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HUMANISTIC DIGITAL TRANSFORMATION IN EARLY CHILDHOOD SCIENCE EDUCATION: DEVELOPING A QUR'AN-INFORMED DIGITAL INQUIRY LEARNING FRAMEWORK

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ABSTRAK

Transformasi digital dalam pendidikan sains anak usia dini perlu diarahkan untuk memperkaya pengalaman belajar, bukan menggantikan interaksi anak dengan lingkungan nyata. Artikel ini bertujuan mengembangkan kerangka konseptual Digital Inquiry Learning yang mengintegrasikan pembelajaran sains berbasis inkuiri, pedagogi humanis, pemanfaatan teknologi digital secara selektif, dan nilai-nilai Al-Qur'an. Penelitian ini menggunakan pendekatan kualitatif berbasis studi kepustakaan dengan analisis konseptual dan tafsir maudhu'i. Sumber kajian meliputi ayat-ayat Al-Qur'an yang relevan, kitab tafsir klasik dan kontemporer, karya John Dewey tentang pengalaman dan pendidikan, serta literatur ilmiah mengenai pendidikan sains anak usia dini dan teknologi digital. Analisis dilakukan melalui identifikasi tema, interpretasi kontekstual ayat, sintesis teori, dan perumusan prinsip serta tahapan model. Hasil kajian merumuskan enam tahapan yang saling terhubung dan dapat berlangsung secara iteratif: stimulasi digital, identifikasi pertanyaan, eksplorasi dan pengumpulan informasi, analisis temuan, komunikasi hasil, serta refleksi dan penguatan nilai. Kontribusi konseptual model terletak pada integrasi empat dimensi secara eksplisit, yaitu mediasi digital yang terbatas dan terarah, pengalaman langsung, agensi serta interaksi sosial anak, dan orientasi etis-spiritual Qur'ani. Nilai tafakkur, tadabbur, tafaqquh, amanah, qaulan sadidan, dan qaulan ma'rufa digunakan sebagai orientasi normatif dengan tetap membedakan makna ayat dalam konteks penafsirannya dari penerapan pedagogis kontemporer. Model ini merupakan kerangka konseptual yang belum divalidasi secara empiris sehingga memerlukan penilaian ahli, uji coba, dan evaluasi pada berbagai konteks PAUD.

Keywords:
Humanistic digital transformation; early childhood science education; Digital Inquiry Learning; Qur'anic values; thematic interpretation.

ABSTRACT

Digital transformation in early childhood science education should enrich learning experiences rather than replace children's engagement with the real world. This article develops a conceptual Digital Inquiry Learning framework integrating inquiry-based science education, humanistic pedagogy, selective use of digital technology, and Qur'anic values. The study adopts a qualitative library-based approach using conceptual analysis and tafsir maudhu'i (thematic Qur'anic interpretation). Sources include relevant Qur'anic verses, classical and contemporary tafsir, John Dewey's writings on experience and education, and scholarly literature on early childhood science education and digital technology. The analysis proceeds through thematic identification, contextual interpretation of verses, theoretical synthesis, and formulation of the model's principles and stages. The study proposes six connected and potentially iterative stages: digital stimulation, question identification, exploration and information gathering, analysis of findings, communication of findings, and reflection with value reinforcement. The model's conceptual contribution lies in explicitly integrating four dimensions: purposeful and limited digital mediation, direct experience, children's agency and social interaction, and a Qur'anic ethical-spiritual orientation. The values of tafakkur, tadabbur, tafaqquh, amanah, qaulan sadidan, and qaulan ma'rufa are treated as normative orientations, while distinguishing the contextual meaning of Qur'anic verses from their contemporary pedagogical application. The framework is conceptual and has not yet been empirically validated; expert appraisal, pilot implementation, and evaluation across different early childhood settings are therefore required.

A. INTRODUCTION

Early childhood science education lays the foundations for curiosity, reasoning, creativity, and children's developing understanding of the natural environment. At this stage, science is not primarily the memorization of abstract concepts; it is a process of noticing phenomena, asking questions, observing, comparing, trying out ideas, and communicating what has been discovered. Children construct understanding through concrete experiences and meaningful interaction with people and objects around them. The teacher's role is therefore to organize situations in which children can participate in age-appropriate inquiry rather than simply receive explanations. Research on preschool inquiry indicates that young children can engage in scientific practices when teachers provide appropriate scaffolding and opportunities to investigate phenomena (Ramanathan et al., 2022; Zudaire et al., 2022).

A continuing pedagogical challenge is that science activities may become dominated by teacher explanation, worksheets, or the delivery of information. When children have limited opportunities to observe and investigate, their curiosity and capacity to build explanations from experience may be constrained. Inquiry-based learning offers an alternative by organizing learning around questions, observation, exploration, comparison, and communication. This does not mean that children conduct formal scientific research; rather, they engage in developmentally appropriate practices through play, guided exploration, and discussion. The quality of inquiry depends substantially on how teachers design the environment, pose questions, and respond to children's ideas (Ramanathan et al., 2022).

Digital technology has added new possibilities to early childhood science education. Short videos, photographs, animations, audio recordings, and simple interactive resources can represent processes that are difficult to observe in a classroom, help children revisit changes over time, and document learning experiences. A scoping review by Hu et al. (2024) identifies multiple roles for digital technology in young children's STEM education, while Papantonis Stajcic and Nilsson (2024) discuss teachers' pedagogical considerations when using digital resources in preschool science. These findings suggest that technology may be useful when selected in relation to learning objectives, developmental appropriateness, and the quality of interaction it supports.

The presence of technology, however, does not automatically improve learning. If digital media becomes the dominant activity, children may spend less time manipulating real objects, moving, playing, talking with peers, and observing their environment. Research comparing digital and analogue approaches in preschool science underlines the importance of treating these resources as complementary rather than interchangeable (Otterborn et al., 2024). The central question is therefore not whether technology should be used in every lesson, but when and how it can make a meaningful contribution. Selection should consider age appropriateness, duration of exposure, teacher supervision, accessibility, privacy, and the educational value of the resource.

