



A Conceptual Model of Tawhid-Based Learning Through the Integration of Biomimicry and the Engineering Design Process

Nurli Nurlinda

University of Muhammadiyah Surakarta, Indonesia
nurlinurlinda@gmail.com

Abstract. Tawhid serves as the epistemological and spiritual foundation of Islamic education; however, its pedagogical implementation often becomes trapped in normative and dogmatic patterns, focused on memorization and lacking integration with scientific and practical approaches. This study responds to such challenges by proposing a conceptual model of tawhid-based education that integrates Biomimicry and the Engineering Design Process (EDP) as a pedagogical approach that is spiritual, scientific, practical, and applicable. The method employed is conceptual analysis, which involves literature review, conceptual mapping, and framework development. The study reveals that these three concepts form an epistemological bridge grounded in the value of divine mercy (*Rahmat*). Biomimicry serves as a means to discover the divine attributes (*Asma' wa Sifat*) and to affirm the existence of God through the observation of natural structures and systems. Meanwhile, the Engineering Design Process (EDP) functions as an instrument for actualizing those divine attributes by refining human sensory potential into innovative, applicable, and solution-oriented creations as acts of devotion (*Uluhiyah*). In this context, human senses and intellect become divine channels for realizing God's will through the human role as caliph (*khalifah*). This process fosters a profound spiritual awareness that all laws and creations submit to a singular divine system, rooted in the absolute authority of servitude to the One and Only God, Allah SWT (*Rububiyah*).

Keywords: Tawhid, Biomimicry, Engineering Design Process.

1 Introduction

1.1 Tawhid as the Foundation of Islamic Education

Tawhid is the fundamental principle of Islam, serving as the core of faith and the foundation of Islamic education. The primary goal of Islamic education is to nurture individuals who serve as stewards (*khalifah*) of God on Earth, wholly devoting their lives to Allah through knowledge, practice, and character [1]. Indonesian National Education Law No. 20 of 2003 also affirms that education must aim to develop faith and piety in the One Almighty God [2]. Consequently, all branches of knowledge in education should ideally be guided by divine values, centered on *tawhid*.

© The Author(s) 2025

A. Dwi Bahtiar El Rizaq et al. (eds.), *Proceedings of International Conference of Islamic Studies (ICONIS 2025)*, Advances in Social Science, Education and Humanities Research 955,

https://doi.org/10.2991/978-2-38476-464-8_15

However, critiques of Islamic Religious Education reveal conceptual and methodological challenges in teaching *tawhid*. Current approaches are often normative and dogmatic, with a focus on memorization over comprehension, resulting in limited real-life application of *tawhid* values [3], [4], [5]. Choudhury notes that a dominance of a legalistic, sectarian approach to Sharia has contributed to the stagnation of Islamic values in contemporary social systems [6]. Fazlur Rahman further critiques the stagnation in *kalam* (Islamic theology), which tends to dwell in speculative debates rather than offering practical solutions to the community's issues [7]. As a result, Muslims have struggled to play a strategic role in addressing urgent global challenges such as poverty, social justice, economic inequality, intellectual stagnation, ignorance, and environmental crises [5], [7].

1.2 The Crisis of Tawhid Thought and the Challenges of Contemporary Islamic Education

One of the core issues in Islamic education is the dichotomy between religious and secular sciences. Islamic education is still largely confined to normative theology, without integration with science and technology, leading to a lack of capacity among students to relate Islamic values to everyday life. Sholeh reveals that the students in Islamic elementary education experience confusion when Islamic and scientific knowledge are delivered in isolation. This dichotomy leads to conceptual dissonance that inhibits the development of holistic understanding and life skills [8].

In the modern era, a single-discipline approach is no longer appealing when confined within an exclusive framework that isolates itself from other fields of knowledge [4]. Dogmatic educational methods are also linked to exclusivism, radicalism, and the limited applicability of Islamic values in real-life contexts [4]. Studies have shown that memorization-based learning inhibits critical thinking and problem-solving development [3].

Tawhid education thus requires a shift from theoretical to anthropocentric approaches, reconstructing classical concepts into frameworks that both defend human dignity while preserving the divine essence within the context of the contemporary world [5]. Aldosari recommends the need for accurate, knowledge-based content and scientifically grounded evaluation methods to foster students' creative thinking skills for the 21st century [9]. Recent studies reveal that the integration of Higher Order Thinking (HOT) strategies in education enables learners to more effectively evaluate, synthesize, and apply scientific values in practical ways, including spiritual values in their daily lives [3].

Albassam emphasizes that the Qur'an presents a doctrinal miracle through its consistent affirmation of monotheism in the aspect of *Rububiyyah*, namely the recognition of divine creation and sustenance, framed through a rational and reflective engagement with the natural world. This approach not only strengthens theological understanding of *tawhid* but also aligns with the innate human disposition to seek meaning, order, and ultimate dependence in life [10].

Globally, Islamic education also faces challenges in pedagogical reform. Studies from the Netherlands indicate that alumni of Islamic education systems call for reforms

in Islamic religious education to better equip youth with critical thinking skills and dialogic engagement. These reforms aim to foster *tawhid* internalization while addressing modern complexities with consciousness and responsibility [11].

Such insights highlight the urgency of reconstructing tawhid-based education in a way that meaningfully addresses contemporary human challenges, while remaining rooted in the human fitrah, the natural inclination to seek and recognize God in all aspects of existence.

1.3 A Holistic, Exploratory, and Applied Approach to Tawhid Education

In Islam, knowledge and spirituality are inseparable, forming integral parts of the Divine order. Islamic education aims to develop *al-insan al-salih* (a righteous human being) by harmonizing intellect, spirit, and body through *ta'dib* (ethical empowerment) [12]. Integrating knowledge within the framework of *tawhid* is essential for civilizational transformation through intellectual leadership that brings about a meaningful and dignified life. Islamic education is not only about forming *insan kamil* (the perfected human) but also about nurturing individuals with innovative capabilities who are responsive to global change. Islamic education should be adaptive and responsive to societal and user needs, go beyond traditional religious instruction by integrating scientific understanding, technology, and a competence-based approach [13]. This requires an integrative design that is applicable across philosophical, material, and methodological levels [4].

Integrating *tawhid* into teaching not only enhances spiritual closeness to God but also supports 21st-century skills such as active thinking, responsibility, and motivation for learning. Teachers report that tawhid integration in teaching is crucial not only for strengthening student's faith in Allah, but also for enhancing their understanding, interactive, and meaningful [14]. Experiential learning and engagement with real-world social issues effectively promote critical thinking and reflective awareness in students' real lives [3]. A rational and critical-based approach to learning avoids blind, dogmatic belief and instead fosters a stronger, more conscious faith. This method develops well-grounded individuals who are thoughtful and morally upright [4].

The scientific and systematic understanding of religious knowledge has been part of Islamic intellectual heritage since the classical period. When rooted in Islamic thought, it is historically formed based on three foundational principles: Tawhid (oneness of God), the universality of ethics, and the integration of various methodological approaches. These principles shape the epistemological and methodological character of religious studies in Islam, positioning it as a distinct and holistic paradigm for understanding religious phenomena within the cultural and civilizational context of Muslim society [15]. Muslim scholars today must master modern disciplines and integrate them into the Islamic intellectual tradition by critically filtering, modifying, or reinterpreting them through Islamic lenses. Despite two centuries of secular education, the Muslim world has yet to produce an institution or generation of scholars that rivals the creativity of the West [16]. Thus, integrating biomimicry into *tawhid* education may yield original, context-sensitive, and competitive solutions. Scientific

approaches in *tawhid* education can both contextualize religious understanding and revitalize Islamic educational methodologies.

Recent research has shown that technology-enhanced Islamic education (e.g., cloud-based learning) can significantly improve students' reflective thinking skills, motivation, and knowledge connection. This reinforces the need for *tawhid* education that moves beyond rote learning to skill development aligned with 21st-century demands [17].

1.4 Biomimicry and the Engineering Design Process (EDP) in the Perspective of Tauhid

Islam assigns humans the responsibility of environmental stewardship, as emphasized in Qur'an 33:72. Islam encourages scientific and technological development as a manifestation of Divine signs to be explored and sustained. Reconstructing the tawhidic worldview regarding the cosmos, nature, and humanity is seen as a solution to ecological crises and global human advancement [18]. The concern for the environment based on tawhid (monotheism) integrated into the curriculum is also a form of human piety, and Islamic higher education has the task of producing graduates who contribute to reducing the impact of global warming [19].

