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(JISTM)**www.gaexcellence.com/jistm**TECHNO-SPIRITUAL INTERACTION: LEVERAGING RAY
CASTING IN AUGMENTED REALITY (AR) TO FOSTER
AMANAH AND AWE IN AVIAN CONSERVATION**

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Abstract:

Current research on Augmented Reality (AR) consistently demonstrates its effectiveness in raising environmental awareness. Yet a persistent values behaviour gap limits the extent to which technical interaction translates into deeply rooted ethical stewardship. This paper proposes a Techno-Spiritual Interaction approach that integrates ray-casting interaction with Islamic environmental ethics to strengthen human character and moral responsibility. A mobile AR application, *Burung Hijrah*, was developed in which users rescue oiled migratory birds, specifically the Whimbrel and the Black Baza, situated at Tanjung Piai National Park, a Ramsar site at the southernmost point of mainland Asia. Through the precision of ray casting mechanics, users are actively and cognitively engaged in performing the act of rescue, which is immediately reinforced by Wonders of Creation content highlighting the biological engineering and migratory feats of the birds. An exploratory single-group post-use evaluation involved 30 participants,

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Keyword:

Amanah, Augmented Reality, Awe, Islamic Environmental Ethics, Moral Agency, Ray Casting, System Usability Scale.



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Introduction

Augmented reality (AR) enhances reality by overlaying virtual items over real-world locations so that users can engage with digitally related content within the physical environment (Azuma, 1997). Many educational studies indicate that AR increases learning, engagement and enjoyment in different areas (Akçayır and Akçayır, 2017; Ibáñez and Delgado-Kloos, 2018), including guided discovery learning in chemistry (Abd Majid and Abd Majid, 2018). In environmental education, AR is used for raising awareness of conservation. Awareness alone, however, does not necessarily cultivate stewardship. Despite these positive outcomes, most AR environmental education studies primarily evaluate engagement, awareness, attitudes, or immediate learning outcomes, while giving limited attention to whether AR interventions cultivate the underlying values and ethical commitments needed to sustain responsible environmental behaviour. Consequently, it remains unclear how AR can be designed to bridge the values behaviour gap by fostering stewardship rather than short-term awareness alone. The key problem is a values-behaviour gap where users may know about an environmental issue after using an application yet fail to develop a sense of personal responsibility toward it. Although AR interactions such as ray casting can effectively engage users in tasks, they do not necessarily promote ethical reflection or foster stewardship.

Recent research on conservation-focused AR suggests that greater environmental awareness does not necessarily translate into long-term responsible behaviour. For example, Pimentel (2022) showed that augmented reality wildlife experiences enhance conservation-related attitudes. Yet, the previous studies did not investigate the underlying values or ethical principles

that could clarify or sustain changes after the experiment, as outcomes were typically assessed only immediately afterwards. In their research, Reh et al. (2025) made similar claims in their experiments where they implemented augmented reality at zoos to show visitors the effects of human waste on wildlife and stated that it increased environmental awareness among them. This represents a significant gap in the existing literature since not many studies have looked into how spiritual or ethical values can be introduced into the AR design in order to facilitate long-term environmental stewardship. Despite these positive results, the previous interventions were unable to establish a moral or ethical basis for lasting behavioural change. This study fills in the gaps in the existing knowledge by incorporating Islamic environmental ethics into the AR learning experience with a view of stating that spiritual values will help connect environmental awareness with personal responsibility and stewardship.

The proposed Techno-Spiritual Interaction approach conceptualises AR interaction as a process of ethical formation rather than merely a means of delivering environmental information. It combines intentional ray-casting actions with spiritual priming and reflective reinforcement grounded in the principle of Amanah, framing technical interaction as a morally meaningful experience related to stewardship. This distinguishes the approach from conventional AR environmental education, which has primarily emphasised engagement, awareness, and conservation attitudes.

This paper proposes that the missing layer is spiritual framing. In the Islamic worldview, human beings are positioned as Khalifah (vicegerents) on Earth, entrusted with an Amanah (trust) to care for creation, and while the natural world is understood as a field of Ayat (signs) that invite reflection and awe towards the Creator (Foltz et al., 2003). Psychological research points to a comparable mechanism. Awe, elicited by perceptually vast or wondrous stimuli, reduces self-focus while strengthening prosocial and ethical behaviour (Keltner & Haidt, 2003; Piff et al., 2015). When an AR experience consistently evokes awe and frames that experience through Amanah, the interaction may function as a vehicle for moral formation rather than simply a means of delivering information.

To investigate this proposition, a mobile AR application named Burung Hijrah (Migratory Birds) was developed. The application tasks users with rescuing oiled migratory birds, specifically the Whimbrel (*Numenius phaeopus*) and the Black Baza (*Aviceda leucophotes*), located at Tanjung Piai National Park in Johor, Malaysia, a Ramsar wetland of international importance at the southernmost point of mainland Asia and a site that has experienced real oil spill incidents. The process of rescue utilizes ray casting, which is a method of interacting with faraway virtual objects via a ray emitted from a device (Bowman & Hodges, 1997). This method has been chosen intentionally as it requires precision and awareness where users need aim, commit and act and execute their intention rather than just tap the screen in order to complete the rescue. After each successful rescue, interactors receive some Wonders of Creation material which gives information about biological properties of birds and their migration feats, thus tying the process to understanding of technical actions to reflection.

