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Educating the Malaysian Community about Islamic Science and Astronomy through an Experiential Learning Approach with Interactive Exhibition Space

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ABSTRACT

The enduring heritage of Islamic science and astronomy (Falak) is integral to Malaysian religious and cultural life, providing the basis for critical practices like Qibla determination and the sighting of the moon crescent (Hilal). Despite this relevance, reliance on traditional, passive education methods has led to a persistent public knowledge deficit, particularly concerning Falak's scientific rigor. This paper proposes and details the implementation of the Interactive Falak Space (IFS) Model at Pusat Falak al-Khawarizmi Melaka (which operates under the Jabatan Mufti Melaka). The model adopts David A. Kolb's Experiential Learning Theory (ELT) and features a deliberate three-phased visitor journey: the Exhibition Space (Concrete Experience), the Interactive Space (Active Experimentation via Augmented Reality, Virtual Reality, and Interactive Wall Projection), and the Dome Projection (Reflective Observation and Abstract Conceptualization). Content is derived from the academic quality of UTeM's Falak curriculum and follows a three-stage curation strategy: general science fundamentals, historical appreciation of Islamic astronomy, and experiential Falak practices. The IFS Model is presented as an innovative and scalable pedagogical solution that effectively bridges the divide between historical scientific contributions and modern, engaging education, ultimately fostering comprehensive scientific literacy and a deeper appreciation for this vital heritage among the Malaysian community.

Keywords: Islamic Astronomy, Falak, Experiential Learning, Interactive Exhibition

INTRODUCTION

Background

The intellectual tradition of Islamic science and astronomy (Falak) occupies a fundamental position in the history of global scientific inquiry, characterized by centuries of sophisticated observation, mathematical precision, and instrument innovation (Hussain & Alias, 2019). In Malaysia, this legacy is particularly salient, as Falak knowledge is directly applied to critical religious duties, including the accurate determination of prayer times (waktu solat), the lunar calendar, and the direction of prayer (Qibla). Integrating this scientific and cultural heritage into the modern Malaysian educational framework is crucial for promoting a holistic and comprehensive understanding of the nation's intellectual past.

However, the current educational landscape often presents this discipline through static, non-participatory means, leading to reduced public interest and a significant knowledge deficit. This central challenge lies in the disconnect between the rich, dynamic history of Islamic scientific methodology and prevailing passive educational approaches (Kolb, 2014). Traditional methods, such as fixed exhibitions and lectures, fail to convey the experiential nature of early Islamic scientific inquiry, resulting in a perceived irrelevance of Falak to contemporary life. To revitalize this crucial field, a transition towards innovative, accessible, and active pedagogical methods is required.

In response to this pedagogical challenge, this paper introduces the Interactive Falak Space (IFS) Model). The primary objectives are:

1. To introduce and justify the adoption of the experiential learning approach as the most effective pedagogical strategy for teaching complex Islamic astronomical concepts to a broad, non-specialist audience.
2. To detail the design and implementation of the three-phased IFS Model (comprising the Exhibition Space, Interactive Space, and Dome Projection) as an immersive, technology-enhanced solution located at Pusat Falak al-Khawarizmi Melaka.
3. To propose the potential of the IFS Model to bridge knowledge gaps, promote cultural pride, and foster a deeper, more comprehensive appreciation of Islamic science and astronomy within the Malaysian community.

Structure Of the Paper

This paper is structured to first establish the theoretical foundation of the study. Section 2 reviews the core literature on Falak, experiential learning theory, and interactive informal education. Section 3 details the methodology, presenting the content curation derived from UTeM's Falak Subject and the three-phased design of the IFS Model. Section 4 discusses the strategic application of technology within each phase and its aligned with experiential learning principles. Finally, Section 5 concludes the paper by summarizing the contributions and outlining avenues for future research and evaluation.

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Defining Islamic Astronomy (Falak) And Its Malaysian Context

Falak is fundamentally an applied science developed during the Islamic Golden Age (8th to 14th centuries). It is defined not merely by celestial observation but by complex fields including spherical trigonometry, geodesy, and the development of sophisticated instrumentation like the Astrolabe, enabling the creation of accurate astronomical tables (Al-Battani, 900). Pioneers like Al-Khawarizmi established systematic methods crucial for the advancement of global astronomy.