Biomimicry offers a strategic educational approach for *tawhid* learning. It not only deepens monotheistic understanding but also instills reflective awareness of how humans should coexist with nature. Biomimicry views nature not merely as an object of protection but as a “model, measure, and mentor” for sustainable design. This field is grounded in the principle that nature has developed efficient solutions over billions of years, inspiring human innovation [20]. The biomimicry approach in tawhid-based education not only fosters an understanding that the orderliness of nature is a tangible manifestation of God's existence but also enhances the ability to explore and apply this potential in meaningful and practical ways.

While biomimicry inspires ecological awareness, it lacks a methodological structure for transforming ideas into viable, testable innovations. In contrast, the Engineering Design Process provides a comprehensive framework for testing ideas, building prototypes, and refining solutions into practical applications. Biomimicry provides the inspiration while EDP transforms it into functional outcomes, a synergy often described in the literature as nature-inspired engineering.

The five-step EDP framework, asking, imagining, planning, creating, and improving, has proven effective in fostering creativity, collaboration, scientific interest, critical thinking, and problem-solving skills among students [21]. Integrating the five-step EDP framework into science modules, such as those covering electric and magnetic fields, has significantly improved students' scientific problem-solving abilities [22]. Sudrajat et al. demonstrated that Engineering Design Process (EDP)-based learning significantly enhanced students' creative thinking skills, with an N-Gain score of 53.3% in the moderate category. Additionally, students' creativity in producing alternative energy-related products reached an average score of 89, and the Mann-Whitney U test confirmed a significant difference between the control and experimental groups [23]. Other studies have emphasized the importance of integrating Islamic

values, such as Quranic verses, within each stage of the EDP framework [24]. This includes the use of Qur'anic verses as reflective anchors in each design phase, bridging spiritual and scientific domains.

The Engineering Design Process (EDP) refers to a problem-solving activity involving the development of ideas or products through systematic creative thinking and evaluative judgment, with the ultimate goal of producing tangible outcomes [22]. The five main stages of EDP have been proven to enhance students' problem-solving skills, critical thinking, and collaborative abilities in learning contexts [21].

Recent studies also indicate that the Higher Order Thinking Skills (HOTS) approach can be effectively implemented in Islamic religious education, including subjects such as *aqidah* (creed) and *akhlak* (ethics) [3]. This reinforces the view that scientific and engineering-based pedagogies not only foster creativity but also deepen the understanding of divine values embedded in the act of creation.

A *tawhid*-based pedagogical approach that relies solely on nature as evidence of God's existence needs further development. Nature is a divine gift that serves as a medium for human beings to realize their cognitive and spiritual potential. Human senses and intellect are not only tools for observation but also for engineering nature according to principles of divine wisdom. Human capacity to emulate nature's mechanisms (biomimicry) and engineer technology reflects the divine attribute of *Al-Khaliq* (The Creator) granted to humans in a limited but tangible form. Engineering is thus not merely a worldly activity but a concrete manifestation of the presence and majesty of the Creator in the physical world.

1.5 Research Gap and Significance of the Study

Previous studies have demonstrated the effectiveness of biomimicry in sustainable design, as well as the engineering design process (EDP) in STEAM education for enhancing critical thinking and problem-solving skills. However, there remains a notable absence of research that adapts both approaches as pedagogical strategies in Islamic monotheism (*tawhid*) education, particularly as instruments for *tadabbur* (spiritual reflection) and for reinforcing divine values in an applied and reflective manner. Although *tawhid* education has begun integrating scientific content, it is still largely limited to proving the existence of God, without evolving into a transformative realization of divine mercy (*rahmah*) and wisdom (*hikmah*) in a tangible, lived experience.

To identify this research gap, a bibliometric analysis using VOSviewer was conducted. Three sets of keywords were employed to map the research landscape between 2019 and 2025. Keyword Set 1 (Tauhid and Islamic education): "Tawhid" OR "tawheed" OR "tauhid" OR "Islamic monotheism" OR "Islamic theology" OR "aqidah" combined with (AND) "education" OR "teaching" OR "learning" yielded 139 documents. Keyword Set 2 (Biomimicry in education): "biomimicry" OR "biomimetic*" OR "nature-inspired design" OR "bionic*" combined with (AND) "education" yielded 234 documents. Keyword Set 3 (Engineering design process in education): "engineering design process" combined with "education" OR "teaching" OR "learning" yielded 413 documents.

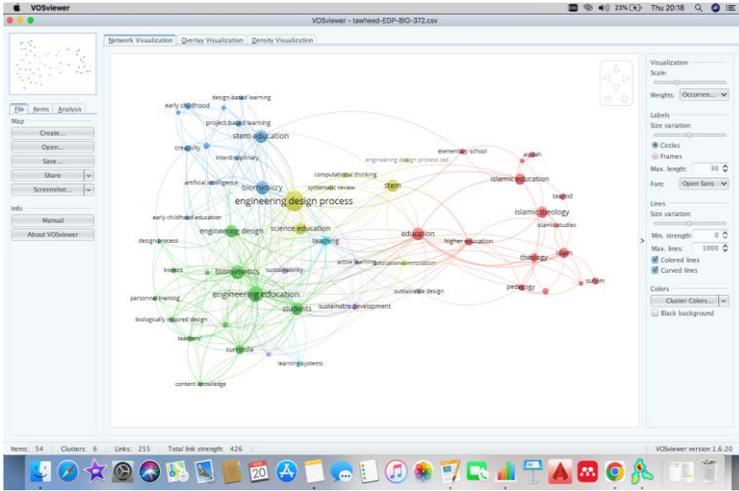


Fig. 1. The visualization reveals the predominance of biomimicry-related research in engineering and design, with limited association to tauhid or Islamic education themes.

The bibliometric analysis by VOSviewer supports these findings: studies on biomimicry are still largely concentrated in architectural and material engineering domains, with minimal linkage to tauhid and Islamic educational values. Similarly, no existing framework has been found that conceptually integrates tawhid, biomimicry, and the engineering design process within a unified educational model.

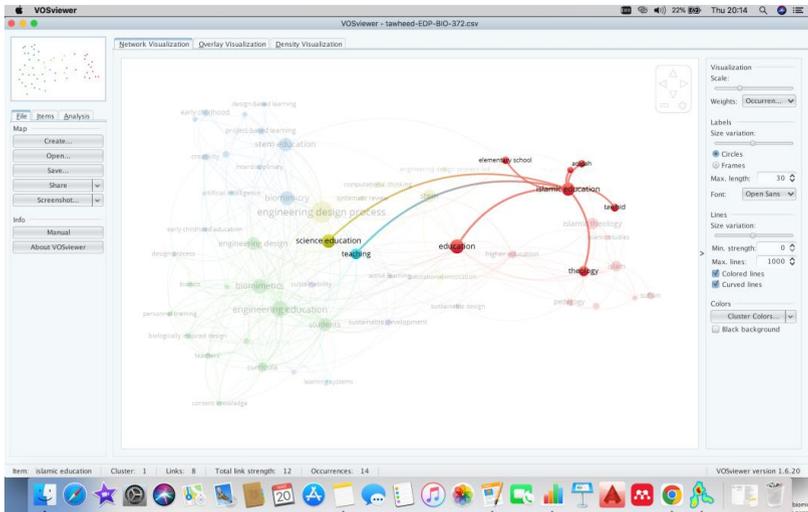


Fig. 2. Overlay visualization: Islamic education intersects with science but lacks integration with engineering design and biomimicry.

Figure 2 shows that tauhid education remains predominantly normative and doctrinal. While Islamic education has begun incorporating scientific knowledge, it still lacks integration with biomimicry and EDP through an applied methodology that facilitates scientific exploration and design for spiritual development.

This study aims not only to fill theoretical and methodological gaps but also to offer a conceptual model that bridges tawhid values with scientific exploration and engineering design. This integration enables learners to understand tauhid in a more contextual, applied manner. Through nature-based and design-based approaches, the model helps students recognize their God-given potential to generate innovative, applicable, and sustainable ideas, reflecting the divine mercy bestowed upon the universe.

With this model, tawhid education moves beyond theoretical instruction or rote memorization. It can now evolve through the observation of natural design patterns that align with the extraordinary human intellect and its capacity to replicate such patterns as a reflection of divine creation, which has often remained underutilized in Islamic pedagogy. This approach addresses the long-standing challenge in Islamic education to fully engage the intellect and senses as instruments for *tadabbur*, creativity, and productivity.

