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Psychological Dimension in The Design of Islamic Education Learning Technology Based on Piaget's Theory

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ABSTRACT

Islamic education in the digital era faces serious challenges in integrating developmentally appropriate learning technology with the psychological needs of students. This study analyzes the design principles of Islamic educational learning technology through the lens of Piaget's cognitive development theory, especially in the concrete operational (7-11 years) and formal operational (12-15 years) phases. Using the library research method with a systematic literature review approach, this study explored 25 primary sources (Sinta 2-Scopus journal, turats such as Iḥyā' 'Ulūm al-Dīn) and applied thematic analysis to identify design patterns that are in harmony with the concepts of schema, assimilation, and accommodation in Piaget's theory. The findings show that 72% of Islamic learning platforms fail to apply the principles of cognitive load management (Sweller, 1988), while gamification-based and augmented reality (AR)-based content has proven to be effective for the concrete operational stage according to the concept of tadrīj (gradual education) in Islam. This study proposes a Piagetian Islamic EdTech Design framework that integrates digital scaffolding with the values of tarbiyah islamiyah. The implications of the study include practical recommendations for madrasah e-learning developers and criticism of the dominance of behaviorist approaches in contemporary Islamic educational technology

Keywords: *Cognitive Development, Piaget Theory, Islamic Edtech, Tadrīj, Learning Design.*

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INTRODUCTION

The era of the industrial revolution 4.0 has massively transformed the Islamic education ecosystem, where digital learning technology has become a necessity (Pusdatin Ministry of Religion, 2023). However, a UNESCO report (2022) revealed that 68% of madrasah e-learning platforms in Indonesia have not considered the psychological aspects of students, especially in terms of content suitability with the stage of cognitive development. This phenomenon poses a paradox: on the one hand, digitalization offers efficiency, but on the other hand, it has the potential to create *cognitive overload* (Sweller et al., 2019) for elementary school-age children. A preliminary study of 5 digital tahfizh applications showed that 80% of the content was designed with a memorization-based behavioristic approach, regardless of *scaffolding principles* in accordance with Piaget's developmental theory (Mu'allim, 2021). This condition is exacerbated by the lack of digital literacy of Islamic boarding school teachers

in curating content based on children's psychological needs (Nisa et al., 2023), thus demanding a more holistic reconstruction of learning technology designs.

Piaget's theory of cognitive development offers a unique perspective to overcome *the mismatch* of Islamic educational technology design through four stages of development (*sensorimotor*, *preoperational*, *concrete operational*, and *formal* operational). Recent research by Akbar & Fauzi (2023) proves that children aged 7-11 years (*concrete operational phase*) need concrete object-based learning media such as 3D simulations of the Prophet's story, while adolescents aged 12-15 years (*formal operational phase*) are more suitable for philosophical discussion platforms about kauniyah verses. These findings are in line with El-Muhammady's (2022) criticism of the dominance of *the one-size-fits-all* approach in the development of Islamic LMS that ignores *schema characteristics* and cognitive *disequilibrium*. Ironically, an evaluation of 10 Islamic edutech startups showed that only 20% explicitly referred to cognitive development theories in their product *white papers* (Islamic EduTech Watch, 2023). In fact, the integration of Piaget's *assimilation-accommodation* principle with the Islamic concept of *tadrīj* (gradual education) can be a more participatory design solution (Al-Haddad, 2021).

The convergence between Western developmental psychology and Islamic pedagogy actually has a strong epistemological basis, especially in the concept of the harmony of education with the nature of children (QS. Ar-Rum: 30). A comparative study by Halimah et al. (2023) found that *Piaget's equilibration* theory has structural similarities to the concept of *tawāzun* (balance) in Islamic education, especially in compiling progressive digital content. Research data from Ma'had Aly Jakarta (2023) revealed that students who learned to use Piaget's stage-based media experienced a 40% increase in their understanding of *fiqh* concepts compared to conventional methods. However, ethical challenges arise when applying *adaptive learning* technology in the context of Islamic values, such as restricting virtual interaction between genders that can hinder the *social learning* process (Bandura, 1986) in the *formal operational* phase (Zulkifli, 2022). Therefore, this study carries a *hybrid theory approach* by combining Piaget's cognitive framework and the principles *of maqāṣid syarī'ah* in educational technology design (Qutub, 2021), as an effort to answer the challenges of the complex digital era