The objective of this paper is to evaluate the proposed Techno-Spiritual Interaction design using a participant group consisting primarily of undergraduate IT students. Three research questions are addressed. First, is the application usable, as measured by the System Usability Scale (SUS)? Second, to what extent does the experience elicit Awe, Amanah and Moral Agency among users? Third, what design elements do users identify as most impactful, and

does the experience influence their intention to build morally oriented applications in the future?

Literature Review

Avian Conservation, Awe, and Islamic Environmental Ethics

Migratory birds provide a natural stimulus for awe. Species such as the Whimbrel travel thousands of kilometres between continents with a navigational precision that surpasses human engineering intuition. Awe is conceptualised as an emotional response to perceptually vast stimuli that require the accommodation of existing mental structures (Keltner & Haidt, 2003). Experimental research shows that awe reduces self-focus while strengthening prosocial behaviour and ethical decision-making (Piff et al., 2015). It also deepens individuals' sense of connection with nature, a quality associated with greater benevolence and prosocial behaviour (Lin et al., 2025; Van Cappellen et al., 2012), while reinforcing a stronger sense of moral responsibility that encourages pro-environmental action (Wu et al., 2025).

These psychological concepts of nature connectedness and responsibility closely align with Islamic environmental ethics. Within this framework, nature is seen as the trust (Amanah) given to human beings as stewards (Khalifah), with accountability for the fulfilment of that responsibility (Foltz et al., 2003; Rakhmat, 2022). It has been shown that the incorporation of these values in educational settings leads to better sustainability results (Ferdinan et al., 2026). The Qur'anic prohibition on harming the environment (Zuhdi et al., 2024) along with the idea of ecological balance (mizan) (Wani & Azhar, 2024) contributes to Amanah, Khalifah, and Tawazun, creating an ethical system for taking care of the environment (Basri et al., 2025). In this light, conservation becomes more than an optional choice where it turns into a moral obligation. For undergraduate Information Technology students, who will create future digital technologies, understanding Amanah would mean that those who consider themselves responsible will be able to introduce that ethic into the products they develop.

Augmented Reality for Conservation: Addressing the Spiritual Gap

Technologies that effectively engage users can cultivate feelings of awe and stewardship. To illustrate this point, immersive media has been noted for its superior ability to induce awe, leading to a greater commitment to environmental care (Chirico et al., 2017; Kahn & Cargile, 2021). The same goes for AR technologies. Indeed, systematic reviews have established that students using AR are more motivated and engaged in their studies, benefiting significantly from the use of AR in their education (Akçayır & Akçayır, 2017), especially in terms of the quality of learning outcomes in science (Ibáñez & Delgado-Kloos, 2018; Cheng & Tsai, 2013). Recent studies have also demonstrated that AR can enhance students' attention, satisfaction, and motivation and positively influence non-cognitive learning outcomes (Nikou, 2026; Prasetya et al., 2024).

In the niche area of environmental conservations, serious and location-based gaming has shown great potential for educational purposes but usually falls short when it comes to specifying goal and gameplay mechanics (Santos et al., 2019). Pimentel (2022) gives a highly relevant example of this when he shows how AR involving injured or oil polluted wildlife is effective in increasing users' wish to support the conservation initiative in question. Similarly, Santos et al. (2020) come up with the idea of combining location-based services and AR and offering a mini-

game “Birds of Prey” where people scan the area with the help of virtual binoculars in order to spot and consequently identify birds, proving that such interaction paradigms are familiar and accessible (Nóbrega et al., 2018).

Nonetheless, there is still a significant void in the literature. Even though AR's cognitive and motivational outcomes have been comprehensively explored in the literature, the conscious use of this technology to evoke explicit moral or spiritual experiences (for example, Amanah) has not been considered a worthwhile subject of discussion. The challenge lies in translating a typical AR interaction into a meaningful act of moral responsibility.

Ray Casting as a Mechanism for Intentional Moral Action

The design of interaction must include semantic and moral significance in order to fill this void. Ray casting involves selecting items from a distance, and it is considered a conventional technique for interaction in virtual and augmented reality (Bowman & Hodges, 1997). Unlike just staring at something or simple screen tap, ray casting necessitates the user aiming a ray, keeping it aimed on a particular spot and then confirming the action. Recently, research suggested that the place of ray casting in relation to a user's eyes or the device's center significantly affects users' sense of control and interaction accuracy (Jeong & Jeong, 2024).

This study assigns a semantic meaning to the method of precision. Following the birdwatching concept of previous applications found in the work of Santos et al. (2020), *Burung Hijrah* goes further by converting the act of simply observing into a purposeful act of ray casting for the rescue operation. The binocular reticle's ray initiates from the center of the camera lens, requiring users to focus directly on the suffering oiled bird before initiating the rescue. The hypothesis behind the design is that ray casting is useful in establishing the connection between the user's vision line and the ray of interaction, which makes the user feel that the act of saving is deliberate and personal, a fundamental precondition for moral agency (Bandura, 2002). By integrating awe, understanding stewardship (Amanah) and intentional interaction, *Burung Hijrah* aspires to provide an engaging conservation activity rich in spiritual meaning.

Methodology

Research Design

This study employed an exploratory single group post use evaluation that combined quantitative instruments with open ended qualitative questions. The techno spiritual instrument was developed and adapted specifically for this study to assess three self-reported constructs, Awe, Amanah, and Moral Agency, using a 5-point Likert scale. To ensure theoretical grounding, the items for Awe were adapted from established psychological research on awe and immersive media (Chirico et al., 2017; Piff et al., 2015). The Amanah (stewardship) construct was operationalised based on foundational frameworks of Islamic environmental ethics (Foltz et al., 2003), while the Moral Agency items were guided by Bandura's (2002) theory of moral agency. The instrument underwent expert review for content validity prior to deployment. Participants experienced the *Burung Hijrah* AR application in a supervised session and subsequently completed an online questionnaire. The design evaluates usability and the immediate techno spiritual response after the experience. It does not include a comparison group or a pre-test, which is acknowledged as a limitation.

