JKTP: Jurnal Kajian Teknologi Pendidikan
Vol. 9, No. 4, November 2026: 473-485
e-ISSN: 2615-8787
DOI: 10.17977/um038v9i42026p473-485
https://journal-fip.um.ac.id/index.php/jktp

DEVELOPMENT OF ANDROID-BASED INTERACTIVE LEARNING MEDIA TO IMPROVE FEMALE STUDENTS' UNDERSTANDING OF FIQIH ZAKAT

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Article History
Received: 08 October 2026, Accepted: 04 November 2026, ***Published: 11 November 2026***

Abstrak
Materi Fiqih Zakat sering dipersepsikan rumit oleh siswi karena pembelajaran konvensional bertumpu pada buku teks naratif dengan ilustrasi minim serta kalkulasi prosedural nisab dan haul yang tidak disertai umpan balik. Penelitian ini bertujuan menghasilkan media pembelajaran interaktif berbasis Android bernama ZakatMedia, menguji kelayakan dan efektivitasnya, serta merumuskan prinsip desain instruksional yang dapat digeneralisasi. Penelitian menggunakan pendekatan *Design-Based Research* dengan kerangka Integrative Learning Design Framework yang dilaksanakan melalui empat fase dan lima siklus evaluasi iteratif, serta berlandaskan teori kognitif pembelajaran multimedia. Subjek penelitian adalah siswi kelas VIII sebuah Mts di Banyuwangi. Data dikumpulkan melalui angket kebutuhan, lembar validasi ahli, observasi, serta pretest dan posttest, kemudian dianalisis secara deskriptif dan dengan uji nonparametrik Wilcoxon Signed-Rank Test. Hasil penelitian menunjukkan bahwa media dinilai layak oleh ahli materi dan ahli media serta meningkatkan pemahaman siswi secara signifikan. Penelitian ini juga menghasilkan tiga prinsip desain, yaitu representasi angka konkret, penjenjangan dan umpan balik, serta media sebagai pemantik. Simpulannya, ZakatMedia layak dan efektif digunakan sebagai suplemen pembelajaran Fiqih Zakat.

Kata Kunci: Android; Design-Based Research; Fiqih Zakat; Media Pembelajaran Interaktif; Multimedia Learning.

Abstract
Fiqh Zakat is often perceived by students as difficult because conventional instruction relies on narrative textbooks with minimal illustrations and offers no feedback on the procedural calculation of nisab and haul. This study aimed to develop an Android-based interactive learning medium named ZakatMedia, to test its feasibility and effectiveness, and to formulate generalizable instructional design principles. The study used a Design-Based Research approach with the Integrative Learning Design Framework, carried out in four phases and five iterative evaluation cycles and grounded in the cognitive theory of multimedia learning. The participants were female eighth-grade students at an Islamic junior high school in Banyuwangi. Data were collected through a needs questionnaire, expert validation sheets, observations, and a pretest and posttest, and were analyzed descriptively and with the Wilcoxon Signed-Rank Test. The results showed that the medium was judged feasible by subject matter and media experts and significantly improved understanding among students. The study also produced three design principles, namely concrete number representation, scaffolded structure and feedback, and media as a catalyst. In conclusion, ZakatMedia is feasible and effective as a supplement for Fiqh Zakat learning.

Keywords: *Android; Design-Based Research; Fiqh Zakat; Interactive Learning Media; Multimedia Learning*

To cite this article:
Izzah, S. M., Taufiqurrahman, & Dhaifi, I. (2026). Development of android-based interactive learning media to improve female students' understanding of fiqih zakat. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *9*(4), 473–485. doi: 10.17977/um038v9i42026p473-485

INTRODUCTION

Islamic Religious Education (PAI) at the Madrasah Tsanawiyah (MTs) level plays a strategic role in fostering a balance between students' intellectual abilities and spiritual maturity through the cultivation of faith, moral values, and social responsibility. Within the madrasah curriculum, PAI is divided into four main subjects: Qur'an and Hadith, Islamic Creed and Ethics (Akidah Akhlak), Islamic Cultural History, and Islamic Jurisprudence (Fiqih) (Ministry of Religious Affairs of the Republic of Indonesia, 2019). Among these subjects, Fiqih holds a particularly vital position as a means of introducing and developing practical understanding of Islamic Sharia law, which governs both ritual worship and social interactions in the community.