In the Malaysian context, Falak takes on a critical dual role: it is both a scientific discipline and a foundation for religious practice. Understanding Falak is necessary for the accurate computation of the five daily prayer times (*waktu solat*), determining the proper lunar phases for the Islamic calendar (*Hijri*), and precisely locating the Qibla (the direction of the Kaaba). Due to its religious necessity, Malaysian Falak education is often institutionalized, falling under the purview of religious bodies like the Jabatan Mufti.

Historically, the teaching of Falak in Malaysia has been constrained, often relying on theoretical or textual approaches within limited religious or university settings. This traditional, passive methodology has fostered a perception of Falak as abstract or purely ritualistic, contributing significantly to the public knowledge deficit and preventing a holistic appreciation of its scientific heritage. Therefore, the strategic mandate for Falak education in Malaysia is to move beyond passive observation and ensure the discipline is taught as a dynamic, engaging, and applied science, directly connecting its historical rigour to contemporary communal relevance.

Experiential Learning Theory (ELT) And Innovation In Islamic Education

This study grounds its pedagogical design in the Experiential Learning Theory (ELT), which defines learning as the process of knowledge creation through the transformation of experience (Kolb, 2014). The full learning cycle involves four interdependent stages: Concrete Experience (CE), Reflective Observation (RO), Abstract

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Conceptualization (AC), and Active Experimentation (AE). The application of ELT is particularly critical for scientific heritage education because it necessitates moving beyond passive consumption of information.

Crucially, the need for an experiential approach addresses a persistent pedagogical challenge within Islamic education generally, and Falak specifically. Much of Islamic knowledge transfer relies on rote memorization and linear, textual instruction, which often fails to stimulate critical thinking, application, or a deep appreciation for the *process* of knowledge generation (Rahman & Idris, 2023). When scientific disciplines like Falak are taught solely through theoretical approaches, the knowledge remains compartmentalized and fails to translate into practical, lived understanding, reinforcing the disconnect identified in the problem statement.

By adopting ELT, the IFS Model introduces an innovative educational opportunity to elevate Islamic education. Utilizing a hands-on, interactive environment, participants are physically and cognitively engaged (CE), allowing them to directly manipulate Falak concepts (AE). This transition from abstract memorization to active participation cultivates a deeper, more personal connection to the subject matter. ELT, therefore, provides the essential framework for transforming Falak from a rigid, historical concept into a dynamic, applied science, fostering intellectual curiosity and ensuring the scientific rigour of Islamic heritage is appreciated and retained.

Interactive Exhibitions and Informal Science Education

Informal learning environments, such as science centers and museums, have proven highly effective in bridging knowledge gaps that formal schooling may leave unaddressed. The efficacy of these spaces rests on their ability to combine cognitive engagement with powerful visual and sensory experiences.

The integration of advanced technologies, such as Augmented Reality (AR), Virtual Reality (VR), and Interactive Projection, within these spaces moves the visitor beyond simple observation into a state of Active Experimentation. For instance, contemporary astronomy education leverages VR and AR to visualize phenomena like black holes or planetary orbits in 3D, enhancing spatial understanding that is difficult to convey in 2D media (Mohd Zulkifly & Abd Rahman, 2021). Similarly, in Malaysia, interactive displays are increasingly used in local museums and Islamic science centers to present historical artifacts, such as ancient calligraphy or indigenous technologies, with digital overlays to explain complex cultural or scientific processes (Sulaiman & Hashim, 2022). This technology-enhanced approach is crucial for revitalizing Falak education. By integrating AR for overlaying data on scholar posters and utilizing VR for simulating historical Qibla calculations, the IFS Model ensures that the interactive exhibits significantly increase visitor engagement time, improve comprehension of complex astronomical and geographical concepts, and enhance the recall of Falak principles, thus maximizing the potential for successful informal learning.