The Burung Hijrah Application

The *Burung Hijrah* application presents an AR rescue scenario set in Tanjung Piai National Park. Every mission starts with a spiritual initiation, where a verse from the Qur'an that points out the greatness of creation is shown, right before the gameplay begins (see Figure 1). This introduction frames the activity as a meeting with the attributes of the Creator instead of a simple game.

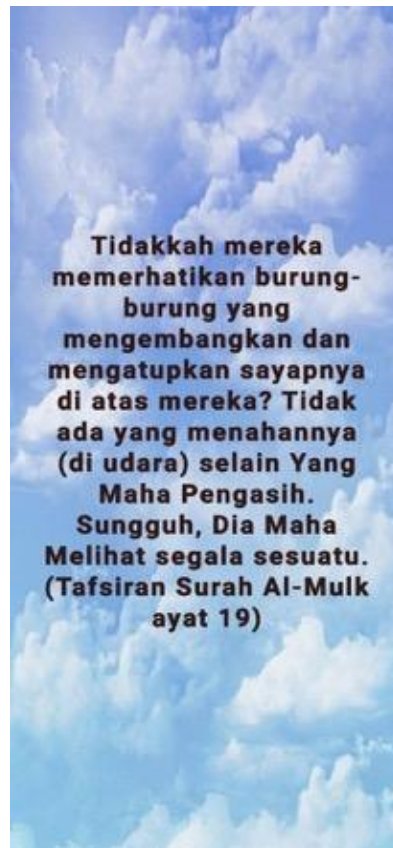


Figure 1: Splash Screen Interface Showing a Quranic Verse On The Greatness Of Creation

Migratory birds affected by an oil spill then appear anchored within the user's real-world surroundings through the device camera. The application interface has adopted the metaphor of binoculars (as depicted in Fig. 2(a)). This means that the user is practically looking through virtual binoculars, where the center point works as a ray-casting reticle. Each mission offers clues for identifying the target bird (such as dark crown stripe and a short downward-curving bill). This imposes upon the user the need to carefully observe and analyze the target bird and engage in the activity accordingly, which corresponds to the guided discovery method described in previous exploratory AR efforts (Abd Majid and Abd Majid, 2018). The game mechanics of pacing have added a sense of urgency by introducing the race between a rabbit and a tortoise; this lends an element of competition to the process of identifying the birds. Once the ray of the virtual binoculars hits the correct target, the rescue of the bird is confirmed by the user using the button "Selamatkan!!" (Rescue!) action, as shown in Figure 2 (a).

Upon a successful rescue, the application displays Wonders of Creation content for the rescued species, such as the Whimbrel's intercontinental migration or the Black Baza's raptor adaptations, as illustrated in Figure 2 (b). This achievement is simultaneously logged in the collection grid shown in Figure 2 (c), where undiscovered species are hidden behind black silhouettes placeholders, and successfully rescued birds are displayed as full-colour illustrations labelled with their names (e.g., Black Baza). Completing all missions earns the user praise affirming the meaning of their deeds, wrapping every technical act (observe, aim, cast, rescue) seamlessly between initial spiritual priming and subsequent reinforcement, praise, and collection tracking.