This article uses the term humanistic digital transformation to refer to the pedagogically guided use of digital resources that places children's dignity, developmental needs, agency, relationships, embodied experience, and well-being at the centre of educational decisions. The concept is operationalized through five mutually related dimensions: (1) child agency and participation; (2) developmental appropriateness and well-being; (3) direct experience and play; (4) social interaction

and teacher facilitation; and (5) ethical responsibility in the use of digital resources. These dimensions mean that technology is a means for supporting learning, not an independent goal or a substitute for relationships and experience.

Inquiry-based learning provides a pedagogical bridge between digital representations and children's real-world experiences. In the present framework, digital media may introduce a phenomenon, make a process visible, or help document observations. Children are then invited to connect the representation with objects and events they can investigate directly. This framework draws on Dewey's emphasis on the continuity between experience, reflection, and learning (Dewey, 1938), while adapting inquiry practices to the developmental characteristics of early childhood. Unlike a technology-enhanced inquiry lesson in which digital tools are simply added to existing activities, the proposed framework assigns technology a selective role within a wider humanistic and value-oriented learning process.

Within Islamic educational thought, science learning may also be oriented toward reflection, responsibility, and ethical awareness. The Qur'an invites people to consider signs in the creation of the heavens and the earth (Q.S. Ali 'Imran [3]: 190–191). The present article examines the pedagogical relevance of tafakkur and related concepts without claiming that the Qur'an directly prescribes contemporary digital pedagogy. Rather, Qur'anic verses and their interpretations provide normative orientations that can inform how teachers frame observation, reflection, responsibility, and communication. Classical exegesis, including Ibn Kathir, and contemporary Indonesian exegesis, including M. Quraish Shihab, are used to distinguish textual meaning from educational application (Ibn Kathir, 1999; Shihab, 2002).

The ethical dimension is equally important. Q.S. al-Nisa' [4]: 58 commands the fulfilment of trusts and justice, while Q.S. al-Ahzab [33]: 70 calls for truthful and upright speech. Q.S. al-Baqarah [2]: 263 emphasizes good speech and forgiveness. These verses do not refer specifically to digital devices; their relevance to digital learning is a contemporary ethical application concerning responsible selection of content, protection of children's privacy, truthful communication, and respectful classroom interaction. Such an approach helps connect cognitive learning with character, care for living things, and responsibility toward others.

Although studies have examined digital technology in early childhood education, preschool science inquiry, and the integration of Islamic values into STEAM learning, these strands are often discussed separately. Research on preschool science has considered teachers' use of digital resources and the relationship between digital and analogue approaches (Eliasson et al., 2023; Hu et al., 2024; Otterborn et al., 2024; Papantonis Stajcic & Nilsson, 2024). Inquiry studies have focused on children's participation, questioning, and teacher scaffolding (Astuti et al., 2023; Ramanathan et al., 2022; Zeng & Ng, 2025; Zudaire et al., 2022), while research on Islamic STEAM learning and digital pedagogy has explored the integration of religious values into learning themes and activities (Asdlori & Yahya, 2023; Feskariani et al., 2026; Martiana et al., 2024; Rahmatullah et al., 2022). Work on moral education and digital storytelling also provides relevant context for value-oriented digital learning (Cahaya, 2023; Suharni & Filtri, 2025). Research on teacher perceptions of deep learning in PAUD further contributes to the broader discussion of pedagogical orientation in early childhood settings (Novitasari et al., 2025). The gap addressed here is the absence, within the literature reviewed for this article, of a single early-childhood science framework that

explicitly connects selective digital mediation, direct inquiry, humanistic developmental principles, and Qur'anic ethical-spiritual orientations.

Accordingly, this article develops a Qur'an-informed Digital Inquiry Learning framework through conceptual synthesis and thematic interpretation of relevant verses. It addresses three questions: (1) What principles should guide humanistic digital transformation in early childhood science education? (2) How can digital technology support inquiry without displacing children's direct experiences and social interaction? and (3) How can selected Qur'anic values inform the ethical and pedagogical orientation of a Digital Inquiry Learning framework? The article's contribution is a conceptual integration of these dimensions into six adaptable stages. It does not claim to report classroom outcomes or empirical validation; those questions are reserved for subsequent field research.

B. METHOD

This article employs a qualitative library-based research design with conceptual analysis and thematic Qur'anic interpretation (tafsir maudhu'i). This design is appropriate because the purpose is to develop a conceptual framework by examining and synthesizing textual, theoretical, and scholarly sources, rather than to describe the practices of a particular early childhood institution. No interviews, classroom observations, or participant data are claimed in this study. Accordingly, the analysis and conclusions are presented as conceptual propositions derived from the sources examined, not as empirical findings about implementation in a school.

The primary textual sources are the Qur'anic verses selected in relation to reflection on creation, understanding, responsibility, and communication: Q.S. Ali 'Imran [3]: 190–191; Muhammad [47]: 24; al-Tawbah [9]: 122; al-Nisa' [4]: 58; al-Ahzab [33]: 70; and al-Baqarah [2]: 263. These verses are not treated as direct statements about digital technology. They are examined for their contextual meanings and for the extent to which their ethical and epistemological orientations can inform contemporary educational practice.

Secondary sources comprise classical and contemporary Qur'anic commentaries, foundational works on inquiry and experience, peer-reviewed studies on early childhood science education, and research on digital technology in early childhood STEM learning. The literature on inquiry includes Dewey (1938), Ramanathan et al. (2022), and Zudaire et al. (2022). Research on digital and analogue learning and teachers' use of digital resources includes Hu et al. (2024), Otterborn et al. (2024), and Papantonis Stajcic and Nilsson (2024). The Qur'anic interpretive sources include Ibn Kathir's classical commentary and Shihab's contemporary Indonesian tafsir.