Based on this background, this study formulates three critical questions: *(1) How can Piaget's principles of cognitive development be integrated into the design of Islamic educational learning technology? (2) What challenges arise in applying Piaget's theory to the development of digital media based on Islamic values? (3) What is the gap between current Islamic edtech practices and the principles of developmental psychology?* The objectives of this study are *(1) To analyze the suitability of Islamic educational learning technology design with Piaget's cognitive stages, (2) To develop a conceptual framework for Islamic edtech design based on cognitive development theory, and (3) To evaluate the effectiveness of the proposed model through comparative literature studies.* Practically, the findings of this study are expected to (1) provide operational guidance for developers of Islamic education applications (such as age-appropriate gamification design of the Qur'an), (2) Increase the awareness of madrasah teachers about the importance of developmental psychology in choosing digital media,

and (3) Enrich scientific treasures through the integration of cognitive psychology disciplines with Islamic education. Theoretically, this study contributes a new perspective on *Piagetian Islamic EdTech Design* that bridges Western epistemology and the principle *of tarbiyah islamiyah*

Literature Study

Jean Piaget stated that children's cognitive development occurs through four successive stages: *sensorimotor* (0-2 years), *preoperational* (2-7 years), *concrete operational* (7-11 years), and *formal operational* (11+ years). Each stage is characterized by unique mental structures (*schemas*), in which the child builds knowledge through the processes of *assimilation* (adaptation of new information into an existing schema) and *accommodation* (modification of the schema to accommodate new information) (Piaget & Inhelder, 1969). Recent research by Akbar et al. (2023) shows that children *of operational concrete* age still rely on physical objects to understand abstract concepts, while *formal operational adolescents* are already able to think hypothetically-deductively. These findings are relevant to the design of learning technologies, where visual-interactive media is more effective for elementary school children, while adolescents need *a problem-solving-based* platform (Sweller, 2020). The main challenge lies in creating *proper disequilibrium*—cognitive imbalances that trigger adaptation—without causing *cognitive overload* (Plass & Pawar, 2022).

Criticism of Piaget's theory reveals that the transition between stages is not always rigid, but is influenced by socio-cultural factors (Vygotsky, 1978). However, its application in educational technology remains valid, particularly in *scaffolding*—learning support tailored to the *zone of proximal development* (ZPD) (Wood et al., 2021). A study by Halimah et al. (2023) proves that gamification based on Piaget stages increases the understanding of mathematical concepts by 30% in madrasah students. Piaget*'s principle of equilibration* is also aligned with modern neuroscience's findings on the plasticity of the child's brain (Immordino-Yang, 2018), which emphasizes the importance of challenging yet non-frustrating media design. In the digital context, this theory encourages the development of *adaptive learning systems* that dynamically adjust the difficulty of content based on user capabilities (Koedinger et al., 2023)

The design of effective learning technologies must consider *cognitive load theory* (CLT), which divides cognitive load into *intrinsic* (material complexity), *extraneous* (way of presentation), and *germane* (mental processing for knowledge construction) (Sweller et al., 2019). Recent research shows that *user-friendly* interfaces with intuitive navigation reduce *extraneous loads*, while the use of *multimedia principles* (images + narratives) optimizes *germane loads* (Mayer, 2021). In Islamic education, the findings of Fauzi & Qutub (2023) reveal that animated videos of the Prophet's stories with a duration of 5-7 minutes are most effective for *concrete operational children*, because they are in accordance with their working memory capacity (avg. 4±1 *chunks* of information). The main challenge is to avoid the *split-attention effect*—when learners have to divide attention on multiple sources of information at once (Ayres & Paas, 2022).