Through biomimicry, learners are invited to witness the greatness of God in the order and balance of natural systems. Meanwhile, through the engineering design process, they directly experience how their potential is designed for creativity and problem-solving, manifesting their divine role as *khalifah* (caliph) of Allah on Earth.

Accordingly, this research seeks to answer the following questions: 1) How can biomimicry be interpreted through the lens of tauhid as an approach in tauhid-based education? 2) How can the exploration of the engineering design process (EDP) uncover divine values as foundational principles for sustainable innovation? 3) How can a conceptual model integrating tawhid, biomimicry, and EDP be designed to enhance students' understanding of Islamic theology in a meaningful and transformative way?

2 Method

This study adopted a qualitative paradigm grounded in conceptual analysis, aiming to build an integrative educational model that connects tawhid, biomimicry, and the engineering design process. Although conceptual in nature, the research applies a structured methodology consisting of three main stages: literature review, conceptual mapping, and framework development.

Literature review was conducted to identify and interpret the foundational epistemological and methodological perspectives across the domains of Biomimicry, Engineering Design Process (EDP), and the essence of Islamic foundation (God, tawhid, revelation, intellect, nature, human, prophethood). It draws upon classical Islamic scholarship, Quranic verse (esp. *ayat kauniyah*), and contemporary sources in science and engineering design-based education. Particular attention is given to the previous model of integrative Islamic education that emphasizes character building,

21st-century skills, and ecological awareness [3], [10], [14]. No prior research frames biomimicry as a tawhidic Islamic education approach, nor integrates it with engineering-based education.

Conceptual Mapping. This stage maps the interrelationships among Islamic foundation, sustainable design principles, and engineering design built aligned with modern pedagogy. It highlights how divine values in nature, natural design principles, and structured engineering design process could be aligned in a coherent pedagogical vision. These mappings reveal the absence of an established model that integrates biomimicry and EDP within tawhid-based paradigms that translate divine reflection into applied, design-based problem-solving rooted in engineering logic that corresponds to contemporary real-world challenges.

Framework Development. This stage builds a new integrative model that connects scientific reasoning and embedded EDP within the tawhidic view. This model interprets engineering stages, including problem identification, exploring ideas from biomimicry, designing, testing, and implementation, as a spiritual process of *tadabur* (deep reflection), *tasyakur* (gratitude), *jihad* (struggle), *ikhtiar* (effort), good deeds, and human agency as Khalifah. Biomimicry is positioned not merely as an ecological tool but as an instrument to transform nature's divine potential into real-world solutions that prove the existence and actualization of Allah.

The study responds to the existence of prior Islamic education methods, highlighting their limitation in integrating experiential science with engineering design-based methods, as well as introducing a novel model that operates tawhid and knowledge through innovative ideas gained from biomimicry integrated with an engineering design framework as a contribution to our knowledge that has not yet been addressed in previous studies.

3 Result and Discussion

3.1 Tawhid as an Epistemological Framework for Science and Engineering

God (Allah) is *al-Wujūd al-Haqq*, the Absolute Reality and the central axis of all existence [12]. In Islamic thought, God is not merely a theological object but the epistemological, ontological, and axiological foundation of education. All knowledge, creation, and systems in the universe originate from Him and operate according to His will and divine laws (*sunnatullah*) [26]. Consequently, all forms of knowledge, including engineering processes such as biomimicry and the Engineering Design Process (EDP), must begin with an awareness of God's existence, oneness, and sovereignty, and be oriented as a path of spiritual proximity to It.

Tawhid serves as the foundational principle of Islamic education and the broader pursuit of knowledge. It affirms the Oneness of God in creation, governance, and the ultimate purpose of human life [1]. Education grounded in *tauhid* emphasizes the internalization and affirmation of divine unity across intellectual, emotional, and practical dimensions. The three dimensions of *tauhid Rububiyyah* (Oneness in creation and governance), *Uluhiyyah* (Oneness in worship and devotion), and *Asma' wa Sifat* (Oneness in the names and attributes of God) shape one's worldview regarding nature,

humanity, and intellectual activity [27]. From this perspective, biomimicry and the EDP are not value-neutral scientific methods but are instead epistemic tools for attaining *ma'rifatullah* (gnosis of God) through contemplation of the marvels of creation, including both the cosmos and the human being, which are means to deepen servitude to God.

Revelation serves as the source of values, direction, and boundaries for the use of intellect and knowledge [12]. It guides the human intellect to study, emulate, design, and derive wisdom from the divine systems embedded in the universe [28], with full awareness of the human role as a servant endowed with sensory faculties and the trust of *khilāfah* (stewardship). In the context of biomimicry and the Engineering Design Process, revelation directs human reason to observe, imitate, model, and design based on the divine systems embedded in nature, undertaken with the consciousness of being God's servant entrusted with sensory faculties and the responsibility of caliph (*khalifah*). Innovation, therefore, is not only to be efficient and creative, but also ethical, sustainable, and beneficial for humanity. Revelation protects the intellect from transgression and ensures alignment with the purpose of creation, the worship of Allah SWT, the Almighty.

The intellect is the human faculty for interpreting both revelation and the natural world. It is a divine gift that enables reflection upon the truth of *ayat kauniyah* (signs of God in nature), the construction of knowledge, critical reasoning, and problem-solving. In biomimicry, the intellect is used to study and learn from nature's systems and mechanisms [29]. The Engineering Design Process functions to design contextually appropriate solutions. However, the intellect must remain guided by revelation and *tawhid*-centered values to ensure that outcomes are not only rational but also ethical and spiritually aligned.

Nature is a manifestation of divine will, attributes, and wisdom. As such, it is sacred and functions according to divine laws. The order, efficiency, adaptability, and sustainability inherent in nature serve as the primary inspiration for the biomimicry approach. In *tawhid*-based education, the study of nature is not merely scientific inquiry but also a spiritual exercise of *tadabbur* (deep contemplation). Through biomimicry and the Engineering Design Process, learners recognize divine attributes embedded in creation, appreciate *sunnatullah* (natural laws), and design solutions that emulate nature's functionality, doing so with gratitude, trust in God, and a sense of spiritual struggle (*jihād*), rooted in sincere worship.

The human being, as the subject of education, is endowed with innate potential: mind, intellect, soul, spirit, heart, and body, all of which must be holistically nurtured [30], [31]. Biomimicry positions nature as a teacher, model, and standard, resonating with the Islamic view that nature must be preserved in its divine purity. The perfection reflected in nature signifies the majesty of God's attributes. The Engineering Design Process, meanwhile, cultivates critical and creative thinking as part of actualizing human responsibility as *Khalifah* on Earth. Therefore, integrating biomimicry and the EDP enables a holistic epistemology, rooted in spirituality, guided by intellect, directed by revelation, and expressed through collaborative and applicable engineering actions.

Prophet Muhammad, peace be upon him, exemplifies how knowledge, including science and technology, may be employed within the framework of *tawhid* and right

actions (*maslahah*) [31]. A *tawhid*-based education that adopts biomimicry and the EDP should embody prophetic principles such as sincerity of intention, justice, reliance on God (*tawakkul*), effort (*ikhtiar*), the pursuit of communal benefit (*maslahah*), and compassion for all creation so that the entire educational process becomes an act of holistic worship. The prophetic values provide a model for integrating reason and ethics, innovation and morality. Education thus goes beyond conveying what is right; it must also teach *how* to be right in thinking, acting, and creating, as demonstrated by the Prophet.

The integration of the concepts of God, *tawhid*, revelation, intellect, nature, humanity, and prophethood within the biomimicry and EDP framework forms a holistic educational system encompassing the spiritual, scientific, and practical domains. In this paradigm, biomimicry and the Engineering Design Process are not merely rational innovations but expressions of reverence toward God's creation. Thus, Educational and engineering activities transform into acts of worship that benefit humanity and the natural world.

3.2 Biomimicry as a Medium for Tawhid Education through Contemplation of Kauniyah Verses

In Islam, the universe is regarded as a manifestation of *ayat kauniyah*, signs of Allah's power and wisdom complementing the *ayat qauliyah* (the written revelations of the Qur'an). The Qur'an repeatedly urges humankind to observe, reflect upon, and derive lessons from the creation of the natural world (QS. Al-Ghasyiyah: 17–20; QS. Al-Ankabut: 20).