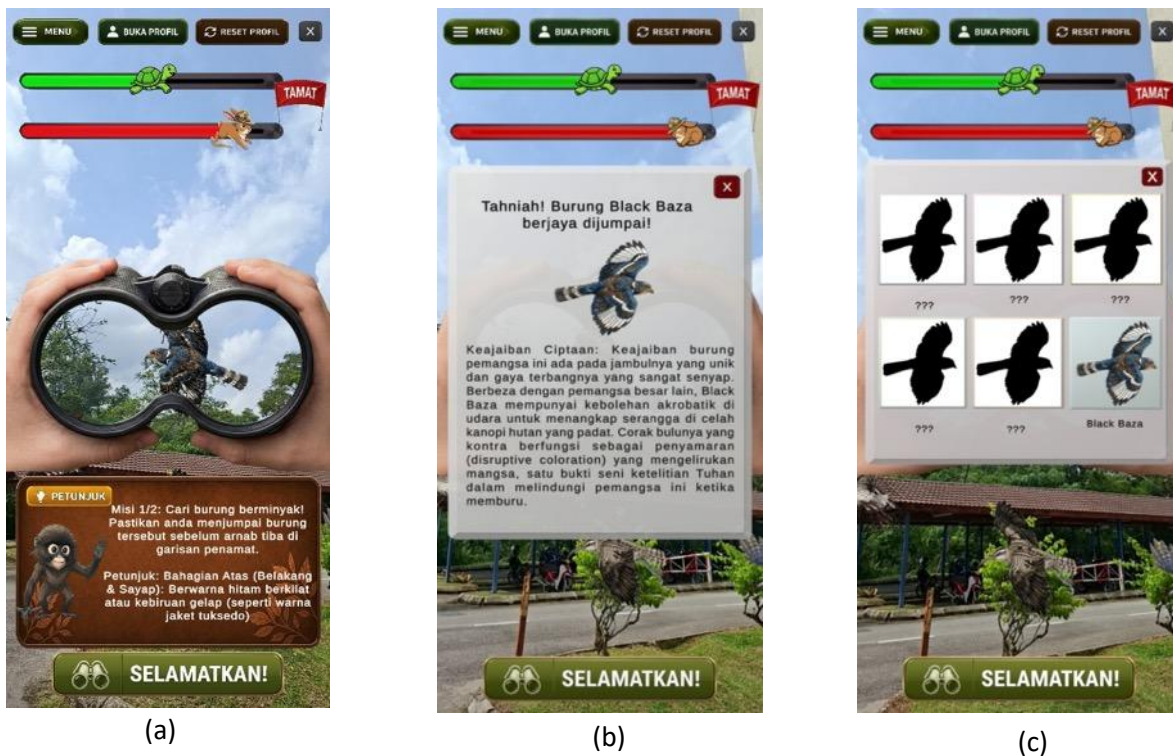


Figure 2: (a) Interface Showing the Binoculars Reticle, the Rabbit–Tortoise Pacing Race, the Identification Clue and the “Selamatkan!” Action Button; (b) Interface Showing the “Wonders of Creation” (Keajaiban Ciptaan) Educational Pop-up for a Rescued Bird; (c) Interface Showing the Silhouette Collection Grid Tracking Rescued Species and Remaining Locked Species Placeholders

The Techno-Spiritual Interaction Model

In *Burung Hijrah*, ray casting is implemented by projecting a virtual ray from the device camera along the direction of the screen-centre binocular reticle into the AR scene. As users orient the device, the ray is continuously tested for intersection with the colliders attached to each anchored bird model (Physics.Raycast). The moment when the ray touches the collider of a bird corresponding to the current mission clue, the rescue can take place, which, however, will only happen after the user clicks on the “Selamatkan!” (Rescue!) button. By requiring the user to point, hold and perform the action, the method becomes very precise and is an intention-driven method. That is what is being applied in the current research, so the process seems like an act of morality rather than just a tap on the screen. Figure 3 illustrates the overall idea of the method. The upper section shows technical steps that any developer can replicate, while the

lower part shows how spiritual priming, reflection and moral framing are added on top of the same mechanic to turn a selection technique into a vehicle for ethical formation.

Ray Casting Interaction Model for Techno-Spiritual AR

A reusable design pattern: pair a precise, effortful interaction (ray casting) with a morally significant act and immediate reflection.

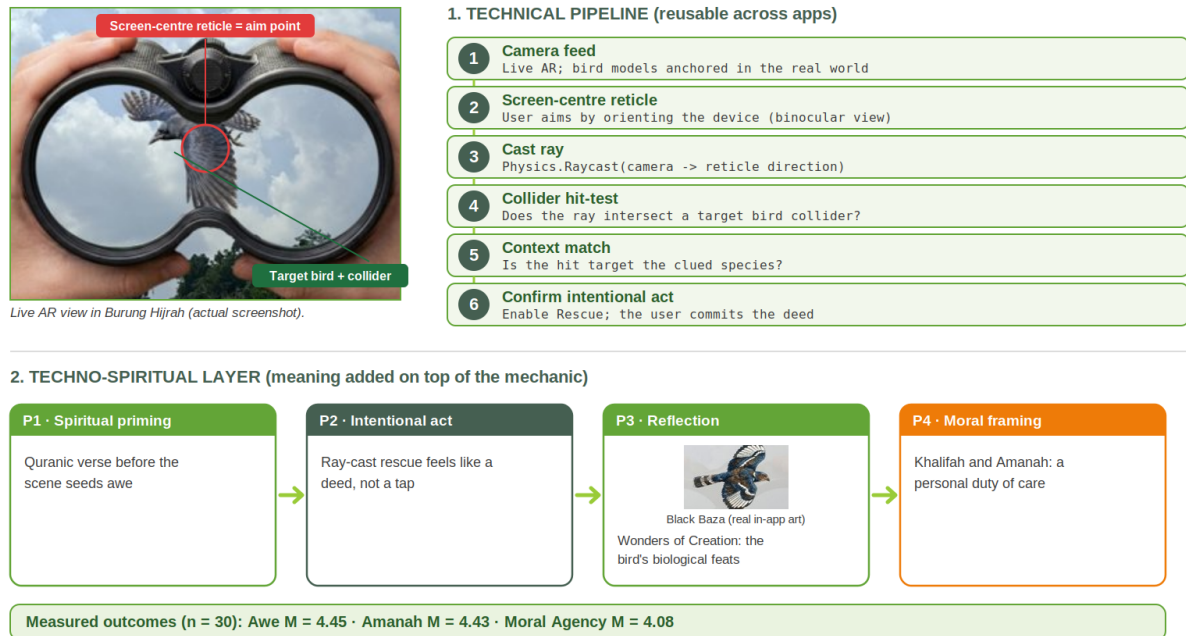


Figure 3: Ray Casting Interaction Model for Techno-Spiritual AR

Figure 4 depicts the design in terms of a three-phase process. Phase 1 is called Spiritual Priming. This phase activates the Quranic verse so that individuals can experience awe before engaging in the task. Phase 2 is called Intentional Act. In this phase, the rescue activity is effortful and deliberate through three steps: clue-based identification, binocular aiming via ray casting, and explicit confirmation of the rescue under the pacing timer. Phase 3, called Reinforcement and Reflection, closes the loop with species-specific Wonders of Creation content and a completion praise screen. It is anticipated that the three outcomes measured-Awe, Amanah, and Moral Agency-result from Phases 1, 2, and 3, respectively.