Gamification and *augmented reality* (AR) emerged as powerful tools in Islamic education technology, particularly for enhancing engagement and spatial understanding (Islamic EduTech Watch, 2023). However, their design must align with *Piagetian*

stages—for instance, AR-based *ablution* simulations for *concrete operational* learners (ages 7-11), and debate platforms for *formal operational* students (ages 12+) (Mu'allim, 2022). Research neuroscience proves that *reward systems* in gamification stimulate dopamine, which strengthens long-term memory (Immordino-Yang, 2018), but must avoid the *overjustification effect* where intrinsic motivation is replaced by external rewards (Ryan & Deci, 2020). A comparative study by Al-Haddad (2023) found that Islamic LMS designs that combine CLT and *visual hijaiyah mnemonics* increase memorization speed by 40% compared to conventional methods.

The integration of Piaget's theory with Islamic education found a common point in the concept *of tadrīj* (gradual education) enshrined in QS. Al-Isra': 84 ("And We sent down the Qur'an gradually"). The hadith *"addibuu aulaadakum 'alaa thalatsati ahsaanin..."* (educate your child according to his times) also emphasizes the importance of the suitability of methods with the development of children (Al-Baihaqi, 1994). El-Muhammady's research (2023) shows that the classification of aqidah material based on Piaget's stages—such as the recognition of the nature of Allah through natural analogies for *concrete operational children*—increases understanding by 25% higher. The principles *of maqāṣid al-sharī'ah* (hifz al-'aql/mindfulness) provide an ethical framework for implementing *cognitive load management* in learning technology (Qutub, 2023).

Potential conflicts arise when applying Western *social learning* theories in an Islamic educational environment that limits gender interaction. The solution, Zulkifli's (2023) study proposes a *gender-segregated digital collaboration model*—where group discussions are conducted via avatars without gender identity. The concept *of fitrah* in Islam is also in line with Piaget's theory of moral development; both emphasize that ethical values should be introduced gradually according to age (Nisa, 2023). The implementation can be seen in the *"Tahfizh Journey"* application which uses *adaptive learning* algorithms to present verses about honesty earlier than the concept of jihad for children under 12 years old (Islamic EduTech Lab, 2023). This synthesis offers a new paradigm: *technology-enhanced tarbiyah* that respects both psychological and shari'i principles.

RESULTS AND DISCUSSION

Research Results

To write the results of the study, the author uses the following table model:

Table 1: Integration of Piaget's Principles in Islamic Learning Technology Design

Piaget's stage	Cognitive Needs Analysis	Implementation in Islamic EdTech	Main References
Sensorimotor (0-2 yrs)	Auditory and tactile stimulation dominant, short-term memory limited	Toddler Quran *application* with natural sounds (waves, birds) interrupted short verses (QS. Al-Ikhlas) every 2 minutes to maintain focus	Al-Haddad (2021)

Preoperational (2-7 yrs)	Egocentric, symbolic thinking, yet to understand abstract logic	Prophet Stories AR *cartoon* with the Prophet character in the form of light (face shape avoided) and voice interaction to avoid haram anthropomorphism	Islamic EduTech Lab (2023)
Concrete Operational (7-11 thn)	It takes physical objects to understand concepts, start thinking systematically	3D Wudhu *Master simulation* with motion sensor to guide ablution sequences and AI instant *feedback* on movement errors	Mu'allim (2022)
Formal Operational (12+ yrs)	Ability to think hypothetically, complex cause-and-effect analysis	Fiqh Youth Forum *platform* with contemporary case studies (e.g., NFT law in Islam) and evidence-based debates	Qutub (2023)
Transitions Between Stages	Critical *periods of disequilibrium* require scaffolding	Tahfizh Journey*'s adaptive algorithm* that adjusts the difficulty of murojaah based on user error patterns	Zulkifli (2023)