Biomimicry is a scientific approach that emulates nature's systems and structures to solve human problems sustainably. It views nature as a model, measure, and mentor [32]. Biomimicry considers nature as an unlimited source of inspiration. Nature is a series of replicable and inspiring designs that principally guide human actions to create conditions favorable to life and the environment [33]. Biomimicry conveys that design must protect the conditions that support life by striving to be like nature, rather than simply allowing nature to be [34]. Biomimicry is a promising approach to developing sustainable technologies by seeking natural solutions to complex system challenges [35],[36]. Biomimicry allows researchers to observe nature and create technological innovations inspired by it at the morphological, structural, molecular, mechanistic, and interaction levels.

Biomimicry can stimulate the development of various design skills, enhance creativity, and enhance the potential for sustainability within the production cycle [37]. At the regional level, for example, the BioS4You project in Europe aims to integrate a biologically inspired STEM approach into learning. The project demonstrates how Bioengineering, Bioscience, and Biotechnology can be integrated into STEM education to foster creativity, sustainability, and real-world problem-solving among young learners [37].

Benyus formulated nine key principles of biomimicry, known as Life's Principles, which reflect how biological systems operate efficiently and adaptively. These are: Nature lives with sunlight; Nature only uses the energy it needs; Nature adapts its form

and function; Nature recycles everything; Nature values cooperation; Nature depends on diversity; Nature demands local expertise; Nature limits excessive things from within; and Nature harnesses the power of boundaries [32].

Biomimicry outlook resonates with Islamic principles of sanctifying Allah's creation. When learners are guided to study how leaves manage water, how birds achieve aerodynamic efficiency, or how honeycomb structures maximize strength with minimal material, they engage in *tadabbur* (deep contemplation) of Allah's creation. Such experiences lead to an awareness of divine wisdom, harmony, and the marvels of God's design, cultivating a sense of nearness to Allah (*ma'rifatullah*) as an act of servitude.

Biomimicry can thus serve as an experiential and observational pedagogical tool for *tawhid*-based education. Through this lens, students learn not only *how* nature functions, but *why* and *for whom* it was created. They are then guided to reflect on their role in stewarding nature. This educational approach fosters a form of *tawhid* that is both scientific and explorative, transcending mere doctrinal or theoretical understanding.

A case in point is Newton's law of gravitation, which humans utilize to design bridges, aircraft, and spacecraft. Similarly, thermodynamic laws underpin the development of efficient machines. These natural laws, embedded in *sunnatullah* (divine patterns), reflect the divine will that enables humans to draw on consistent, observable patterns to innovate through reason and sensory faculties inherently compatible with the natural world. Each structure and function found in nature, as captured in biomimicry principles, is a valid object of *tadabbur*, guiding learners toward recognition of Allah's attributes as exemplified in Table 1.

Accordingly, in the context of *tawhid*-based education, biomimicry not only develops scientific skills but also nurtures reflection on the Divine Names and Attributes (*Asma' wa Sifat*), and Islamic values such as *ihsan* (excellence), *mizan* (balance), *shukr* (gratitude), sustainability, and efficiency. Mimicking nature is thus an act of recognizing and affirming the existence of Allah, fostering gratitude and faith. Philosophically and methodologically, biomimicry aligns with the Islamic concept of *tadabbur* of *sunnatullah*, bridging rational knowledge with spiritual consciousness, and connecting empirical experience (through observing creation) with faith-based reflection (awareness of the Creator).

3.3 The Universe and the Human Senses: Divine Mercy as Engineering Potential

The Qur'an illuminates this integration through the following *ayat kauniyah*:

"And Allah brought you forth from the wombs of your mothers while you knew nothing, and He gave you hearing, sight, and intellect so that you might be grateful." (QS. An-Nahl: 78)

"He it is Who created you and gave you hearing, sight, and hearts. Little are you grateful." (QS. Al-Mulk: 23)

"Indeed, We have created everything in due proportion." (QS. Al-Qamar: 49)

"I did not create jinn and mankind except to worship Me." (QS. Az-Zariyat: 56)

"And [remember] when your Lord said to the angels, 'Indeed, I will place a vicegerent upon the earth.'" (QS. Al-Baqarah: 30)

"And in your own selves, will you not then see?" (QS. Az-Zariyat: 21)

"The best of people are those most beneficial to others." (HR. Ahmad)

Based on these revelations, an integrative relationship can be summarized as follows:

Creation 1, The senses (measuring tools): Allah created hearing, sight, and intellect to enable gratitude and comprehension of reality (QS. An-Nahl: 78; QS. Al-Mulk: 23). Creation 2, Nature (measured objects): Allah created the universe with order, balance, and proportion, as a medium for exploration and engineering (QS. Al-Qamar: 49). Creation 3, Human creativity: Through the compatibility of senses and natural order, humans are entrusted to design and innovate beneficial solutions, embodying divine attributes in fulfilling their role as Allah's caliph (QS. Az-Zariyat: 21; HR. Ahmad; QS. Az-Zariyat: 56; QS. Al-Baqarah: 30).

Without the continuity between Creation 1 and 2, Creation 3 cannot be actualized. This reflects that human senses do not function independently, but in harmony with the natural world, which operates under divine laws. This compatibility manifests divine mercy, enabling humans to comprehend natural laws and apply them in real-life contexts. For instance, the light spectrum is set such that human eyes can perceive what is essential for survival, while the auditory range is likewise divinely calibrated. These constants serve as foundational data for both visual and technical design.

If the human senses were incompatible with the natural world, or nature were not subject to divine constants, humans would be unable to perceive reality, interpret nature, plan, predict, or engineer life solutions. Biomimicry exemplifies how nature's design carries embedded engineering wisdom. Allah further endows humans with intellect and conscience to fulfill their mandate as *khalifah*. This potential is a call for intellectual and spiritual *jihād* through the development of beneficial technologies.

These evidences affirm that sensory (perceptual), intellectual (rational), and spiritual (conscientious) faculties are divine gifts that must be actualized to build a civilization rooted in *tawhīd* and to bring real benefit to humanity.

3.4 Engineering Design Process as the Next Stage of Tadabbur

The Engineering Design Process (EDP) continues *tadabbur*, or contemplative biomimetic exploration, wherein learners, after recognizing the signs of God and understanding His existence and attributes, step into their role as *Khalifah*. They are now tasked with employing natural potential and human senses to create sustainable, beneficial designs, thereby restoring the sanctity of the universe as an embodiment of divine values.

The Qur'an invites humankind to contemplate creation and provides explicit and implicit foundations for using reason, knowledge, and the senses to respond to *ayat kauniyah* through innovation and design. While the term *Engineering Design Process* does not appear literally in the Qur'an, its principles, observation, exploration, ideation, design, and evaluation are embedded in the Qur'anic epistemology (see Table 1).

Table 1. Reflection of Divine Values through the Principles of Biomimicry (Benyus) as Scientific Contemplation.

Biomimicry Principle	Cosmic Signs	Contemplative Reflection	Implications of Tawhid
Tadabur Kauniyah Verse			
Principle 1: Nature is Powered by Solar Energy	QS An-Nur: 35 QS Ibrahim: 33	This principle reflects the Qur'anic verse that emphasizes Allah as the Light of the heavens and the Earth. As a celestial body, the sun is subjected to divine order, indicating that the energy sustaining nature is created to be continuous and inexhaustible.	It manifests Allah's attributes: <i>An-Nur</i> (The Light), <i>Al-Wahhab</i> (The Giver of Abundant Gifts), <i>Al-Baqi</i> (The Everlasting), <i>Al-Muhyi</i> (The Giver of Life), and <i>Al-Hayy</i> (The Ever-Living), as the ultimate source of energy for all ecosystems.
Principle 2: Nature Only Uses the Energy It Needs	QS Adz Zariyat: 20-21, QS An-Nahl: 68-69	This principle underscores that the human body is divinely designed to operate efficiently, consuming only the minimal energy required for optimal function. Bees, for instance, construct hives and produce honey with remarkable efficiency using nearby resources, reflecting divine order and submission.	This exemplifies Allah's attributes: <i>Al-Hakim</i> (The All-Wise) and <i>Al-Muqaddir</i> (The Determiner). It demonstrates that natural systems function efficiently and sustainably without excess, aligning with the principle of balance in creation.
Principle 3: Nature Adapts Form to Function	QS Al-Ghasyiah: 17-20, QS Al-Insan: 2	The Qur'an invites reflection on camels, the heavens, mountains, and the Earth as signs of Allah's adaptive and contextual design. The camel's ability to survive harsh deserts and the sensory systems of living beings illustrate adaptive intelligence.	Each creation is precisely and purposefully designed, embodying the attributes: <i>Ar-Rashid</i> (The Guide), <i>Al-Bari</i> (The Evolver), and <i>Al-Musawwir</i> (The Fashioner), reinforcing awareness of divine wisdom and functional design.