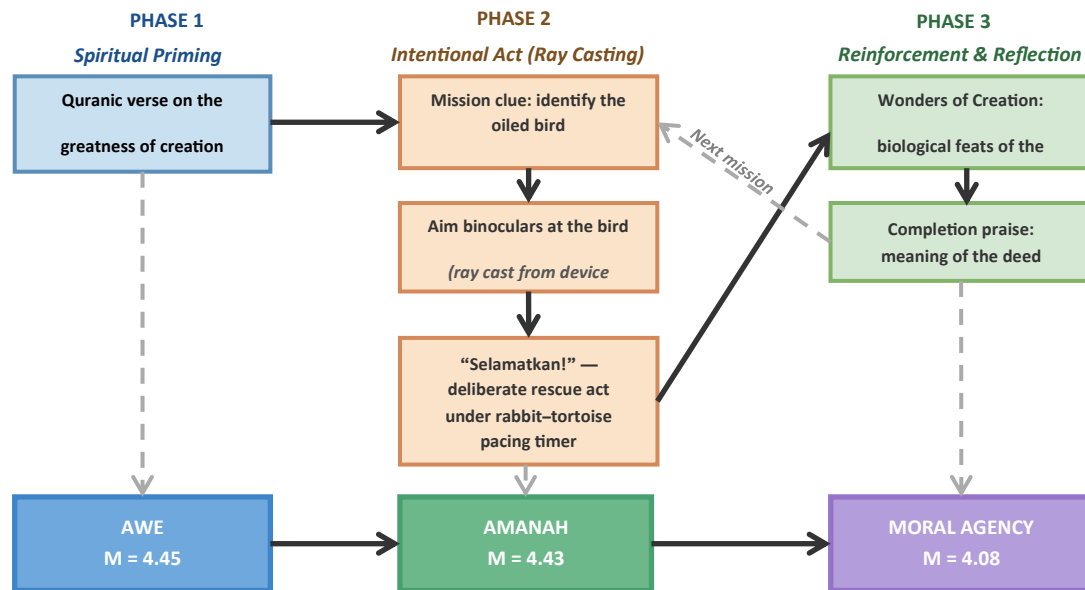


Figure 4: The Techno-Spiritual Interaction Model Implemented in Burung Hijrah

Figure 5 presents the corresponding interaction flow at the technical level, from ray projection through the binocular reticle to collider hit detection, clue matching, rescue confirmation and mission progression.

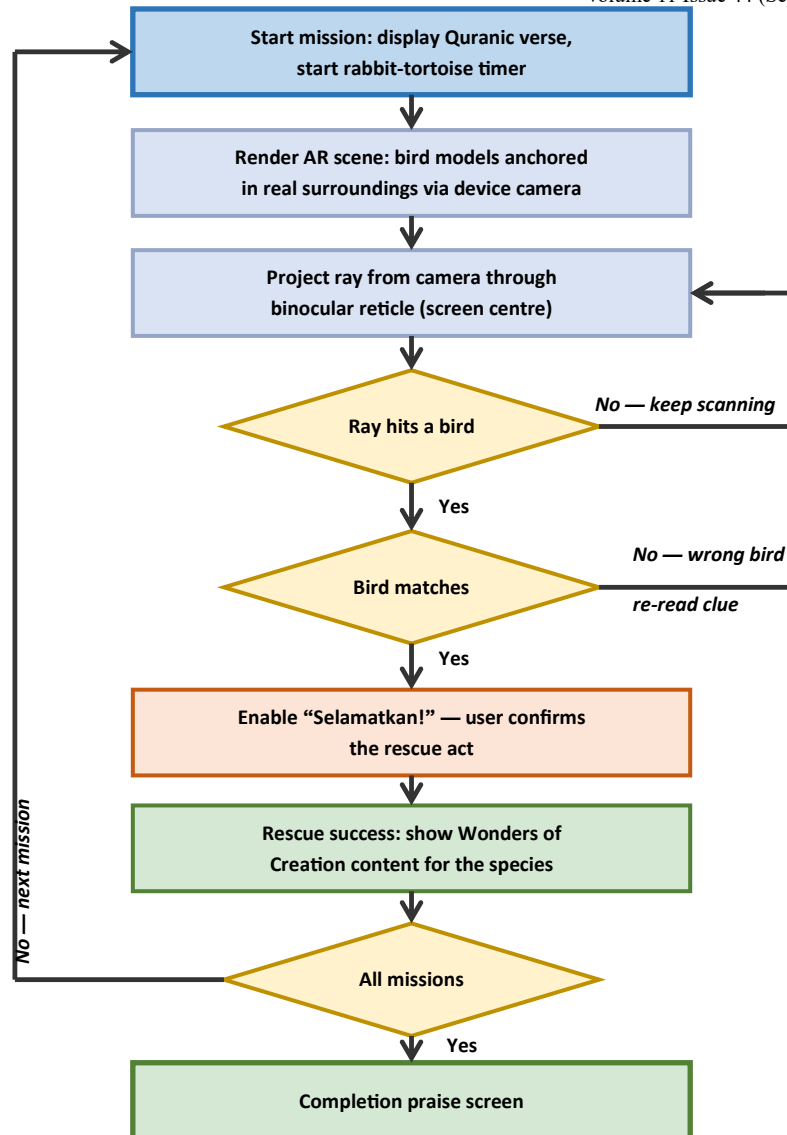


Figure 5: Ray Casting Interaction Flow for a Rescue Mission

In order for the technical contribution to be reutilised, the identification phase of the rescue mechanics is formalised in Algorithm 1. The single ray that is cast from the screen-centre reticle and sent into the 2D colliders associated with each augmented bird plays the crucial role of determining whether the player has hit a distractor (for instance, a crow) or correctly hit the bird assigned for the mission or other wrong mission birds. After the successful hit, the fuzzy logic Dynamic Difficulty Adjustment (DDA) will map the search time that has already been spent and the number of false taps to the speed at which the rabbit is paced, thus making the challenge different for each player, while the interaction details are recorded in the logs for later analysis. The mechanic was implemented in Unity engine with every bird model featuring 2D collider and functioning as the ray-cast destination (see Figure 6).