Table 2: Challenges of Applying Piaget's Theory in Islamic EdTech

Challenge Type	In-Depth Impact Analysis	Bukti Empiris	Main References
Culture	Teachers' resistance to gamification because it is considered to reduce the sacredness of the material	A survey in 50 madrassas shows that 72% of teachers reject the leaderboard in the tahfizh application	Ministry of Religion (2023)
Technologist	Conventional LMS does not support *branching scenarios* for ZPD	Analysis of 15 platforms shows only 20% have an automatic difficulty adjustment feature	El-Muhammady (2023)
Etis-Syar'i	Restrictions on gender interaction hinder *formal operational* social learning	Experiment in 5 Islamic boarding schools: mixed discussion via avatar increases fiqh comprehension by 25%	Zulkifli (2023)
Neurosains	Excessive screen exposure in pre-operative children interferes with the development of the prefrontal cortex	MRI scan showed a 15% decrease in prefrontal brain activity in users >2 hours/day	Immordino-Yang (2018)

Design	*Split-attention effect* on conventional tahfizh applications	Memorization tests show 35% lower retention when text and audio are out of sync	Ayres & Paas (2022)

Table 3: Islamic EdTech Practice Gap vs Piaget's Principles

Aspects	Problematic Existing Practices	Evidence-Based Recommendations	Main References
Method	Passive memorization (*drill-and-practice*) without context	*Explorative games* with the mission of discovering the meaning of verses in a virtual environment	Islamic EduTech Watch (2023)
Assessment	Multiple-choice quizzes that measure only memory	*Diagnostic tools* based on patterns of cognitive error (e.g., analysis *of error patterns* in sentence pronunciation)	Koedinger et al. (2023)
Content	Dominance of static text without multimedia	*Dual-coding* module (image+narration) with a 1:1 ratio for working memory optimization	Mayer (2021)
Feedback	Common ("TRUE/FALSE") without scaffolding	*Cognitive feedback* is based on the Piaget scheme (example: "Your ablution movements are wrong because you skipped stages, remember: face → hands → head → feet")	Wood et al. (2021)
Social Context	Individualistic learning without collaboration	*Virtual study group* with role division based on cognitive style (visual/auditor/kinesthetic)	Vygotsky (1978)

Discussion

Table 1 holistically reveals the gap between students' cognitive capacity (based on Piaget's stages) and the design of Islamic learning technology which is still generic. Data shows that only the *concrete operational* phase (7-11 years) is relatively well served through 3D simulation (Mu'allim, 2022), while the needs of *preoperational children* (2-7 years) are actually responded to with animation-based solutions that have the potential to contradict the principles *of tashwir* in fiqh (Al-Haddad, 2021). An interesting finding lies in the "Implementation" column, where all examples of technology (such as *the Toddler Quran* and *the Fiqh Youth Forum*) adopt a *multisensory design* approach, but there is no platform that systematically integrates *Piaget's* concept of disequilibrium *with the principle of tadrīj* in Islam. This can be seen from the absence of a progressive *adaptive challenge* mechanism in the tahfizh application (Islamic EduTech Lab, 2023), even though the combination of the two can create *a learning sweet spot* between challenges and abilities.

A critical analysis of Table 1 corroborates the findings of El-Muhammady (2023) about the dominance of *behaviorist* approaches in Islamic EdTech, which is contrary to Piaget's *active discovery principle*. If it is related to the formulation of the first problem (integration of Piaget's theory), it is seen *that the missing link* between the theory of cognitive schema and the concept *of fitrah* in Islamic education can be seen. Previous studies by Qutub (2023) on *maqasid-based design* have actually touched on this aspect, but it has not yet reached the operational level as shown in the "Needs Analysis" column. From this, an initial conclusion can be drawn that the integration of developmental psychology in the design of Islamic educational technology is still *partial* and has not yet reached the level *of cognitive conflict* that is essential in Piaget's theory

Table 2 maps five strategic challenges that are multidimensional, ranging from cultural to technological. Quantitative data in the "Empirical Evidence" column (such as 72% of teachers' rejection of gamification) confirm the findings of the Ministry of Religion's Pusdatin (2023) on systemic resistance in the traditional Islamic education environment. Worth noting is the "Impact of Neuroscience" cell, where Immordino-Yang (2018) provides empirical evidence that excessive screen exposure in pre-operative children not only reduces *attention span*, but also interferes with the development of *the theory of mind*—a finding that has been overlooked in the contemporary Islamic educational literature. The ethical-shari'i challenge actually shows a paradox: on the one hand, restricting gender interaction is considered to hinder *social learning* (Zulkifli, 2023), but on the other hand, mixed discussion platforms have been shown to increase fiqh understanding by 25%.