Source selection followed three criteria: relevance to at least one of the article's central themes; identifiable scholarly or exegetical authorship; and sufficient bibliographic information to permit verification. Priority was given to peer-reviewed studies directly addressing early childhood, science inquiry, digital technology, and Islamic educational integration. The sources were read comparatively to identify convergences, differences, and conceptual gaps. This procedure is a structured literature-based synthesis, not a systematic review with database-wide screening or quantitative aggregation.

The Qur'anic analysis followed the thematic procedure associated with tafsir maudhu'i. Following the methodological orientation described by al-Farmawi (1977),

the process began by determining the central themes, collecting verses relevant to those themes, examining their textual contexts and relations, consulting exegetical explanations, and synthesizing the meanings without detaching individual verses from their contexts. First, the article identified verses associated with reflection on creation, deliberation, understanding, trust, and ethical speech. Second, the selected verses were read in their textual and thematic contexts with reference to classical and contemporary exegesis. Third, the analysis distinguished the primary meaning of each verse from its proposed pedagogical implication. This distinction is important: the application of Qur'anic values to digital learning is an interpretive and normative extension, not a claim that the verses explicitly discuss modern educational technologies.

The conceptual synthesis proceeded in four steps. First, recurring principles were extracted from the literature on early childhood development, science inquiry, humanistic pedagogy, and digital learning. Second, these principles were compared with the ethical and reflective orientations identified through the thematic Qur'anic analysis. Third, the principles were organized into design dimensions: child agency, developmental appropriateness, direct experience, social interaction, teacher facilitation, and responsible digital use. Fourth, the dimensions were translated into six learning stages and an accompanying set of observable pedagogical indicators.

The six stages were formulated by synthesizing the recurring sequence in inquiry-oriented learning—stimulus, questioning, exploration, interpretation, communication, and reflection—with the specific need to position digital resources selectively and maintain direct experience as the core of early childhood science learning. The Qur'anic values provide an ethical-spiritual orientation across the stages rather than functioning as separate technical steps. The model is therefore a proposed conceptual framework, not a model derived from unreported interviews or observations.

Analytical credibility was pursued through source comparison and interpretive transparency. Claims about children's learning and digital technology were linked to relevant peer-reviewed literature, while claims about Qur'anic concepts were related to the selected verses and tafsir references. The different source types were not treated as equivalent forms of empirical triangulation: Qur'anic texts provide normative and interpretive foundations; educational studies provide scholarly evidence about pedagogical contexts; and Dewey's work provides a theoretical lens for experience and inquiry.

The analysis used Dewey's account of experience and education as a pedagogical lens, particularly the relationship between experience, continuity, interaction, and reflective inquiry (Dewey, 1938). This lens was not treated as identical to Qur'anic epistemology. Instead, the article compares their possible points of dialogue while preserving their distinct intellectual and historical contexts. The resulting framework is an integrative proposal, not an assertion that Dewey's philosophy and Qur'anic concepts are interchangeable.

The scope of the study is limited to conceptual development. It does not include participant recruitment, field observation, interviews, intervention, or outcome measurement. Consequently, the article cannot establish the effectiveness, feasibility, or causal impact of Digital Inquiry Learning. These questions require subsequent expert review, pilot implementation, and empirical evaluation in diverse early childhood settings.

Because the study is library-based, statistical correlation, regression, and significance testing are not applicable. The validity of the argument depends instead on the clarity of source selection, contextual interpretation, consistency of conceptual synthesis, and transparent distinction between textual meaning, theoretical inference, and proposed pedagogical application.

C. RESULTS AND DISCUSSION

The analysis produces a conceptual framework for humanistic digital transformation in early childhood science education. The framework begins from the premise that children's learning requires concrete experiences, play, interaction, and active participation. Digital resources may enrich this process when they provide a clear educational function, such as introducing a phenomenon, making gradual change visible, or documenting an observation. They should not displace children's opportunities to handle real objects, move, explore, ask questions, and communicate with others.

The pedagogical synthesis connects inquiry-oriented learning with Dewey's emphasis on experience and reflection. The proposed model adapts this foundation to early childhood by using short, purposeful digital stimuli while keeping exploration of real phenomena central. Its six stages are not intended as a rigid sequence: reflection may generate new questions, and teachers may revisit earlier stages according to children's interests, responses, and developmental needs.

The Qur'anic analysis contributes an ethical and spiritual orientation rather than a technological prescription. Q.S. Ali 'Imran [3]: 190–191, Allah SWT berfirman:

اِنَّ فِيْ خَلْقِ السَّمٰوٰتِ وَالْاَرْضِ وَاخْتِلَافِ الَّيْلِ وَالنَّهَارِ لَاٰيٰتٍ لِّاُولِى الْاَلْبَابِ ۙ﴿۱۹۰﴾ الَّذِيْنَ يَذْكُرُوْنَ اللّٰهَ قِيَامًا وَّقُعُوْدًا وَّعَلٰى جُنُوْبِهِمْ وَيَتَفَكَّرُوْنَ فِيْ خَلْقِ السَّمٰوٰتِ وَالْاَرْضِ ۚ رَبَّنَا مَا خَلَقْتَ هٰذَا بَاطِلًا ۚ سُبْحٰنَكَ فَقِنَا عَذَابَ النَّارِ ﴿۱۹۱﴾ (اٰل عمران/3: 190-191)

190. "Indeed, in the creation of the heavens and the earth and the alternation of the night and the day are signs of Allah's greatness for those who possess understanding."
191. "Those who remember Allah while standing, sitting, or lying on their sides, and reflect upon the creation of the heavens and the earth, saying, 'Our Lord, You have not created all this in vain. Glory be to You! So protect us from the punishment of the Fire.'"
(Qur'an, Surah Ali 'Imran [3]: 190–191)

Supports reflection on the created order; Q.S. Muhammad [47]: 24, Allah SWT berfirman:

اَفَلَا يَتَدَبَّرُوْنَ الْقُرْاٰنَ اَمْ عَلٰى قُلُوْبٍ اَقْفَالُهَا ﴿۲۴﴾ (محمّد/47: 24)

"Do they not then reflect upon the Qur'an, or are there locks upon their hearts?" (Qur'an, Surah Muhammad [47]: 24).