Design And Implementation

Study Location and Context

The Interactive Falak Space (IFS) Model is physically implemented at the Pusat Falak al-Khawarizmi Melaka (Pusat Falak). The Pusat Falak operates under the Jabatan Mufti Melaka (Melaka Mufti Department) and its original and primary function is to conduct astronomical observation and calculation crucial for determining important dates in the Islamic calendar, such as Eid al-Fitr, Eid al-Adha, and the start of Muharram. Since 2020, the facility’s public engagement role has been significantly expanded through the development of the IFS. This initiative serves as a pilot project to transform its public infrastructure into a pedagogically grounded experiential learning environment, showcasing astronomical knowledge in general, progressing toward the specifics of Islamic astronomy (Falak), and detailing the history of Falak, including prominent early and modern Muslim astronomy scholars and Islamic astronomical artifacts.

Content Curation Strategy

The content deployed throughout the IFS Model is intentionally curated to be both academically rigorous (derived from the syllabi of the Falak Subject offered to first-year undergraduate students at Universiti

Teknikal Malaysia Melaka, or UTeM) and accessible to the general masses. The content strategy follows a three-stage progressive learning pathway:

1. **General Astronomy Fundamentals:** The initial focus is on introducing fundamental scientific concepts, including the solar system, universe scale, and the mechanics of the Earth, Moon, and Sun, along with related technologies like rocketry. This forms the essential scientific foundation.

2. **Historical Appreciation of Islamic Astronomy:** The next stage introduces the rich history of Islamic astronomy, highlighting prominent early and modern Muslim scholars and demonstrating how their empirical observations and mathematical advancements significantly contributed to—and often helped shape—modern astronomical science. This helps foster cultural pride and intellectual appreciation.

3. **Experiential Falak Practices:** The final stage focuses on applying Falak knowledge to practical religious duties. This includes experiential learning modules on core practices such as Qibla determination and the method for sighting the moon crescent (*Hilal*) to determine the start of major Islamic months (e.g., Eid alFitr and Eid al-Adha). Notably, these hands-on Falak practices are adapted from modules initially taught as student co-curriculum activities at UTeM, ensuring pedagogical soundness and practical relevance before implementation for the public in the IFS.

This structured content flow ensures a seamless transition from foundational science to cultural heritage, culminating in direct, applied religious practice.

The Three-Phased Ifs Model

The IFS Model is structured as a sequential, three-phased journey, ensuring a logical progression that maps directly to Kolb's learning cycle (See Table 1).

Table 1. The Three-Phased Experiential Journey of the IFS Model.

Phase	Physical Space	Content Focus	Pedagogical Role (ELT)
Phase 1	**Exhibition Space (Balai Cerap)**	General foundational astronomy (planets, stars, models).	**Concrete Experience (CE)**: Establishes a cognitive baseline.
Phase 2	**Interactive Space (Balai Interaktif)**	Core Islamic Astronomy (Al-Falak), instruments, Qibla, AR/VR implementation.	**Active Experimentation (AE)**: Hands-on application with technology.
Phase 3	**Dome Projection (Planetarium)**	Immersive cosmology, universe flythroughs, spiritual context.	**Reflection & Conceptualization (RO/AC)**: Synthesizes knowledge.

Technology Integration in Interactive Space (Phase 2)

Phase 2 is the engine of the IFS, designed for Active Experimentation using specific interactive technologies:

1. **Augmented Reality (AR):** AR is applied to physical exhibits, such as scanning posters of Muslim scholars to trigger an overlay of detailed biographical information and astronomical data. This connects the historical figure to their scientific output.
2. **Virtual Reality (VR):** VR provides immersive simulations, allowing users to experience virtual environments of planets (space exploration) or navigate the earth (Google Earth) to understand celestial positioning and geography.
3. **Interactive Wall Projection:** This large-scale system allows users to directly interact with a projection of the solar system or star charts, facilitating collaborative and kinesthetic learning of celestial dynamics.