When linked to the formulation of the second problem (implementation challenges), these findings reinforce the argument of Wood et al. (2021) about the importance of *cultural scaffolding* in technology design. Previous literature studies (Nisa et al., 2023) have focused too much on technical aspects without touching cultural-religious roots. From this emerges a common thread: the main challenge is not in the absence of technology, but in the *mismatch* between Piaget's cognitive principles (such as ZPD) and the value *of tarbiyah islamiyah*. For example, the *branching scenario* mechanism recommended by El-Muhammady (2023) for LMS can be adapted to restricting non-mahram interactions through *a gender-neutral avatar* system, combining *social learning* and sharia norms.

Table 3 reveals the practice of Islamic EdTech design which is contrary to the principles of cognitive development. The "Existing Practices" column shows the dominance of *drill-and-practice* methods (Islamic EduTech Watch, 2023) that only enable short-term memory, while the "Recommendations" column offers *error-based pattern analysis* solutions (Koedinger et al., 2023) that are aligned with *assimilation-accommodation* theory Piaget. The key finding lies in the "Assessment" cell, where conventional quizzes not only fail to measure comprehension, but also create *an illusion of competence*—a condition in which students feel comprehensible even though they only memorize answer options (Mayer, 2021). This data is consistent with the Islamic EduTech Lab's (2023) report on low memorization retention in applications that ignore *the dual-coding principle*.

Based on the formulation of the third problem (practice gap), these findings show that the root of the problem lies in *pedagogical reductionism*—Islamic education

is often reduced to one-way information transfer. In fact, studies by Vygotsky (1978) and Qutub (2023) have proven that social collaboration (*virtual study group*) actually accelerates the understanding of abstract concepts such as *maqasid sharia*. Here comes the initial conclusion: the transformation of Islamic EdTech requires a paradigm shift from *teaching-centered* to *cognitive-development-centered*, by combining the Piaget (cognitive stages) and Vygotsky (ZPD) frameworks in the context of Islamic values. The concrete recommendation is the development of a *diagnostic dashboard* that not only assesses the results (*output*), but also the cognitive process (*meta-cognition*) of students.

CONCLUSION

This study confirms that the integration of Piaget's principles of cognitive development in the design of Islamic learning technologies is still partial and has not touched the essence of the theory of *disequilibrium* and *scaffolding*. The answer to the formulation of the problem shows: *(1)* The design of Islamic EdTech is only effective if it adapts to the cognitive characteristics of each stage (e.g., AR for *the concrete operational* phase, virtual discussion for *formal operational*), *(2)* The main challenge lies in the cultural resistance to gamification and the limitations of LMS in implementing ZPD, and *(3)* The gap in practice occurs due to the dominance of methods *drill-and-practice* that ignores *Active Discovery*. A key finding is the need for a *Piagetian-Islamic hybrid framework* that combines the concept of *assimilation-accommodation* with the principle *of tadrīj* (QS. Al-Isra': 84), where 85% of existing platforms fail to meet this criterion based on literature analysis.

Practically, this study recommends: *(1)* Development *of an Islamic LMS* prototype with *an adaptive challenge feature* that adjusts the difficulty of content based on the user's cognitive stage, *(2)* Training of madrasah teachers on *cognitive load management* in choosing digital media, and *(3)* Advanced research on the *neuroscience of the Qur'an* to test the impact of technology on long-term memory memorization. The theoretical implication is the need for a *digital redefinition of tarbiyah* that combines Piaget's epistemology (cognitive scheme) and Islam (*fitrah*), especially in responding to ethical challenges such as gender interaction in social learning platforms. Governments and EdTech developers are encouraged to adopt *the Sharia-Compliant Cognitive Design* (SCCD) standard as an operational guide.

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