Concerns deliberation; Q.S. al-Tawbah [9]: 122, Allah SWT berfirman:

وَمَا كَانَ الْمُؤْمِنُوْنَ لِيَنْفِرُوْا كَاۤفَّةً ۗ فَلَوْلَا نَفَرَ مِنْ كُلِّ فِرْقَةٍ مِّنْهُمْ طَاۤىِٕفَةٌ لِّيَتَفَقَّهُوْا فِى الدِّيْنِ وَلِيُنْذِرُوْا قَوْمَهُمْ اِذَا رَجَعُوْٓا اِلَيْهِمْ لَعَلَّهُمْ يَحْذَرُوْنَ ﴿۱۲۲﴾ (التوبة/9: 122)

"However, it is not appropriate for the believers to go forth all together (to the battlefield). Rather, a group from each community should remain behind to deepen their understanding of religion and to warn their people when they return to them, so that they may guard themselves (against wrongdoing)." (Qur'an, Surah At-Tawbah [9]: 122)

Addresses the development of deep understanding in religious learning; Q.S. al-Nisa' [4]: 58, Allah SWT berfirman:

اِنَّ اللّٰهَ يَأۡمُرُكُمۡ اَنۡ تُؤَدُّوا الۡاَمٰنٰتِ اِلٰٓى اَهۡلِهَا ۙ وَاِذَا حَكَمۡتُمۡ بَيۡنَ النَّاسِ اَنۡ تَحۡكُمُوۡا بِالۡعَدۡلِ ؕ اِنَّ اللّٰهَ نِعِمَّا يَعِظُكُمۡ بِهٖ ؕ اِنَّ اللّٰهَ كَانَ سَمِيۡعًاۢ بَصِيۡرًا ﴿۵۸﴾ (النسآء/4: 58)

"Indeed, Allah commands you to render trusts to those entitled to them. And when you judge between people, judge with justice. Excellent indeed is the instruction Allah gives you. Surely, Allah is All-Hearing, All-Seeing." (Qur'an, Surah An-Nisa' [4]: 58)

Concerns the fulfilment of trusts and justice; Q.S. al-Ahzab [33]: 70, Allah SWT berfirman:

يٰٓاَيُّهَا الَّذِيۡنَ اٰمَنُوا اتَّقُوا اللّٰهَ وَقُوۡلُوۡا قَوۡلًا سَدِيۡدًا ۙ ﴿۷۰﴾ (الاحزاب/33: 70)

"O you who believe, fear Allah and speak words of truth." (Qur'an, Surah Al-Ahzab [33]: 70)

Calls for upright speech; and Q.S. al-Baqarah [2]: 263, Allah SWT berfirman:

قَوۡلٌ مَّعۡرُوۡفٌ وَّمَغۡفِرَةٌ خَيۡرٌ مِّنۡ صَدَقَةٍ يَّتۡبَعُهَآ اَذًى ؕ وَاللّٰهُ غَنِىٌّ حَلِيۡمٌ ﴿۲۶۳﴾ (البقرة/2: 263)

"A kind word and forgiveness are better than charity followed by hurtful conduct. And Allah is Self-Sufficient, Most Forbearing." (Qur'an, Surah Al-Baqarah [2]: 263)

Values good speech. Their pedagogical applications are developed cautiously and in context.

The discussion is organized into six related themes: the principles of humanistic digital transformation; the supporting functions and safeguards of digital technology; the Qur'anic foundations; the conceptual construction and distinctive contribution of Digital Inquiry Learning; its six stages and observable indicators; and the integration of digital resources, direct experience, and Qur'anic values.

1. Principles of Humanistic Digital Transformation in Early Childhood Science Education

Humanistic digital transformation in early childhood science education refers to the integration of digital technology into learning processes that prioritize children's needs, developmental characteristics, experiences, and holistic growth. In this perspective, technology is not the primary objective of education but a supporting medium that facilitates meaningful learning experiences. Digital transformation should therefore be directed toward strengthening the relationship between children and their learning environment rather than merely introducing technological devices into the classroom. The success of digital learning depends not only on the availability of technological facilities but also on the pedagogical principles guiding their use.

A humanistic approach positions children as active subjects in the learning process. Children need opportunities to observe, ask questions, explore objects, conduct simple experiments, express their ideas, and construct their own understanding of scientific phenomena. Digital technology can facilitate these activities by providing

visual representations, learning stimuli, and opportunities to document observations. However, children should not be positioned merely as passive recipients of digital information. Their curiosity, initiative, participation, and interaction with the surrounding environment must remain central to the learning process.

The integration of digital and analog learning experiences is particularly important in early childhood science education. Scientific concepts at this developmental stage are more meaningful when children can connect information with concrete experiences. Digital media may introduce a phenomenon or display a process that is difficult to observe directly, while real-world activities enable children to examine objects, recognize changes, and develop explanations based on their observations. Research by Otterborn et al. (2024) highlights the relevance of considering digital and analog approaches within preschool science education. This perspective supports the principle that digital technology and direct experience should complement one another rather than function as competing approaches.

Another important principle is the appropriateness of digital learning activities to children's developmental characteristics. Digital content should be selected according to the children's age, cognitive abilities, attention span, interests, and learning objectives. Simple images, short videos, interactive visualizations, and other developmentally appropriate materials may help introduce scientific phenomena. Nevertheless, the use of digital media needs to be selective, limited, and supervised by teachers. The primary consideration is not how frequently technology is used, but whether its use contributes meaningfully to children's understanding and engagement with scientific learning.