Principle 4: Nature Recycles Everything	QS Al-Hajj:5 QS Yasin: 78-79	The recurring cycles of life and death reflect a continuous biological recycling system, embedded within divine design. This dynamic process demonstrates life's ongoing rotation under Allah's will and regulation.	It reflects Allah's attributes: <i>Al-Hayy</i> (The Ever-Living), <i>Al-Muhyi</i> (The Giver of Life), and <i>Al-Mumit</i> (The Taker of Life), who governs the life cycle with wisdom and harmony.
Principle 5: Nature Operates Through Cooperation	QS Al-Anbiya: 30, QS Ali Imran 190-191	The Qur'an mentions that the Earth was once united before being divided—now interlinked and interactive. Photosynthesis, the water cycle, and interactions among biological elements like light and energy highlight a grand cosmic coordination.	This illustrates the divine attributes of <i>Al-Ahad</i> (The One), <i>Al-Jami'</i> (The Gatherer), and <i>Ar-Rahman</i> (The Most Compassionate). The principle of cooperation reflects the interconnectedness and unity in creation, symbolizing the Oneness of God.
	Hadith Bukhari no. 6011, muslim no. 2586	Humans are likened to a single body—when one part is in pain, the whole body responds. This analogy reinforces the importance of coordination, collaboration, and solidarity, mirroring the harmonious operation of natural systems.	It expresses the values of compassion and unity found in <i>Ar-Rahim</i> (The Most Merciful) and <i>Al-Jami'</i> (The Gatherer), indicating that humanity is bound within one social and spiritual system.
Principle 6: Nature Depends on Diversity	QS Al-Fussilat: 53	The signs of Allah are evident throughout the universe and within the human self, expressed in diverse forms, functions, and systems. Observing cross-species interactions reveals that biodiversity fosters innovation and ecological richness. Every creature represents a unique manifestation of the Divine attributes.	Diversity in creation reflects the richness of God's design, in which all elements complement one another within the harmonious order of life, reflecting <i>Al-Khaliq</i> (The Creator), <i>Al-Badi'</i> (The Incomparable Originator), and <i>Al-Fattah</i> (The Opener of Ways).
Principle 7: Nature Avoids Toxic and Harmful Substances	Al-A'raf: 56, Al- Baqarah :205, Ar- Rum:41	The human body is created with high biomolecular precision and is free from harmful design. The Qur'an prohibits corruption on Earth after Allah has set it right—this includes environmental pollution and the degradation of flora, fauna, and natural ecosystems.	This reflects Allah's attributes: <i>Al-Hakim</i> (The All-Wise), <i>Al-'Adl</i> (The Just), and <i>Ar-Rahman</i> (The Compassionate). Environmental destruction is a consequence of human actions and must be addressed as a divine trust.

Principle 8: Nature Restrains Excess from Within	QS Al- Baqarah : 164	Nature maintains equilibrium through internal mechanisms that prevent overexploitation, revealing the divine principles of justice and balance. Natural systems preserve internal stability to adapt to environmental changes through self-regulation (homeostasis).	This reflects the divine attributes: <i>Al-'Adl</i> (The Just), <i>Al-Muqsit</i> (The Equitable), and <i>Al-Hakam</i> (The Giver of Verdicts).
Principle 9: Nature Utilizes the Power of Limits	QS Al- Baqarah : 286	Allah creates all systems proportionately and according to their specific capacities and roles. For example, large birds have limited wing surfaces, yet maintain sufficient oxygen intake and reduced water loss due to their fine feathers, demonstrating efficient design within constraints.	This principle reveals the divine attributes: <i>Al-Hakim</i> (the All-Wise), <i>Al-Khaliq</i> (the Creator), <i>Al-'Adl</i> (the Just), <i>Al-Muqtadir</i> (the Omnipotent), and <i>Al-Qadir</i> (the All-Powerful).
	QS Al- Mulk: 3 QS Al- Qamar: 49	All of creation is governed by divine limits—measured capacities, roles, and forms designed to fulfill their cosmic functions. Each element in the universe operates within specific proportions that serve as tools of precision and reference for design.	These boundaries represent divine attributes: <i>Al-Hakam</i> (the Arbitrator), <i>Al-Muqaddir</i> (the Determiner of Measurement and Destiny), <i>Al-Hakim</i> (the All-Wise), <i>Al-'Adl</i> (the Just), and <i>Al-Qadir</i> (the Powerful). They illustrate that limits are a form of divine mercy and wisdom in creation.

This table illustrates how nature's design, as explored through biomimicry principles, reflects divine order embedded in the universe. Each principle is linked to Quranic verses (*ayat kauniyah*) and the names of Allah (*Asma'ul Husna*), highlighting the spiritual dimension of scientific contemplation. From solar energy to biological cooperation, these patterns demonstrate that nature operates with purpose, balance, and harmony, guiding towards a deeper awareness of tauhid (Oneness of God) and the interconnectedness of all creations.

3.5 Engineering as a Medium for Tawhid Education through the Reflection of Revelation

In Islamic epistemology, revelation is regarded as the highest source of knowledge and serves as the ontological and epistemological foundation of all sciences. In contrast, engineering is categorized as *'ilmkasbi*—acquired knowledge derived through human effort, observation, experimentation, and rationality.

Islam views knowledge as inseparable from values; thus, there is no dichotomy between religious and secular sciences. Accordingly, engineering inherently contains the values of *tawhid*, though it does not embody revelation in its literal form (as found

in the Qur'an). Rather, it is guided by the light of revelation as the moral compass and spiritual direction for technical activities and human character development.

For instance, while the Qur'an does not explain how to construct a bridge, it provides *tauhid*-based principles that encourage solving human problems through scientific and technological means. In the Islamic perspective, engineering is not value-neutral; it can serve as a path to fulfilling the role of *khalifah* (vicegerent) (Qur'an, Al-Baqarah: 30), transforming divine mercy into wisdom through creation (Ar-Rahman: 7), and integrating revelatory values at every stage of technical solutions (Al-Mulk: 3–4).

Engineering thus becomes a medium for *tawhid*-centered learning that is applicable, contextual, and contemplative. Each phase, problem identification, solution exploration, and implementation, can be aligned with values derived from revelation: *ikhtiar* (effort) in identifying problems, *tawakkal* (reliance on God) during the design process, *amanah* (trustworthiness) and *'adl* (justice) in technical solutions (An-Nisa: 58), contemplation of nature in exploring sustainable solutions (Al-Ghasiyah: 17–20), and collaboration in design. Integrating engineering into *tawhid*-based education fosters the internalization of revelation in reasoning, problem-solving, and innovation, enabling learners not only to master technical concepts but to perceive engineering as an act of worship, intellectual struggle (*jihad*), and faith enhancement.

3.6 Engineering Design Process as a Manifestation of the Khalifah's Trust

The Engineering Design Process (EDP) is a systematic framework for problem-solving. It consists of five stages: asking (problem identification), imagining (ideation), planning (solution design), creating (implementation), and improving (evaluation). EDP facilitates the application of biomimicry by translating observation into tangible and practical innovations.

Within the context of *tawhid*-oriented education, the Engineering Design Process invites learners to transform the contemplative insights derived from biomimicry into acts of worship (*tauhid uluhiyah*) through innovation and engineering solutions. Biomimicry cultivates ecological awareness and submission to the natural order, while EDP activates the human engineering potential to concretize those observations, grounded in spiritual awareness, intention (*niyyah*) for the sake of Allah, the consciousness of the *khalifah* mandate, collaborative ethics, *jihad* spirit, and the aim of bringing benefit (*maslahah*) to humanity. Together, they form a holistic continuum from contemplation to application.

One of EDP's essential features is iteration and failure as integral parts of the learning process. In Islam, this reflects the value of *jihad*, striving earnestly to achieve benefit despite hardship. As stated in Surah Al-Insyirah (94:6), "Indeed, with hardship comes ease," affirming that the innovation process, marked by trial and error, is spiritually rich.

Ibn Sina (Avicenna) explained that medicine was derived from observing the four elements: Earth, air, fire, and water. Ibn Sina adopted the concept that all creatures on Earth, including the human body, are composed of natural elements, as a microcosm of the macrocosm, and based his treatment on the natural seasonal cycle and the balance of the natural elements [31].