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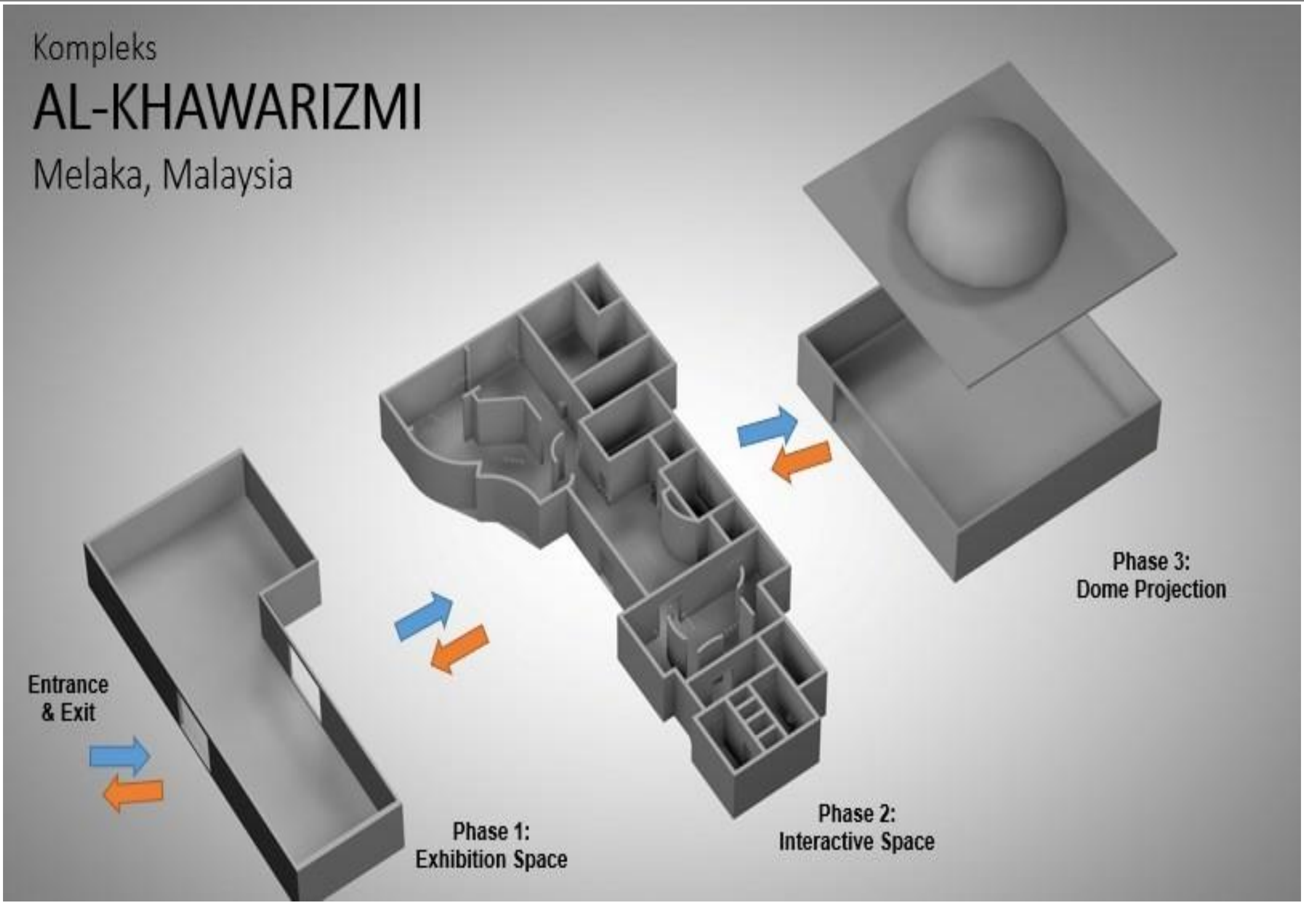

Figure 1: Three phases implementation throughout the exhibition space

System Implementation and Pedagogical Alignment

Detailed Description of Key Exhibits Across Phases

The sequential nature of the IFS Model ensures a smooth transition from foundational knowledge to deep conceptual insight. (See Figure 1)

1. **Phase 1 (Concrete Experience):** The Exhibition Space, featuring static displays like the Cosmic Scale Wall, establishes the visual and factual groundwork necessary before engaging with the abstract.

2. **Phase 2 (Active Experimentation):** High-impact stations like the AR Astrolabe Station and the VR Qibla Simulator allow visitors to virtually manipulate historical instruments and conduct simulations, providing immediate feedback on their application of Falak principles.

3. **Phase 3 (Synthesis and Reflection):** The Dome Projection culminates the experience with the "The Cosmos: An Islamic Perspective," presentation, synthesizing scientific data with verses from the Qur'an, driving the conceptual leap into holistic understanding.