Teachers play a central role in implementing humanistic digital transformation. Their responsibilities extend beyond operating digital devices to include designing learning experiences, guiding children's exploration, asking questions, facilitating discussion, and helping children connect digital information with direct observation. Teachers also need to consider when digital technology is useful and when children would benefit more from physical activities, play, or social interaction. In this respect, pedagogical decisions remain more important than the technology itself. Papantonis Stajcic and Nilsson (2024) discuss teachers' considerations in digitalized preschool science learning contexts, emphasizing the importance of pedagogical judgment when integrating technology into early childhood education.

Ultimately, humanistic digital transformation should support the holistic development of children. Science learning is not limited to the acquisition of factual knowledge but also involves curiosity, creativity, communication, collaboration, responsibility, and reflection. Digital activities should therefore be designed to encourage children to think, interact, express ideas, and develop positive attitudes toward their environment. From this perspective, technology becomes educationally meaningful when it strengthens children's active participation and supports their intellectual, social, emotional, and moral development. These principles provide the foundation for integrating digital technology into early childhood science education in a manner that remains centered on children and their developmental needs.

2. Digital Technology as a Supporting Medium for Early Childhood Science Inquiry

Digital technology can support early childhood science inquiry by providing stimuli, information, and representations that encourage children to investigate

phenomena in their surroundings. Science learning begins with curiosity about objects, events, and changes that children encounter in everyday life. Digital images, short videos, animations, and interactive media can introduce questions about phenomena such as plant growth, changes in weather, the movement of objects, or the characteristics of animals. These resources can stimulate children's curiosity and provide an initial context for inquiry. Nevertheless, digital stimuli should lead to further exploration rather than replace children's direct engagement with the phenomena being studied.

One function of digital technology is to introduce scientific phenomena that may be difficult to observe directly within the classroom. For example, a short video can illustrate how a seed develops over time, how clouds form, or how certain animals behave in their natural habitats. Such representations can help children identify features and changes that might otherwise be difficult to notice. Teachers can use these materials as starting points for questions and discussions. After observing a digital representation, children should be encouraged to examine relevant objects, compare their observations, and investigate the phenomenon through activities appropriate to their developmental stage.

Digital technology can also assist children in observing and recognizing patterns. Visual representations can make certain differences, sequences, and changes more accessible to young learners. For instance, photographs taken at different stages of plant growth can help children compare the height, shape, and appearance of a plant over time. The teacher can guide children to identify similarities and differences without requiring them to formulate explanations beyond their developmental capacities. In this way, digital media serves as a bridge between visual information and the construction of scientific understanding. Its educational value depends on how effectively the teacher connects the representation with meaningful learning experiences.

Another supporting function is the documentation of children's observations. Teachers may use digital photographs, audio recordings, or simple digital records to document children's exploration and the changes they observe during learning activities. Documentation enables children to revisit previous experiences and compare them with later observations. It can also help teachers understand how children express ideas, recognize patterns, and develop explanations. However, documentation should remain manageable and appropriate to the learning objectives. The purpose is to support observation, reflection, and assessment rather than to increase the technical complexity of classroom activities.

Digital technology may also facilitate communication and collaboration during inquiry-based learning. Children can describe what they have observed, share their interpretations, and discuss differences between their findings and those of their peers. Teachers can use digital images or records to encourage children to explain their ideas and listen to alternative explanations. These activities can support language development and social interaction alongside scientific learning. Papantonis Stajcic and Nilsson (2024) emphasize the importance of teachers' considerations when integrating digital resources into preschool science education, indicating that the educational context and the teacher's pedagogical decisions are essential to the use of technology.

The selection and use of digital technology should ultimately be determined by its contribution to children's inquiry processes. Teachers need to consider whether a particular resource stimulates meaningful questions, supports observation, facilitates

documentation, or strengthens communication and reflection. Technology that does not contribute to these objectives may be unnecessary, particularly when direct experience can provide a more appropriate learning opportunity. Therefore, digital technology should function as a supporting medium within a broader inquiry process involving exploration, interaction, discussion, and reflection. This position establishes the pedagogical basis for the proposed *Digital Inquiry Learning* model.

3. Qur'anic Foundations of Humanistic Digital Inquiry

The Qur'an provides a normative framework for reflection, responsibility, and ethical conduct. In this article, Qur'anic values are not used to claim that the scripture directly prescribes digital learning methods. Rather, selected verses are interpreted in context and then considered for their relevance to educational decisions. This approach requires a distinction between the verse's textual meaning, the exegetical explanation, and the contemporary pedagogical application proposed by the authors.

Tafakkur is connected in this study with Q.S. Ali 'Imran [3]: 190–191, which draws attention to signs in the creation of the heavens and the earth and describes people who remember God and reflect on creation. Ibn Kathir explains these verses by referring to the signs and features of creation that invite people of sound understanding to contemplate (Ibn Kathir, 1999). In early childhood science education, this provides a normative orientation for inviting children to notice natural phenomena, ask simple questions, and attend carefully to changes. The classroom activity is a developmentally adapted application; it should not be equated with the full theological meaning of tafakkur in the verse.

Tadabbur is associated with Q.S. Muhammad [47]: 24, which asks whether people reflect deeply upon the Qur'an. Ibn Kathir's commentary explains the verse as an exhortation to ponder and understand the Qur'an rather than turn away from its meanings (Ibn Kathir, 1999). The verse's immediate subject is engagement with revelation, not the observation of nature. Its educational relevance in this article is therefore analogical and carefully bounded: teachers may encourage children to revisit what they have observed, consider its meaning in everyday life, and connect learning with responsible care for living things.

