systems, and learning analytics. Longitudinal and experimental studies are also needed to examine the sustained impact of such platforms on learners' conceptual development, critical thinking, and epistemological awareness.

In conclusion, this study affirms that integrated digital platforms such as QuranAstro hold significant potential in advancing innovative, holistic, and sustainable models of Islamic education, aligning traditional knowledge systems with the evolving demands of 21st-century learning.

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Conflict of Interest Statement
The author declares that there are no conflicts of interest related to the publication of this study. This research was conducted independently, and the funding body had no involvement in the design, data collection, analysis, interpretation, or writing of the manuscript.

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