One of the essential topics in the Fiqih curriculum for Grade VIII in the first semester, which is closely related to the social aspects of religious life, is Zakat. Unlike daily acts of worship such as prayer, zakat is performed at specific times and involves relatively complex technical calculations, including the determination of nisab (the minimum threshold of wealth), haul (a one-year period of ownership), and the applicable percentage of zakat, which varies according to the type of wealth (Al-Ghazzi, 1924). This procedural complexity is often perceived by students as difficult, rigid, and tedious. Consequently, students' mastery of both zakat concepts and calculation skills depends largely on the effectiveness of the instructional methods and media implemented in madrasahs.

A preliminary study and needs analysis conducted at MTs X in Banyuwangi Regency revealed fundamental problems in the teaching and learning of Fiqih, particularly the topic of Zakat. Observations and interviews with the Fiqih teacher and female students in Class VIII C indicated that instruction had predominantly relied on conventional lecturing methods and static textbooks. The textbooks used were characterized by dense textual content, tightly spaced lines, and a lack of interactive visual illustrations. These conditions contributed to cognitive fatigue and learning boredom even before the learning process began. Furthermore, a quantitative needs analysis involving 21 female students yielded a media needs score of 75.95%, classified as indicating a very high need, underscoring the urgency of developing alternative digital learning media (Arikunto, 2013).

From a sociological and academic perspective, MTs X has a distinctive characteristic in terms of the heterogeneous backgrounds of its students. The madrasah accommodates both residential female students (santri living in Islamic boarding schools) and non-residential female students (those who commute from outside the boarding school). Residential students generally have a solid foundation in religious knowledge acquired through traditional Islamic boarding school studies but are not permitted to bring mobile devices. In contrast, non-residential students generally have relatively limited prior knowledge of religion but have extensive daily access to Android-based smartphones. The cognitive gap between these two groups highlights the need for flexible, adaptive, and offline-accessible mobile learning media that students can use independently outside formal classroom hours.

Previous studies on the development of multimedia- and Android-based Fiqih learning media have generally adopted conventional linear research and development (R&D) models, such as ADDIE and Borg and Gall (Rohmah & Rohmah, 2025). Another study by Hidayatulloh et al. (2023) developed Android-based interactive media for Fiqih instruction, focusing on product feasibility testing through validation by media and subject matter experts. However, it did not examine how students' thinking processes changed throughout the trial stages. A similar pattern can be observed in studies by Afifah (2023) and Sejati and Hardi (2023), which measured media effectiveness by comparing pretest and posttest scores without examining the cognitive adaptation processes occurring between the two measurements. Meanwhile, Nurani et al. (2025), Apriliani and Rohmah

(2026), and Sari et al. (2026) began to address multimedia design principles in their discussions. However, these principles were applied post hoc, meaning that they were mapped only after the products had been completed to justify the results, rather than being systematically operationalized from the initial design stage. A similar pattern is also evident in several studies on interactive media development published in JKTP. Inawan, Sulthoni, and Ulfa (2022) developed interactive multimedia for elementary school science using Sugiyono's R&D model, which concluded with expert validation and user trials without examining the cognitive processes involved during development. Saifudin, Susilaningsih, and Wedi (2020), as well as Rifai, Sulton, and Sulthoni (2020), demonstrated a similar approach by assessing media feasibility and effectiveness solely through expert validation percentages and pretest–posttest results, without documenting the design revision rationale throughout the development process. Consequently, no studies have yet been identified that use the Cognitive Theory of Multimedia Learning as a rigorous guiding framework throughout the entire development cycle while also formulating generalizable design principles for developers of similar media. Furthermore, no studies have addressed the context of madrasahs with heterogeneous student populations, such as residential and non-residential female students who simultaneously differ in device access and prior religious knowledge.

This gap underscores that the novelty of this study lies not merely in the adoption of the 'Design-Based Research' (DBR) methodology through the 'Integrative Learning Design Framework' (ILDF) as an alternative to linear R&D models, but also in the explicit and iterative operationalization of the principles of the 'Cognitive Theory of Multimedia Learning' from the needs analysis stage through evaluation. This approach leads to the formulation of empirically validated multimedia design principles for zakat learning in a learning context involving a heterogeneous student population, while also tracing students' cognitive adaptation processes, which have largely been overlooked in previous studies.