Tafaqquh is related to Q.S. al-Tawbah [9]: 122, which discusses a group gaining understanding of religion and warning their community after returning to it. The verse concerns religious learning and communal instruction. It should not be cited as if it directly defines scientific inquiry. In this framework, tafaqquh is used as a broader ethical reminder of the importance of developing understanding rather than merely collecting information. Its pedagogical application is to support children, at an age-appropriate level, in connecting observations with simple explanations through guided dialogue.

Amanah is grounded in Q.S. al-Nisa' [4]: 58, which commands that trusts be delivered to those entitled to them and that judgment among people be conducted justly. Ibn Kathir explains the command as encompassing different forms of trust and obligations, not only a narrow category of deposited property (Ibn Kathir, 1999). Applied to digital learning, amanah can inform teachers' responsibility to select suitable content, supervise access, protect children's privacy, and use documentation only for legitimate educational purposes. These are contemporary ethical applications of the principle of trust.

The communication values are supported by Q.S. al-Ahzab [33]: 70 and Q.S. al-Baqarah [2]: 263. The former commands believers to speak qaulan sadidan; Ibn Kathir explains this as upright and truthful speech (Ibn Kathir, 1999). The latter praises a good word and forgiveness over charity followed by hurtful conduct. In classroom practice, qaulan sadidan can orient teachers toward accurate explanations and honest feedback, while qaulan ma'rufa can inform respectful, age-appropriate, and encouraging interaction. These applications do not exhaust the verses' meanings; they translate their ethical direction into a child-centred educational setting.

Table 1. Qur'anic values, textual contexts, and proposed pedagogical orientations

Value	Verse and Textual Context	Proposed Pedagogical Direction
Tafakkur (Contemplation)	Q.S. Ali 'Imran [3]: 190–191: Signs in creation and the reflection of those who possess understanding.	Encouraging children to observe, pay attention to changes, and ask simple questions.
Tadabbur (Deep Reflection)	Q.S. Muhammad [47]: 24: The command to reflect upon the Qur'an.	Inviting children to review their experiences and relate them to everyday life; this application is analogical in nature.
Tafaqquh (Deep Understanding)	Q.S. al-Tawbah [9]: 122: Deepening religious understanding and conveying reminders to the community.	Emphasizing the process of developing understanding while acknowledging that the verse specifically concerns religious learning.
Amanah (Trust and Responsibility)	Q.S. al-Nisa' [4]: 58: Fulfilling trusts and upholding justice.	Teachers' responsibility in selecting content, supervising media use, protecting privacy, and caring for living creatures.
Qaulan sadidan (Truthful Speech)	Q.S. al-Ahzab [33]: 70: The command to speak truthful and upright words.	Promoting accurate information, honest feedback, and communication that does not mislead.
Qaulan ma'rufa (Kind and Appropriate Speech)	Q.S. al-Baqarah [2]: 263: Kind words and forgiveness are better than charity accompanied by hurtful conduct.	Building courteous communication, respecting children, and allowing room for differences of opinion.

4. The Digital Inquiry Learning Model: A Humanistic and Qur'anic Framework

Digital Inquiry Learning is proposed as a conceptual framework that integrates four dimensions often discussed separately: (1) selective digital mediation; (2) direct, embodied engagement with natural phenomena; (3) children's agency, play, and social interaction under teacher facilitation; and (4) Qur'anic ethical-spiritual orientation. The framework does not simply add digital tools to a conventional inquiry sequence. It specifies the conditions under which technology is appropriate, requires a return from digital representation to real experience, and embeds ethical responsibilities across the learning process.

The inquiry dimension draws on the view that children develop understanding through active engagement with phenomena. Inquiry practices may include noticing, asking questions, exploring, comparing, interpreting, and communicating. Studies of preschool inquiry provide relevant pedagogical foundations for organizing these activities (Ramanathan et al., 2022; Zudaire et al., 2022). Dewey's account of experience further emphasizes that educational experiences should support continuity and meaningful interaction rather than remain isolated activities (Dewey, 1938).

Digital resources are incorporated only when they provide a clear learning benefit. A short image sequence may help children notice changes over time; a video may introduce a process that cannot be observed in full during one lesson; and a camera may document children's observations. Each use should be judged against age appropriateness, duration, teacher supervision, accessibility, privacy, and whether the same objective could be achieved more meaningfully through direct experience. The framework does not prescribe a universal screen time ratio; decisions must follow applicable guidance, children's needs, and the learning purpose.

The humanistic dimension makes children active participants rather than passive viewers. Children should be able to express interests, propose questions, manipulate safe materials, move, play, and discuss ideas with peers. Teachers facilitate rather than dominate: they provide scaffolding, ask open questions, maintain safety, and adapt the activity to differences in children's development. The model also treats emotional well-being, inclusion, and accessibility as design considerations rather than optional additions.

The Qur'anic dimension supplies a normative orientation across the stages. Tafakkur and tadabbur encourage reflection, while tafaqquh emphasizes the development of understanding within its religious context. Amanah informs responsible stewardship of learning resources and children's data; qaulan sadidan and qaulan ma'rufa guide truthful and respectful communication. The framework deliberately distinguishes these values' meanings in the Qur'anic context from their proposed educational applications.

The model's originality is therefore its explicit integration of digital selectivity, embodied inquiry, child agency, and Qur'anic ethical-spiritual guidance in one adaptable framework for early childhood science education. Its six stages are a planning and facilitation structure, not a fixed script or a validated intervention. Figure 1 illustrates the sequence and its feedback loop: reflection may produce a new question, and new exploration may follow. The stages can therefore be revisited according to children's interests, teacher judgment, and learning context. The model requires expert review, pilot implementation, and empirical evaluation before claims about its effectiveness or generalizability can be made.