**Algorithm 1. Ray-Cast Target Identification With Fuzzy Dynamic Difficulty Adjustment
(Burung Hijrah)**

```
Input : screen-centre reticle; current mission target t; timers
Output: rescue outcome; logged interaction record; adapted pacing

1  if not gameActive then return
2  ray ← ViewportPointToRay(0.5, 0.5)      ▷ ray from reticle centre
3  hit ← Physics2D.RayIntersection(ray, 50)
4  if hit.collider = ∅ then return          ▷ nothing under reticle
5  tag ← hit.collider.tag
6  if tag = DISTRACTOR then                 ▷ e.g. crow (Gagak)
7      wrongTaps ← wrongTaps + 1
8      showHint("only a crow – find the oiled bird"); blink(); return
9  else if tag = t.birdTag then              ▷ correct mission bird
10     elapsed ← now – searchStart
11     rabbitSpeed ← FuzzyDDA(elapsed, wrongTaps)  ▷ adapt difficulty
12     logToCSV(t.name, elapsed, wrongTaps, rabbitSpeed)
13     onRescued(t)                          ▷ success → reflection
14 else                                     ▷ non-target mission bird
15     wrongTaps ← wrongTaps + 1
16     showHint("not the bird Cikong means – re-read the clue"); blink()
17 end if
```



Figure 6: Unity Implementation: Augmented Bird Models with 2D Colliders Used as Ray-Cast Targets

Participants and Procedure

A study involved 30 participants who were mostly from the Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, and a few participants from other backgrounds. Among the sample, there were 13 male (43%) and 17 female (57%) whose mean age was 22.4 years ($SD = 4.0$). The majority of the participants were between 20 and 21 years, with a small number being older. Consent was obtained from the respondents prior to filling out the questionnaire. All the respondents successfully completed the AR rescue missions before taking the survey.

Instruments

The questionnaire was divided into four separate areas. Part A scrutinized application-related beliefs using three questions regarding ray-casting knowledge, how information is organized, and user's overall satisfaction. Part B used the ten-item System Usability Scale (Brooke 1996), and this was done by applying the usual scoring results of 0 – 100 with a comparison due to a previously established means of empirical assessment with value 68 (Bangor et al., 2008) and evaluation of usability and learnability aspects was based on the principles proposed by Lewis and Sauro (2009). Part C consisted of a techno-spiritual instrument developed for this study, measuring three constructs on a 5-point Likert scale: Awe (4 items; e.g., “I felt a sense of wonder in the way these birds are created”), Amanah/Stewardship (4 items; e.g., “I personally feel responsible for ensuring the survival of wildlife”) and Moral Agency (4 items; e.g., “Even though this is a digital simulation, I felt the ray-casting rescue was a morally meaningful act”). Part D included open-ended questions exploring the most awe-inspiring aspect of the experience, suggested improvements, and participants' intention to develop morally oriented applications in the future.

Results

Usability of the Application

The application achieved a mean SUS score of 73.5 (SD = 13.3, range 50–100, median 73.8), which is above the empirical benchmark of 68 and corresponds to a “good” rating on the adjective scale (Bangor et al., 2008); 63% of participants scored the application at or above the benchmark. Examining the sub-dimensions, the usability component recorded a mean of 3.97 and the learnability component 3.83 on the 5-point scale after reverse scoring. Application-specific items were also positive: 87% of participants agreed that they quickly understood how to operate the ray casting mechanic (M = 4.07), 83% rated the information layout of the bird facts positively (M = 4.40), and 83% were satisfied overall with how the application functioned (M = 4.33). These results indicate that the interaction layer did not obstruct the experience; users could devote their attention to the rescue and the reflection rather than to fighting the interface. Internal consistency of the SUS in this sample was acceptable for a small-n exploratory study ($\alpha = .699$).