Divine values such as mercy, benefit, cooperation, compassion, creativity, *jihad*, leadership, and wisdom are all embedded within the Engineering Design Process (EDP), making it a channel of worship that mirrors the attributes of Allah SWT. Engineering Design Process (EDP) provides a systematic cognitive framework from problem identification to idea generation, design, testing, and evaluation, aligned with scientific reasoning and Islamic work ethics.

3.7 Integrating Tawhid, Biomimicry, and Engineering Design Process in Tauhid-Based Education

The conceptual integration reveals that *tauhid* provides the spiritual and ethical foundation; biomimicry offers a lens to observe *sunnatullah* (divine laws in nature); and the Engineering Design Process (EDP) provides a structured mechanism to transform biomimetic observations into tangible innovations for human benefit. This triadic relationship constructs a comprehensive educational framework that bridges faith and knowledge. The study of nature and the human self through biomimicry reinforces the understanding that human senses are not autonomous, but harmonized with universal laws (*sunnatullah*): knowledge and action. Engineering Design Process (EDP) translates the sensory and cognitive potentials into creative output. Spiritually, this reflects an effort to harness and manage Allah's mercy scattered across creation, fulfilling the *khalifah* mandate and serving as a form of worship: contemplation and application. Understanding *sunnatullah* does not end with affirming divine existence but must be manifested in practical, beneficial actions and concrete expressions of the *khalifah*'s responsibility. Spiritually, this affirms divine will (*irada*) and creative power (*al-Khaliq*), bringing forth what did not exist before. Mercy and wisdom. Engineering Design Process (EDP) becomes a means to access Allah's mercy, which permeates the cosmos. Similarly, biomimicry guides humankind to receive this mercy with *hikmah* (wisdom) and ecological mindfulness.

In the context of the engineering design process, a product functions optimally only when all its components operate according to the Creator's original design (manual book). If one part resists the system, the whole structure may collapse. This analogy reflects the tawhid principle, where Allah's creation functions harmoniously toward one singular purpose: to worship Him as guided by God's manual book, Al-Quran Al-Kareem.

Table 2. Reflection of Tawhidic Values through the Engineering Design Process

No.	Engineering / Design	Reflective Contemplation
1	Every design must be directed toward a clear and unified purpose.	Nature, as the creation of Allah, embodies a singular divine vision: submission and devotion to the One and Only God, Allah.
2	All elements within a design system must function harmoniously and exhibit structured collaboration.	Every component of the natural world operates effectively only when each part performs according to its designated capacity (function) and specification (role), as ordained by its Creator

3	Engineered products require an operational manual that aligns with the intended purpose and component specifications as determined by the designer.	Similarly, nature operates and sustains itself by adhering to a set of divine standards, the Qur'an, which serves as its ultimate manual prescribed by the Creator.
4	The final product reflects not only the designer's intellectual and technical capacity but also their emotional and spiritual intelligence.	Nature reflects the majesty and perfection of Allah as the sole and absolute source, Al-Khaliq, the Creator.

The analogy between engineering and natural design holds true only when the system operates in accordance with its guiding manual. In the case of nature, the Quran serves as the ultimate manual, governing the operation of all natural processes within the time frame and boundaries predetermined by the will of its Creator.

Table 3. Theological Values Implications in the Engineering Design Process as a Learning Model

Stage	Quranic Based	Tawhid Reflection
1 Problem Identification		
QS Yusuf: 43-49	Prophet Yusuf demonstrated predictive analytical skills in interpreting the King's dream, identifying a potential famine crisis, and formulating a preventive strategy by storing agricultural yields.	Tawhid Rububiyah: Acknowledging that all problems and crises, whether good or bad, occur with Allah's knowledge and permission, and contain divine wisdom.
QS Al-A'raf: 56 QS Hud: 61	This Qur'anic principle affirms that humankind is appointed as <i>khalifah</i> (caliph) to preserve the Earth, refrain from corruption, and utilize nature responsibly.	Tawhid Uluhiyah: The intention to work is aligned with worship, carried out sincerely for the sake of Allah and in accordance with His commands.
2 Biomimicry Exploration		
	(Refer to Table 1. Reflection of Divine Values through the Principles of Biomimicry (Benyus) as Scientific Contemplation.	Tawhid Asma wa Sifat: Recognizing and believing in the existence of Allah through His Names and Attributes.
3 Design/ Innovation		
QS. Nuh: 36-37	Prophet Nuh received divine instruction to design a ship as a prototype for his people's salvation,	Tawhid Uluhiyah: Continuous improvement for collective well-being is regarded as an act of

QS An Naml: 38-44	demonstrating obedience and the integration of technology within the framework of revelation and humanitarian goals.	worship. Tawhid Rububiyah: All knowledge and solutions originate from Allah.
QS Ar-Rahman: 33	The Qur'an encourages humans to traverse the heavens and Earth through knowledge and technology, emphasizing intellectual empowerment and the optimal use of reasons.	Tawhid Rububiyah: Belief in divine support in every solution. Tawhid Uluhiyah: Scientific endeavor as a form of <i>jihad</i> , emphasizing persistence and collaboration despite failure.
QS Al Kahfi: 95-97	Dhul-Qarnayn engineered and constructed an iron wall as a defense system tailored to the specific needs of a community. The process involved gathering iron, melting metals, and reinforcing the structure with copper, which was executed in strategic phases.	Tawhid Uluhiyah: <i>Istiqamah</i> —steadfastness in the face of challenges and perseverance in pursuing solutions.

4 Testing/ Evaluation

QS Al Kahfi: 95-97	Evaluation involved assessing the durability of structures and implementing technical strategies with responsibility.	Tawhid Rububiyah: Dependence on Allah and patience through trials and failures, followed by persistence through trial and error. Tawhid Uluhiyah: Diligent effort (<i>ikhtiar</i>) and resolute determination (<i>azam</i>) without fear of failure.
QS At Taubah: 105	This stage reflects the principle of continuous improvement and innovation accountability, stressing the importance of maintaining balance and repairing damage with a focus on sustainable solutions.	Tawhid Uluhiyah: <i>Tawakkul</i> —reliance on Allah after exhausting all efforts, while remaining accountable for the outcomes.

5 Implementation and Production

QS Saba': 10-11	Allah taught Prophet Dawud the skill of crafting precise armor, illustrating knowledge transfer through revelation and a functional model of defense technology. He was endowed with the ability to	Tawhid Uluhiyah: The final product is developed as a tangible proposal for implementation in classrooms, prayer rooms, schools, or community reading spaces. Large-scale prototypes can also be
-----------------	---	--

process iron and produce protective gear with practical benefits.	constructed as educational demonstrations and direct contributions to society.
---	--

6 Spiritual and Ethical Reflection

QS Al Baqarah: 30	“I will appoint a vicegerent on Earth.” This verse emphasizes the human mandate to serve as <i>khalifah</i> , responsible for the flourishing of the Earth through knowledge and moral responsibility toward the environment and fellow beings.	Students are encouraged to reflect on how their interaction with nature inspired environmentally friendly innovations, and how their role as <i>khalifah</i> is manifested in the pursuit of beneficial solutions that avoid environmental harm.
-------------------	---	--

The table illustrates that the engineering design process is not merely a technical endeavor, but can serve as a form of worship when integrated with tauhidic values, reflecting *jihad*, *istiqamah* (steadfastness), *ikhtiar* (effort), *tawakkul* (reliance on God), and the responsibility of being a *khalifah* (caliph).

Table 4. Stages of the Tawhidic Biomimicry-Engineering Design Process Learning Model

Stage	Main Activity	Tawhid Education
1 Problem Identification		
	Students investigate real-world challenges derived from natural or social phenomena, such as water contamination or extreme heat that affects life systems.	They identify thematic issues like energy crises, pollution, and global warming through a scientific approach framed as an act of critical thinking and worship. This process cultivates a consciousness of their responsibility as <i>khalifah</i> (caliph) to obey Allah and preserve the Earth’s sustainability.
2 Biomimicry Exploration		
	Students analyze structures or systems found in living organisms as sources of inspiration for innovative solutions, such as leaves for water filtration, termite mounds for temperature regulation, or lotus leaves that remain clean in dirty water.	This exploration is conducted with spiritual awareness (<i>hikmah</i>), aiming to design biomimetic solutions that are efficient, functional, and environmentally friendly as a form of worship and service to Allah.
3 Engineering Design Process		
	Students develop prototypes inspired by natural systems, such as water filtration devices, passive cooling systems, or air circulation mechanisms.	These initial designs are created with the intention of worship, applying biomimicry principles, such as using bamboo structures

for natural cooling or roof designs inspired by natural formations.