Table 2. Operational matrix of the six Digital Inquiry Learning stages

Stage	Role of Digital Technology	Hands-on Experience and Teacher's Role	Values/Observable Indicators
1.Digital Stimulation	Short photos or videos are used as stimuli, rather than for prolonged viewing.	The teacher connects the stimulus to real objects or phenomena and stimulates children's curiosity.	Tafakkur; children demonstrate attention or curiosity.
2.Question Identification	Digital media may be displayed again if it helps children recall the initial stimulus.	The teacher facilitates children's questions without providing answers prematurely.	Child agency; children begin to ask simple questions.
3.Exploration and Information Gathering	Photos or audio recordings may optionally be used for relevant documentation.	Children observe, touch, compare, and experiment; the teacher ensures safety and provides scaffolding.	Amanah; active participation in exploration and the ability to describe observations.
4.Analysis of Findings	Digital documentation helps children compare changes when necessary.	The teacher guides children in identifying patterns and connecting explanations with simple evidence.	Tafaqquh as an orientation toward understanding; children express initial explanations.
5.Communication of Findings	Photos or recordings may help children present their findings but are not mandatory.	Children tell stories, draw, or demonstrate their findings; the teacher facilitates dialogue.	Qaulan sadidan and qaulan ma'rufa; truthful and courteous communication.
6.Reflection and Value Reinforcement	Digital documentation is used to recall the	The teacher invites children to reflect on their	Tadabbur and amanah; children identify what they have learned and

	learning process when beneficial.	experiences and connect them with everyday life; reflection may generate new questions.	describe forms of responsibility.

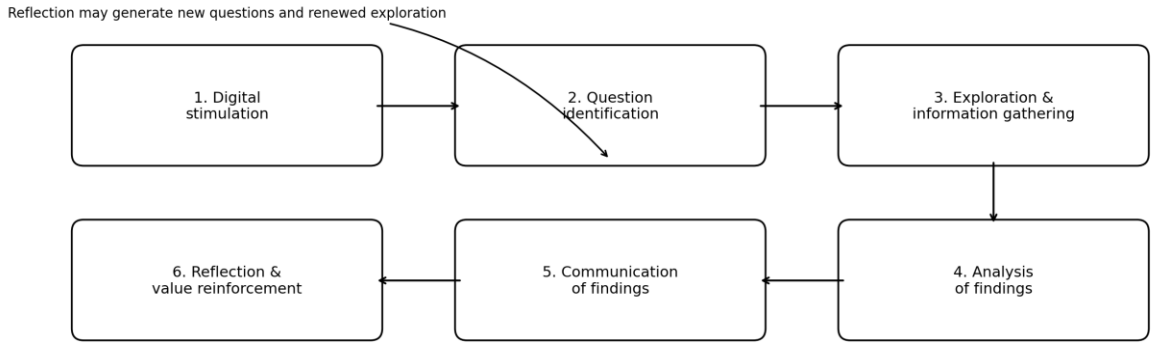


Figure 1. Conceptual sequence and iterative feedback in Digital Inquiry Learning

5. Stages of Digital Inquiry Learning in Early Childhood Science Education

Stage 1—Digital Stimulation. The teacher introduces a phenomenon through a brief, relevant, and age-appropriate digital resource, such as a photograph or short video. For example, a sequence showing seed germination may invite children to notice changes and wonder what a seed needs to grow. The teacher should avoid prolonged passive viewing and move promptly from the screen to conversation or direct observation. The indicator is children's expressed curiosity or attention to a feature of the phenomenon, not their ability to operate a device.

Stage 2—Question Identification. Children are invited to describe what they noticed and formulate simple questions. In a plant activity, they may ask what happens if a plant receives no water or why a stem changes. Teachers can model question forms and encourage children's own questions without supplying explanations too early. The indicator is the emergence of child-generated questions or a clearly expressed point of curiosity.

Stage 3—Exploration and Information Gathering. Children investigate real objects or phenomena by observing, touching, comparing, sorting, measuring in simple ways, or conducting safe experiments under supervision. Digital photographs or audio records may document observations when useful, but documentation must not interrupt exploration. The indicator is children's participation in direct investigation and their ability to describe or represent what they observe.

Stage 4—Analysis of Findings. With teacher guidance, children revisit observations, compare similarities and differences, and identify simple patterns. In a plant-growth activity, they may compare plants receiving different amounts of water and describe visible differences. Teachers should avoid expecting formal scientific reasoning beyond the children's developmental level. The indicator is an emerging explanation linked to an observation, comparison, drawing, or other evidence.

Stage 5—Communication of Findings. Children share what they observed through conversation, drawings, demonstrations, displays, or photographs. Teachers

support turn-taking, listening, truthful description, and respect for different ideas. Digital presentation is optional and should be used only if it improves communication. The indicators include children's attempts to explain their observations and engage respectfully with peers.

Stage 6—Reflection and Value Reinforcement. Children revisit their initial questions, describe what they discovered, and connect the experience with daily life. Teachers may reinforce care for plants and living things as an age-appropriate expression of responsibility (amanah), and invite thoughtful reflection (tafakkur) without forcing abstract theological explanations. Reflection may generate new questions and return the class to Stage 2 or Stage 3; thus, the model is iterative rather than strictly linear.

6. Integrating Digital Technology, Direct Experience, and Qur'anic Values

The integration of digital technology, direct experience, and Qur'anic values is the organizing principle of humanistic digital transformation in early childhood science education. Digital media can provide a stimulus or support documentation; direct experience enables children to investigate real phenomena; and Qur'anic values provide ethical and spiritual orientation. These elements are complementary but not interchangeable. The screen cannot replace handling materials, observing living things, movement, play, or relationships with teachers and peers.

A plant-growth activity illustrates the relationship. The teacher may begin with a short sequence of images showing germination, then invite children to ask what a seed needs. Children plant seeds, observe them over several days, care for them, and record selected changes through drawings or photographs. They compare observations and explain what they notice. The activity concludes with a discussion about caring for living things. In this example, digital media provides an initial representation and optional documentation, while the core learning occurs through sustained observation, participation, and interaction with the environment.