Awe, Amanah and Moral Agency

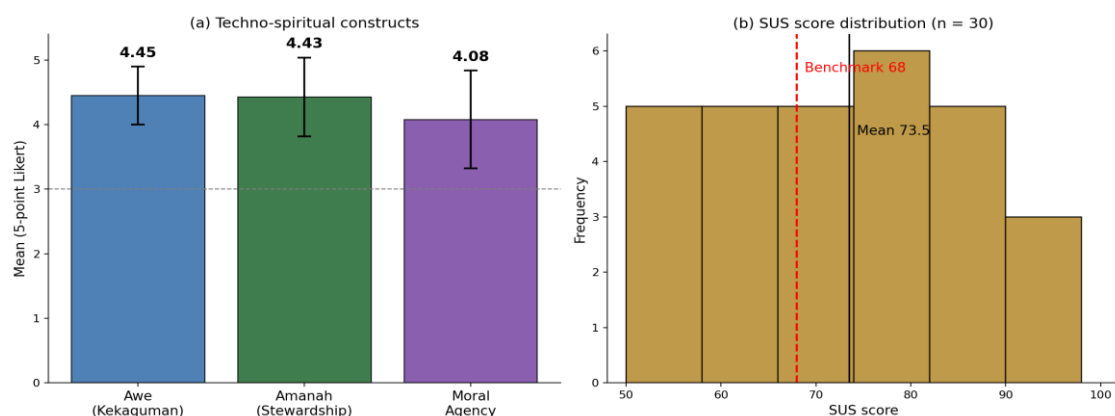
Table 1 presents the item-level results for the three techno-spiritual constructs, and Figure 7(a) summarises the construct means. Awe recorded the highest overall mean (M = 4.45, SD = 0.45), driven by near-ceiling agreement on wonder towards creation: 93% felt amazed by something greater than themselves (CA2, M = 4.63), 93% sensed wonder in how the birds are created (CA3, M = 4.67), and 93% reported gaining a new perspective on the greatness of creation (CA4, M = 4.57). The small-self item (CA1, “I felt small when seeing the magnificence of the birds' biological structure”) was somewhat lower (M = 3.93, 77%), suggesting that the wonder facet of awe was elicited more strongly than the self-diminishment facet; the modest internal consistency of this construct ($\alpha = .590$) is largely a product of this distinction combined with ceiling effects, and is discussed as an instrument refinement priority.

Amanah recorded a very high mean (M = 4.43, SD = 0.61, $\alpha = .829$). Notably, 93% of participants reported feeling personally responsible for the survival of wildlife (WE1, M = 4.60) and 87% felt responsible regarding the impact of oil spills on migratory birds (WE4, M = 4.40), indicating that the stewardship framing attached to a specific, real Malaysian site was internalised personally rather than abstractly. Moral Agency was high (M = 4.08, SD = 0.76, $\alpha = .777$): 90% agreed that the ray casting rescue felt morally meaningful despite being a simulation (MA1, M = 4.27), 77% reported feeling guilt when failing to rescue a bird (MA2, M = 4.03), and 83% felt that their in-application actions reflected their values (MA4, M = 4.37). The lowest item was MA3 on forgetting that the experience was only computer code (M = 3.63, 53%), showing that full immersion-driven suspension of disbelief was achieved by about half of the participants.

Table 1: Item-Level Results for the Techno-Spiritual Constructs (n = 30)

Code	Item (abridged)	Mean	SD	% Agree
CA1	I felt small/humbled seeing the birds' biological magnificence	3.93	0.83	77%
CA2	The experience made me feel amazed by something greater than myself	4.63	0.61	93%
CA3	I felt a sense of wonder in the way these birds are created	4.67	0.61	93%
CA4	The AR experience gave me a new perspective on the greatness of creation	4.57	0.63	93%
WE1	I personally feel responsible for ensuring wildlife survival	4.60	0.62	93%
WE2	I see myself as able to play a role in protecting wildlife	4.27	0.83	83%
WE3	Protecting animals such as birds is part of my responsibility	4.47	0.73	87%
WE4	I feel responsible regarding the impact of oil spills on the birds	4.40	0.81	87%
MA1	Although a simulation, the ray casting rescue felt morally meaningful	4.27	0.64	90%
MA2	I felt guilty (irresponsible) if I failed to rescue a bird	4.03	1.03	77%
MA3	The AR experience made me forget it was only computer code	3.63	1.22	53%
MA4	My actions in the application reflected my values	4.37	0.96	83%

Source: Survey data analysis (2026)

**Figure 7: (a) Construct Means with One Standard Deviation; (b) Distribution of SUS Scores**

Qualitative Findings and Future Intention

Answers of the participants of the study can be divided into three main themes in response to the question of what element awe-inspiring them most. The first theme is embodied discovery, with participants stating that observing for birds in their environment was “like visiting a bird park” or “like watching real birds through binoculars” with one of the participants suggesting that it “felt like Pokémon GO.” This statement correlates with the issue of using the binoculars’ theme in the design of the application, suggesting that respondents understood its implementation as intended. The second theme relates to the rescue mechanism, whereby ray casting and the rabbit-and-tortoise timer were singled out as the most memorable elements of the design, supporting the design decision to make the rescue an effortful, intentional act.

The third theme is the encounter with the creation of the participants, who pointed out the diversity of birds and positive emotions from the process of “saving” them truly amazed them. Recommendations for improvements were concrete and constructive, including the creation of animated bird movements/flight, fixing occasional discrepancies between rescue indicators and selectable birds, inclusion of language options and iOS compatibility. Remarkably, in response to the question about their intention to develop an ethically oriented application in the future, 29 out of 30 subjects (97%) gave positive answers to the question, some of them with emphatic answers, “yes, definitely”. This shows that most of the participants, many of whom are future IT practitioners, are sending a strong message that techno-spiritual orientation is applicable beyond the immediate surroundings.

Discussion

The Techno-Spiritual Chain: Usability to Awe

Results support the main premise of Techno-Spiritual Interaction which states that when the users conduct an intricate technical operation in combination with spiritual reflection, the effect on them is positive both in cognitive and moral terms. The pattern of data was quite uniform beginning with quite a high level of usability (SUS score of 73.5). It means that interaction layer was sufficiently transparent and intuitive enough, enabling communication of the deep meaning without creating high cognitive load.