4 Implementation and Evaluation

Students test the effectiveness of their proposed solutions and reflect on the outcomes and impacts.

This stage is treated as a form of intellectual *jihad*, a meaningful contribution, scientific responsibility, and trust (*amanah*) in addressing everyday environmental and social problems.

5 Spiritual Reflection

They discuss the spiritual values, societal impacts of their solutions, and their responsibility toward the creation of Allah.

Students engage in spiritual reflection throughout the process, from contemplating the *ayatkauniyah* (signs of God in nature) to the implementation and evaluation stages.

The table outlines the stages of the Tawhidic Biomimicry Engineering Design Process learning model, integrating Quranic principles into each engineering design step. The model begins with problem identification, followed by exploration of nature to derive innovative ideas that reflect divine attributes. It includes the phases of design, testing, and continuous spiritual reflection throughout the design process. It stimulates students' problem-solving and critical thinking skills while reinforcing their belief in the Oneness of God, ultimately leading to holistic learning outcomes rooted in Islamic faith.

Several integrative Islamic education learning models have adopted problem-based learning approaches to shape students' moral character, problem-solving skills, self-directed learning, and active participation [39], [40], [41]. Similarly, project-based learning in Islamic education has been shown to enhance motivation, creativity, critical thinking, and independent character [42], [43], [44]. Integrative models also develop tauhid-based character, moral awareness, and spiritual commitment. However, these approaches primarily focus on character formation and have yet to produce original innovations derived from nature-based inspiration.

The similarity between this study and existing PAI models, such as PBL, PjBL, and integrative learning, is their shared foundation in real-life problems or contextual phenomena, including environmental and social issues. These models encourage problem-solving and the creation of concrete solutions, positioning students as active agents in exploration and inquiry. At the same time, teachers serve as facilitators and guides in the thinking process. Nevertheless, although character and moral values are emphasized, previous models have not done so comprehensively. Prior studies also tend to follow prototypical models without clearly identifying sources of inspiration or innovation.

In contrast, biomimicry offers the potential to generate unprecedented ideas and innovations by learning directly from nature as a source of divine wisdom. Traditional

models have yet to embed the mission of the khalifah within problem-solving or the creation of solutions. They often lack incorporated core values to God at each stage of learning in line with human fitrah, such as intention, purpose, process, worship, jihad (striving), *amanah* (trustworthiness), and responsibility as servants (*abd'*) and *khalifah* (caliph) on Earth. The outcome orientation is typically limited to practical products or solutions, without including implementative testing phases or framing the process within the context of worship and servitude to God.

The development of this learning model can be further enriched by teachers through alternative themes, such as environmentally friendly packaging inspired by the cocoon structure of a caterpillar, leak-proof water bottle designs inspired by the pomegranate peel, or automated irrigation systems based on plant root principles.

4 Conclusion

The conceptual synthesis reveals that the principles of tawhid, the biomimicry approach, and the *Engineering Design Process (EDP)* are interwoven in an epistemological framework that fosters a holistic learning experience, spiritually reflective, scientifically grounded, and practically applicable. Biomimicry serves as a medium of *tadabbur* (contemplation) on Allah's creation, leading learners toward recognizing divine attributes (*Asma' wa Sifat*) and affirming God's existence. The EDP then functions as a means to transform those insights into real-world engineering solutions that are beneficial (*amal salih*) and seen as acts of worship (*uluhiyyah*). This model connects faith and knowledge, science and action, contemplation and application, exploration and actualization, wisdom and divine mercy. This integrative tawhid-based educational model is developed through the following three stages:

Stage of Ma'rifatullah (Tawhid Asma' wa Sifat). Students are guided to recognize Allah's attributes by observing natural structures and systems, using the principles of biomimicry as a scientific bridge to attain awareness of the Creator. Stage of Action and Devotion as *Khalifatullah* (Tawhid Uluhiyyah). Divine values derived through biomimicry are transformed into innovative solutions through the EDP stages: problem identification, design, prototyping, testing, and refinement with an awareness of humanity's caliphal responsibility to bring divine mercy into the world. Stage of Consciousness as Servants of God and Receivers of Divine Mercy (*Tawhid Rububiyyah*). The learning process culminates in the internalization of spiritual consciousness that all creation adheres to a divine system, originating from and returning to a single Creator. Students recognize their identity as servants (*'abd*) operating within the cosmic order governed by the "manual" of divine guidance, the Qur'an.

This study is limited by its theoretical-conceptual approach without classroom implementation, restricted scope in educational levels, and lack of empirical validation. Future research is recommended to conduct field trials, develop specific assessment tools, and adapt the model to primary, secondary, or higher education levels. Additionally, integration into National curricula such as Merdeka Belajar or an Islamic-based STEAM framework should be explored, along with cross-cultural comparative studies to assess adaptability in various educational systems.

References

- [1] I. R. Al-Faruqi, *Al-Tawhid: Its Implications for Thought and Life*. Herndon: International Institute of Islamic Thought (IIIT), 1995.
- [2] Republic of Indonesia, *Law No. 20 Year 2003 on the National Education System, Chapter II, Article 3*. Jakarta, Indonesia, 2003.
- [3] N. K. R. Putri and C. Setiawan, "What Islamic Education Teachers Need To Know and Be Able To Do To Teach Students Higher-Order Thinking Skills?," *Afkaruna Indones. Interdiscip. J. Islam. Stud.*, vol. 18, no. 2, pp. 308–323, Dec. 2022, doi: 10.18196/afkaruna.v18i2.9462.
- [4] S. Sirait, *Tauhid dan Pembelajarannya*. Yogyakarta: Postgraduate Program, Faculty of Education and Teacher Training, UIN Sunan Kalijaga, 2020.
- [5] N. H. H. P. W. Kasno and A. K. Fata, "FROM GOD TO HUMANITY: Reconstruction of Islamic Theology in Contemporary Era," *J. Dharma*, vol. 48, no. 4, pp. 429–448.
- [6] M. A. Choudhury, "Tawhid and Shari'ah," *Tawhid and Shari'ah*, 2020, doi: 10.1007/978-3-030-49087-4.
- [7] S. Altay, "Fazlur Rahman's Criticism of Kal'm in the Context of Reconstructing of the Science of Kal'm," *Cumhur. İlahiyat Derg.*, vol. 25, no. 2, pp. 853–874, 2021.
- [8] M. Saleh, S. Sutrisno, Z. Arifin, M. Maemonah, and R. Solihin, "Paradigm of Integration of Islamic and Scientific Knowledge: Philosophical Reflection on Islamic Basic Education," *Scaffolding J. Pendidik. Islam dan Multikulturalisme*, vol. 7, no. 1, pp. 484–498, May 2025, doi: 10.37680/scaffolding.v7i1.7102.
- [9] A. T. Aldossari, "Creative Thinking Skills Included in the Content of Evaluation Questions in the Curricula of the Kingdom of Saudi Arabia," *Int. J. Educ. Pract. Conscientia Beam*, vol. 9, no. 3, pp. 520–531, 2021.
- [10] M. S. Albassam, "The Doctrinal Miracle in the Holy Quran through Its Approach of Establishing the Oneness of Lordship (Tawheed Al-Rububiyah)," *Quranica*, vol. Special Is, 2024.
- [11] H. K. Altinyelken, "Critical thinking and non-formal Islamic education: Perspectives from young Muslims in the Netherlands," *Contemp. Islam*, vol. 15, no. 3, pp. 267–285, Nov. 2021, doi: 10.1007/s11562-021-00470-6.
- [12] S. M. N. Al-Attas, *Prolegomena to the Metaphysics of Islam*. Kuala Lumpur: ISTAC, 1995.
- [13] H. Ainissyifa, "Development Strategy of Islamic Education Institution," *Int. J. Sci. Technol. Res.*, vol. 8, no. 4, pp. 141–149, 2019.
- [14] R. M. Hutapea, M. Husnaini, I. Victorynie, and A. S. Fuady, "Exploring the Strategies of Teachers to Integrate Tauhid in Teaching Science and History in Selangor, Malaysia," *Int. J. Soc. Learn.*, vol. 1, no. 2, pp. 89–102, Apr. 2021, doi: 10.47134/ijsl.v1i2.9.
- [15] Badrane Benlahcene and Ibrahim Mohammad Zain, "The Early Foundations of the Study of other religions in Islamic Thought: Historical and Conceptual Approach.," *Glob. J. al thaqafah*, vol. 13, no. 2, pp. 124–148, Dec. 2023, doi:

10.7187/GJAT122023-9.