Digital resources should be selected through a pedagogical and ethical screening process. Teachers should ask whether the content is accurate, safe, relevant, accessible, and suitable for the children's developmental stage; whether the duration is proportionate to the objective; whether adult supervision is available; and whether privacy and consent are protected when images or recordings are created. Digital use is not required when real objects and direct observation provide a better learning experience. Assessment and documentation should also remain developmentally appropriate, as illustrated by research on digital assessment resources for early childhood development (Mufliana et al., 2024). This position is consistent with research emphasizing the complementary role of digital and analogue approaches in preschool science (Hu et al., 2024; Otterborn et al., 2024), and with work highlighting outdoor and experiential learning opportunities (Kiviranta et al., 2024).

Qur'anic values can inform the teacher's decisions and the social climate of learning. Tafakkur is reflected in encouraging careful attention to natural phenomena; tadabbur in revisiting experiences and considering their significance; and tafaqquh in supporting the development of understanding, while recognizing the verse's specific context of religious learning. Amanah informs responsible care for living things and responsible handling of children's information. Qaulan sadidan and qaulan ma'rufa guide accurate, respectful, and encouraging communication. These are educational

applications of Qur'anic ethical orientations, not claims that the verses explicitly prescribe classroom technologies.

Planning, implementation, and assessment should be aligned. During planning, teachers identify the scientific phenomenon, learning objectives, children's developmental needs, safe materials, and any digital resource that adds genuine value. During implementation, teachers facilitate questions and exploration, supervise digital use, and protect children's privacy. Assessment should be authentic and developmentally appropriate, drawing on observation, children's talk, drawings, demonstrations, and participation. It should focus on curiosity, exploration, communication, collaboration, and emerging understanding rather than technical proficiency.

The framework therefore offers a principled way to ensure that digital transformation strengthens rather than diminishes children's experiences and relationships. Its claims remain conceptual: the article does not establish a universal screen-use prescription or demonstrate learning gains from classroom implementation. Future research should examine how teachers adapt the stages, how children participate, and what safeguards are needed across different institutional and family contexts.

The conceptual analysis addresses the three research questions by defining the principles of humanistic digital transformation, specifying the supporting rather than dominant role of digital technology, and formulating a Qur'an-informed Digital Inquiry Learning framework. The analysis indicates that technology should be selected according to a clear pedagogical purpose and integrated with children's developmental needs, direct experiences, social interaction, and holistic well-being. The six stages provide an adaptable structure for organizing this integration; they are not presented as observed classroom practices.

The framework extends inquiry-based science education by specifying how digital representation should connect to direct investigation. Digital resources may introduce phenomena, support comparison over time, or preserve records, but meaningful learning still depends on children's opportunities to observe real objects, ask questions, explore, compare, and communicate. This synthesis is consistent with research on digital and analogue preschool science and on teacher considerations in digitalized science learning (Otterborn et al., 2024; Papantonis Stajcic & Nilsson, 2024). Research on outdoor learning further reinforces the educational importance of experiences beyond the screen (Kiviranta et al., 2024). Its distinctive feature is not the use of a device itself, but the explicit design principle that digital mediation remains selective and subordinate to embodied inquiry.

The Qur'anic contribution is a normative layer that connects knowledge with reflection, responsibility, and ethical communication. Q.S. Ali 'Imran [3]: 190–191, Muhammad [47]: 24, al-Tawbah [9]: 122, al-Nisa' [4]: 58, al-Ahzab [33]: 70, and al-Baqarah [2]: 263 provide different textual contexts and should not be collapsed into one undifferentiated educational message. The framework therefore draws pedagogical implications cautiously, with reference to classical and contemporary tafsir, and does not claim that these verses directly address digital technologies or early childhood science curricula.

The model's limitations are significant. It has not undergone expert validation, classroom piloting, or empirical evaluation, and its proposed indicators remain design

suggestions rather than validated measurement instruments. Its applicability may vary according to children's ages, teacher competencies, available resources, institutional policies, and family expectations. These limitations define the next research agenda: expert appraisal of the conceptual structure, participatory design with teachers, pilot implementation, and developmentally appropriate evaluation.

CONCLUSION

This article argues that humanistic digital transformation in early childhood science education should be understood as the pedagogically and ethically guided use of technology in support of children's holistic development. Digital resources should not become the centre of learning or replace direct experience, play, social interaction, and teacher-child relationships. Their value depends on whether they help children notice phenomena, formulate questions, revisit observations, or communicate ideas in developmentally appropriate ways.

The principal contribution is the conceptual formulation of Digital Inquiry Learning as a Qur'an-informed framework integrating four dimensions: selective digital mediation, direct and embodied inquiry, children's agency with teacher-facilitated social interaction, and ethical-spiritual orientation. The framework is organized into six adaptable stages: digital stimulation, question identification, exploration and information gathering, analysis of findings, communication of findings, and reflection with value reinforcement. Unlike approaches that simply add digital media to inquiry activities, this framework makes the limits and purposes of digital mediation explicit and positions Qur'anic values as an ethical orientation across the process.

The Qur'anic analysis draws on verses concerning reflection on creation, deliberation, understanding, trust, and good speech. It distinguishes the contextual meaning of each verse from its contemporary pedagogical application. Tafakkur, tadabbur, tafaqquh, amanah, qaulan sadidan, and qaulan ma'rufa therefore function as normative and reflective orientations rather than as technical instructions for using devices. The article's contribution is conceptual and interpretive; it does not demonstrate that the proposed model has already produced measurable educational outcomes.

The study is limited by its library-based design and the absence of expert validation or field implementation. Future research should subject the framework to expert review, co-design it with early childhood teachers, pilot the six stages in different PAUD settings, and evaluate children's engagement through authentic, developmentally appropriate indicators. Such work should also examine digital-content selection, screen exposure, supervision, accessibility, and privacy safeguards. These steps are necessary before the model's feasibility or effectiveness can be established.

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