After that, users reported high levels of Awe after their experience. This was made possible by introducing the Quranic interpretations (tafsir) at the beginning of the experience allowing for a spiritual lens through which users viewed wildlife. The application unveiled the migratory birds' specialities and survival. This insight is supported by qualitative data. Asked about the participants' perceptions of the most astonishing aspect of their experience, they unanimously talked about the immersive experience itself and the interactive nature of the design. Most participants shared that the experience was similar to using binoculars ("it felt like observing real birds through binoculars") while some praising the 3D models ("the bird models looked incredibly lifelike"). In addition, respondents commented on the interactive feature. As one of the participants put it, "The ray-casting element was highly engaging, making it feel as if we were in the real world." These findings are in line with the reports by Chirico et al. (2017) and Kahn and Cargile (2021), who found out that immersive and interactive technologies are superior to passive types of media in generating awe.

Activating Amanah through Intentional Rescue

The switch from experiencing the feeling of Awe to internalizing the concept of Amanah (responsibility) was caused by the fact that the application demanded that users perform immediate deeds intentionally. Users do not just see the magnificent traits of the birds, but see a bird that oiled, suffers and needs help. The technique of ray-casting shifted from being a commonly used selection tools into an urgent rescue mission, which was enhanced by the use of gamification components (like the rabbit and turtle timer that users pointed out as making their task exciting).

By placing the user in the role of an active rescuer, the experience personalized the concept of stewardship. This is in line with the Islamic environmental ethics approach (Foltz et al., 2003; Rakhmat, 2022), which posits that nature is an Amanah that necessitates intervention and care from humans. The positive Amanah scores indicate that users did not only comprehend the idea of conserving nature; they were also obliged to participate in conservation activities as moral agents rather than spectators (Bandura, 2002; Piff et al., 2015).

Moral Agency and The Multiplier Effect in Future Developers

What stands out primarily in this study is its influence on the participants composed mainly of undergraduate students in Information Technology programs. The combination of technical knowledge, Sustainable Development Goals (SDGs) and ethics paved new directions for these future developers. The qualitative responses about their intention to create morally oriented applications yielded significant empirical evidence for the phenomenon described in the literature as the "multiplier effect".

The answers we got were almost all positive. The qualitative data demonstrates that the intervention has successfully triggered the internal ethical orientation (Griffin et al., 2024). The participants understood their technical skills' wider social value, which is well illustrated by some of them stating, "I am interested because this method can attract public interest while simultaneously instilling noble values through the application." Another participant mentioned the career and impact opportunities, noting, "I see many opportunities arising from the skills I have learned here." Some participants demonstrated a rather strong but conditional commitment: "Definitely yes if I have a chance and the right skills."

The aforementioned findings indicate that a properly done techno-spiritual class can help with much more than just bringing to awareness environmental issues; it can help shape the ethical outlook of future developers, as participants showed willingness to use the philosophies of Khalifah and Amanah in their future work after undergoing their respective course, potentially contributing to more responsible and values-driven digital development over time.

Conclusion

The main contribution of this research is the introduction of the techno-spiritual path that facilitates people's intentional use of AR through ray casting technology to help them experience awe and reflection, which ties to their moral agency and sense of responsibility when it comes to the environment. Instead of portraying AR merely as a tool for increasing awareness, this approach demonstrates how interaction design should be associated with spirituality so that it becomes an ethical environmental education instrument.

The main aim of this research was to discover the potential of using Augmented Reality for creating not only environmental awareness but also enabling the users to take the active role in the environment stewardship. Through the use of ray-casting rescue mechanics in combination with spiritual contemplation on the Wonders of Creation situated within the real-world context of the Tanjung Piai Ramsar site, the *Burung Hijrah* app proved that the incorporation of techno-spiritual elements into the application can substantially improve the human character and moral responsibility.

The application has successfully shown great usability, being able to bring the significant levels of Awe, Amanah and Moral Agency into participants, with almost all students expressing desire to create similar applications in their future. An important lesson learned is the importance of the role of developers in aligning technologies with spirituality since the application makes users think actively and cognitively engage their own bodies to find the birds and match some visual features with particular species. The successful rescue and subsequent thinking about the greatness of the Creator's design anchored to the certain ecological context created an environment that activated users' sense of Amanah, thus may support the transformation of the abstract concept of conservation into the long-lasting moral duty to care about the environment. This article presents a replicable model of Techno-Spiritual Interaction, which is of great importance for future developers. It proposes that an effortful interaction technique (for example, ray casting) should be selected and connected to the moral act and then done in a real and vulnerable location and immediately afterward followed by reflections that associate the action with the Creator. The paper contributes theoretically to the research of Augmented Reality interaction, awe psychology, and Islamic environmental ethics. At the same time, this contribution has practical implications for educators and developers, as it can serve as a concrete framework for bringing ethical commitment in the users' actions, especially for future IT specialists responsible for creating digital technologies. This corresponds perfectly with national aspirations to save spiritual and civilizational values as a result of fast development of technologies, indicating that this technology-spirituality model has to find broader interactive applications in the future.

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- Author Contribution Statement:** Nazatul Aini Abd Majid was responsible for conceptualization, techno-spiritual interaction design, prototype development, data collection and analysis, and overall supervision. Lam Meng Chun, Rimaniza Zainal Abidin, and Tan Siok Yee contributed to the AR application interaction design and expert review. Nur Asyiah Suwadi contributed to prototype development, literature review, and manuscript drafting. Nurhazarifah was responsible for reviewing manuscripts, editing, language refinement, improvement of the manuscript structure and clarity, critical revision of the intellectual content, and preparation of the final version for submission. All authors read and approved the final version of the manuscript.
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