- [16] A. El-Moslimany, *Teaching Children: A Moral, Spiritual, and Holistic Approach to Educational Development*. London–Washington: IIIT, 2017.
- [17] M. Abdulsalam Suliman Al Arood, M. Zaki Aljallad, and N. Baioumy, “The Effectiveness of a Cloud-Based Learning Program in Developing Reflective thinking Skills in Islamic Education among Students in UAE,” *Int. J. Educ. Pract.*, vol. 8, no. 1, pp. 158–173, 2020, doi: 10.18488/journal.61.2020.81.158.173.
- [18] M. Masturin, M. R. Ritonga, and S. Amaroh, “Tawhid-Based Green Learning in Islamic Higher Education: An Insan Kamil Character Building,” *QIJIS (Qudus Int. J. Islam. Stud.)*, vol. 10, no. 1, pp. 215–252, Jul. 2022, doi: 10.21043/qijis.v10i1.14124.
- [19] Leli, P. A. Sunarya, N. Lutfiani, N. P. Lestari Santoso, and R. Ajeng Toyibah, “The Importance of Technology to the View of the Qur’an for Studying Natural Sciences,” *Aptisi Trans. Technopreneursh.*, vol. 3, no. 1, pp. 58–67, Mar. 2021, doi: 10.34306/att.v3i1.142.
- [20] H. Dicks, *The Biomimicry Revolution: Learning from Nature How to Inhabit the Earth*. New York: Columbia University Press, 2023.
- [21] H.-J. Han and K.-C. Shim, “Development of an engineering design process-based teaching and learning model for scientifically gifted students at the Science Education Institute for the Gifted in South Korea,” *Asia-Pacific Sci. Educ.*, vol. 5, no. 1, p. 13, Dec. 2019, doi: 10.1186/s41029-019-0047-6.
- [22] M. Syukri, L. Halim, L. E. Mohtar, and S. Soewarno, “The Impact of Engineering Design Process in Teaching and Learning to Enhance Students’ Science Problem-Solving Skills,” *J. Pendidik. IPA Indones.*, vol. 7, no. 1, pp. 66–75, Apr. 2018, doi: 10.15294/jpii.v7i1.12297.
- [23] U. Sudrajat, D. Ardianto, and A. Permanasari, “Engineering Design Process (EDP)-Based Learning to Enhance High School Students’ Creativity in Alternative Energy Topics,” *J. Penelit. Pendidik. IPA*, vol. 9, no. 11, pp. 9547–9553, Nov. 2023, doi: 10.29303/jppipa.v9i11.5248.
- [24] E. F. Rusydiyah, D. Indarwati, S. Jazil, S. Susilawati, and G. Gusniwati, “STEM Learning Environment: Perceptions and Implementation Skills in Prospective Science Teachers,” *J. Pendidik. IPA Indones.*, vol. 10, no. 1, pp. 138–148, Mar. 2021, doi: 10.15294/jpii.v10i1.28303.
- [25] Muzakkir, R. A. Abd Rauf, and H. Zulnaidi, “Development and validation of the Quran – Science, Technology, Engineering, Art, And Mathematics (Q-STEAM) module,” *STEM Educ.*, vol. 4, no. 4, pp. 346–363, 2024, doi: 10.3934/steme.2024020.
- [26] S. M. N. Al-Attas, *Islam and Secularism*. Kuala Lumpur: ISTAC, 1993.
- [27] S. A.-I. I. Taimiyyah, *Majmu’ al-Fatawa (Kumpulan Fatwa Ibu Taimiyyah), Tahqiq oleh Amir Al-Jazzar dan Anwar al-Bazz*, 28th ed. Jakarta: Pustaka Azam.
- [28] S. H. Nasr, *Knowledge and the Sacred*. New York: State University of New York Press, 1981.
- [29] S. H. Nasr, *Science and Civilization in Islam*, 2nd ed. Cambridge: Islamic Texts

- Society, 1987.
- [30] S. H. Nasr, *Man and Nature: The Spiritual Crisis of Modern Man*. London: George Allen & Unwin, 1968.
- [31] S. M. N. Al-Attas, *The Concept of Education in Islam, a framework for an Islamic Philosophy of Education*. Kuala Lumpur: ISTAC, 1991.
- [32] J. M. Benyus, *Biomimicry: Innovation Inspired by Nature*. London and New York: Harper Collins e-books, 1997.
- [33] D. Lestari, "Biomimicry Learning as Inspiration for Product Design Innovation in Industrial Revolution 4.0," *Int. J. Creat. Arts Stud.*, vol. 7, no. 1, pp. 1–18, Jul. 2020, doi: 10.24821/ijcas.v7i1.4160.
- [34] H. Dicks, *Philosophy and Biomimicry: Life Lessons for Design*. Cambridge: Cambridge University Press, 2023.
- [35] E. Kennedy, D. Fecheyr-Lippens, B.-K. Hsiung, P. H. Niewiarowski, and M. Kolodziej, "Biomimicry: A Path to Sustainable Innovation," *Des. Issues*, vol. 31, no. 3, pp. 66–73, Jul. 2015, doi: 10.1162/DESI_a_00339.
- [36] A. A. M. de Sá and D. M. Viana, "Design and Biomimicry: A Review of Interconnections and Creative Potentials," *Biomimetics*, vol. 8, no. 1, p. 61, Feb. 2023, doi: 10.3390/biomimetics8010061.
- [37] D. Persano Adorno *et al.*, "The BioS4You European Project: An Innovative Way to Effectively Engage Z-Generation Students in STEM Disciplines," *Educ. Sci.*, vol. 11, no. 12, p. 774, Nov. 2021, doi: 10.3390/educsci11120774.
- [38] "Ibnu Sina » Nature Ace Indonesia." Accessed: Jul. 17, 2025. [Online]. Available: <https://natureace.id/ibnu-sina/>
- [39] A. Triono, S. I. Aflachah, N. Hidayah, M. I. I. Al-Qowim, and A. Radianti, "Problem-based learning in Islamic Education subject to build students' morals in online learning (pandemic experiences)," *Insa. J. Pemikir. Altern. Kependidikan*, vol. 28, no. 1, pp. 80–97, Jun. 2023, doi: 10.24090/insania.v28i1.6922.
- [40] K. Damayanti, M. Effendi, and R. W. Daryono, "The Effectiveness of The Problem-Based Learning Model on Student Learning Achievement in Islamic Education Learning," *IJORER Int. J. Recent Educ. Res.*, vol. 5, no. 5, pp. 1097–1108, Sep. 2024, doi: 10.46245/ijorer.v5i5.653.
- [41] A. Z. A. Aljalalma, "Cooperative and Problem-Based Learning Practice in Islamic Education in Bahrain: Strengths and Challenges," *Adv. Anthropol.*, vol. 13, no. 04, pp. 279–294, 2023, doi: 10.4236/aa.2023.134018.
- [42] P. Muthaharo, P. Pitnizar, and S. Halimah, "Penerapan Project Based Learning dalam Meningkatkan Hasil Belajar Siswa pada Mata Pelajaran Pendidikan Agama Islam (PAI) di Kelas VC SD Negeri 13/I Muara Bulian dengan Menggunakan Metode Tanya Jawab," *ISLAMIKA*, vol. 7, no. 1, pp. 93–106, Jan. 2025, doi: 10.36088/islamika.v7i1.5475.
- [43] R. Rofiqoh, R. Rofika, and R. Rutinah, "Implementasi Project-Based Learning dalam Pembelajaran Fikih untuk Meningkatkan Pemahaman Siswa SDN 18/1 Teluk," *ISLAMIKA*, vol. 7, no. 1, pp. 53–66, Jan. 2025, doi: 10.36088/islamika.v7i1.5472.
- [44] S. Sistriyanti, S. Marpuah, and S. Sarinah, "Penerapan Project-Based Learning

dalam Pembelajaran Akidah agar Dapat Menumbuhkan Akhlakul Karimah pada Mata Pelajaran PAI di SDN 021/1 Maro Sebo Ulu Kabupaten Batanghari,” *ISLAMIKA*, vol. 7, no. 1, pp. 67–78, Jan. 2025, doi: 10.36088/islamika.v7i1.5473.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