Based on these academic gaps and practical needs, this study addresses the question of how the development process of Android-based interactive learning media for the topic of Fiqih Zakat can be designed by consistently operationalizing the principles of the 'Cognitive Theory of Multimedia Learning' within a DBR framework, and to what extent the resulting media are suitable for use and effective in improving the cognitive understanding of students with diverse levels of prior knowledge and access to digital devices.

Based on this background and the identified research problem, this study aims to develop ZakatMedia, an Android-based interactive learning medium, using the DBR-ILDF framework through to the formulation of design principles; analyze the feasibility of ZakatMedia based on assessments by subject matter and media experts; and examine the effectiveness of ZakatMedia in improving the cognitive understanding of Grade VIII C female students at MTs X regarding the topic of Fiqih Zakat.

METHOD

This study employed the Design-Based Research (DBR) methodology, a research approach that integrates the design of theory-based learning environments with contextual field investigation. The implementation of DBR was guided by Brenda Bannan's (2003) Integrative Learning Design Framework (ILDF), which consists of four phases: Informed Exploration, Enactment, Evaluation: Local Impact, and Evaluation: Broader Impact.

The study was conducted at an MTs in Banyuwangi Regency. Participants in the Small Group Tryout during the formative evaluation phase consisted of five female students from Class VIII B, selected through purposive sampling to represent high, medium, and low academic achievement levels based on recommendations from the Fiqih teacher. Meanwhile, the full-class implementation

involved 28 female students from Class VIII C, who participated in a pretest, an intervention using the ZakatMedia application, and a posttest.

The Informed Exploration phase involved classroom observations, interviews, a needs analysis questionnaire consisting of 30 Likert-scale items, benchmarking to identify weaknesses in the existing textbooks, a theoretical review of Information Processing Theory, the Working Memory Model, Cognitive Load Theory, and CTML, as well as the development of an initial Conjecture Map (Bannan-Ritland, 2013; Bannan-Ritland & Baek, 2008).

The Enactment phase translated the theoretical framework into an Android application through an iterative process (Bannan-Ritland, 2013; Bannan-Ritland & Baek, 2008). The researcher operationalized CTML principles in the content structure of ZakatMedia using Kotlin in Android Studio, Firebase Realtime Database with offline persistence enabled, and CorelDRAW for graphic elements, while the audio narration was recorded using an actual human voice. The resulting product was an application in .apk format with a minimum system requirement of Android 8.0 (Oreo).

The Evaluation: Local Impact phase constituted the core integration of formative and summative evaluations, conducted through repeated iterative microcycles (Bannan-Ritland, 2013; Bannan-Ritland & Baek, 2008). In this study, formative and summative evaluations were conducted through five iterative cycles: media expert validation (Cycle I), subject matter expert validation (Cycle II), Small Group Tryout (Cycle III), first-day classroom implementation accompanied by non-participant observation (Cycle IV), and second-day classroom implementation followed by the posttest (Cycle V). Details of the revisions made in each cycle are presented in Table 2. The Evaluation: Broader Impact phase involved formulating generalizable design principles, documenting the reasoning behind each revision in the Designer Log, and analyzing the attributes of innovation diffusion proposed by Rogers (1995).

The research instruments included a needs analysis questionnaire, an interview guide, subject matter and media expert validation sheets using a 1–5 Likert scale, pretest and posttest sheets, observation sheets and field notes, as well as a Designer Log documenting problem findings, hypotheses regarding their causes, revision actions, and theoretical justifications for each cycle (Cobb et al., 2003). Of the 15 initial test items analyzed using Jamovi, 10 items were found to be valid (calculated $r >$ critical r of 0.4438; $p < 0.05$), with Cronbach's Alpha coefficients of 0.705 for the pretest and 0.811 for the posttest, indicating acceptable to high reliability.

Questionnaire data were analyzed using descriptive percentages, while expert validation data were analyzed using mean scores for each aspect, which were then converted into Nieveen's (1999) feasibility criteria. The normality of pretest and posttest data was assessed using the Shapiro–Wilk test, while hypothesis testing was conducted using the Wilcoxon Signed-Rank Test with rank-biserial correlation as the effect size measure. Meanwhile, improvements in cognitive understanding were measured using Hake's (1998) Normalized Gain Score, classified into high, medium, and low categories.