Discussion On Technology-Pedagogy Fit

The implemented technologies are highly aligned with the needs of the ELT framework. AR and VR are uniquely suited to overcome the limitations of 2D learning in astronomy, providing the spatial and temporal control necessary for Active Experimentation. Furthermore, the immersive, shared nature of the Dome Projection effectively facilitates Reflective Observation, allowing visitors to collectively synthesize their hands-on findings into a unified worldview that integrates faith and science.

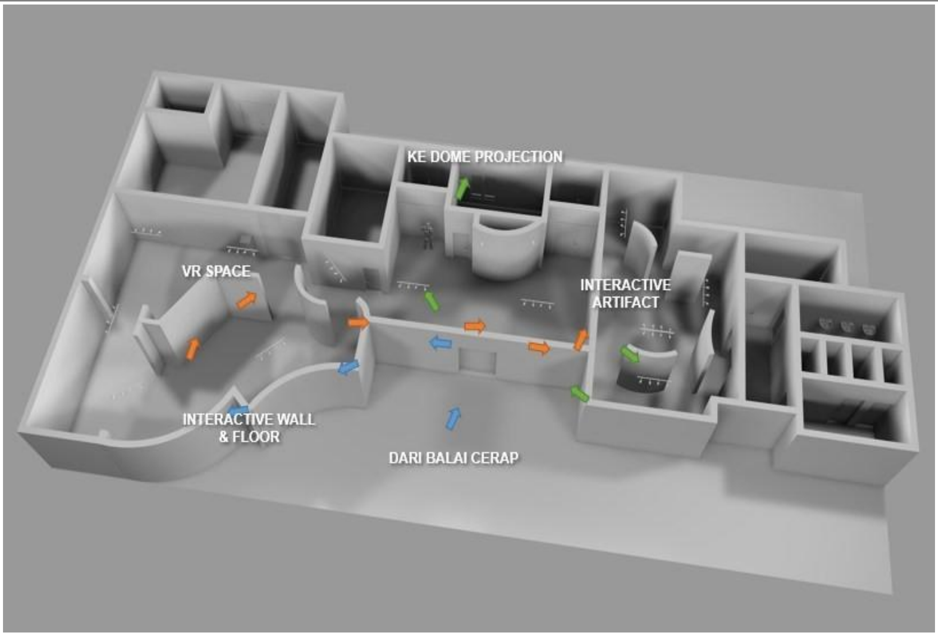

Figure 2 Phase 2 implementation focuses on interactive content such as VR, AR, interactive wall

Potential Impact and Community Engagement

The IFS Model is positioned to make a significant impact on the Malaysian community by achieving two critical outcomes. First, it bridges the knowledge gap by making complex Falak concepts accessible and demystified, promoting an evidence-based religious and scientific literacy. Second, by presenting Islamic astronomy as a dynamic, applied science, it actively promotes cultural and scientific heritage, fostering cultural pride and positioning the heritage as an integral part of global progress. This innovative framework serves as a replicable blueprint for science education across Malaysia.

CONCLUSION AND FUTURE WORK

SUMMARY

This paper detailed the successful development and strategic implementation of the three-phased Interactive Falak Space (IFS) Model at Pusat Falak al-Khawarizmi Melaka. The core contribution is the successful integration of Kolb's Experiential Learning Theory with advanced interactive technologies (AR, VR, Projection) to create a structured and highly engaging learning environment. The model effectively moves participants through the phases of experience, application, and synthesis, ensuring that the legacy of Islamic science and astronomy is taught dynamically and relevantly.

Conclusion

The IFS Model represents a powerful and innovative solution for advancing heritage and science education in Malaysia. By combining the academic quality of UTeM’s curriculum with modern pedagogical tools, the model successfully re-establishes Falak as a vital, applied science integral to national and cultural identity. It empowers citizens with a comprehensive scientific understanding and a renewed appreciation for their Islamic scientific heritage.

Future Work

Future work will prioritize the formal evaluation of the IFS Model through rigorous quantitative and qualitative data collection (pre/post-surveys, visitor engagement metrics). This evaluation is necessary to validate the model's effectiveness in achieving measurable learning outcomes. Additionally, research will explore the scalability and replication of the three-phased structure to educate the public on other domains of Islamic science (e.g., mathematics or medicine) across Malaysia.

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