RESULTS

The needs analysis questionnaire administered to 21 female students from Class VIII C yielded a total score of 1,914 out of an ideal score of 2,520, equivalent to 75.95% (rounded to 76%). Based on Arikunto's (2013) criteria, this score falls within the 76%–100% range, categorized as "Very High Need." Meanwhile, benchmarking of the existing Fiqih textbooks revealed four weaknesses, namely lengthy textual narratives without colored graphics that contribute to cognitive fatigue, explanations of nisab and zakat rates presented only as rigid formulas without flowcharts or simulations, fragmented organization of the Zakat Maal subtopics, and the absence of automated feedback in

practice exercises, which prevents students from independently identifying calculation misconceptions.

The final product was an Android application called ZakatMedia, developed through five iterative evaluation cycles. The application has two types of accounts. Female students can register independently through the registration page, while teacher accounts are created by the administrator to ensure secure access privileges. The student interface has three main menus, whereas the teacher interface has five menus because it includes question input and grade printing features, allowing the teacher to retain full control over the evaluation process (Figure 1).



Figure 1. ZakatMedia Account Access and Main Menus: (a) Login Page, (b) Registration Page, (c) Student Menu, and (d) Teacher Menu

The CTML (Cognitive Theory of Multimedia Learning) principles were incorporated into the presentation of the learning materials (Figure 2). The Segmenting Principle was implemented by dividing the content into individual subtopics to prevent cognitive overload, while the Modality Principle was applied through a combination of illustrations and audio narration. The Spatial Contiguity Principle was reflected in the placement of labels close to their corresponding images and the glossary in the upper-right corner, while the Coherence Principle was implemented through a minimalist interface. The Multimedia Principle was applied through the integration of text, images, audio, and video, while the Signaling Principle was implemented using arrows, tables, and color contrast to highlight key information, such as nisab and zakat rates.



Figure 2. Implementation of CTML Principles in ZakatMedia: (a) Segmenting, (b) Modality, (c) Spatial Contiguity, (d) Coherence, (e) Multimedia, and (f) Signaling

Learning assessments are presented through multiple-choice and essay questions, accompanied by immediate visual feedback for both correct and incorrect answers (Figure 3). The quiz cannot proceed if an answer is left blank, thereby encouraging female students to complete every question. Questions are managed by the teacher through Firebase, allowing changes to be implemented immediately without requiring an application update. Female students can view their scores and learning achievement history, while teachers can monitor their results through the evaluation menu and dashboard.

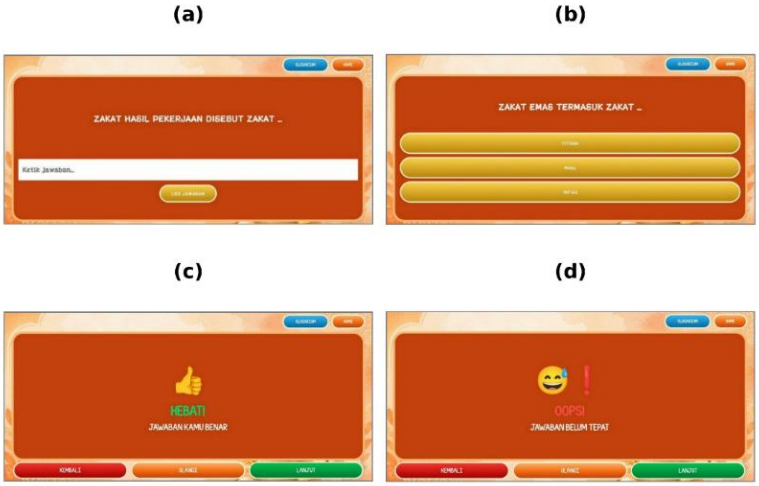


Figure 3. Assessment Items and Feedback: (a) Essay Question, (b) Multiple-Choice Question, (c) Feedback for Correct Answers, and (d) Feedback for Incorrect Answers

These components demonstrate that the product has been fully developed and subsequently underwent validation before being tested with the female students. Validation was conducted through assessments by media and subject matter experts. The quantitative assessment results provided by the subject matter and media experts are summarized in Table 1.

Table 1. Validation Results from Subject Matter and Media Experts

Validator	Scoring Aspect	Question Number	Average Score	Feasibility Category
Subject Expert	Content Relevance	4	3,75	Layak
	Content Accuracy	3	4,00	Layak
	Content Currency	3	4,00	Layak
	Supporting Materials	3	4,00	Layak
Overall Mean Score from Subject Expert		**13**	**3,92**	**Layak**
Media Expert	Presentation Techniques	3	3,66	Layak
	Instructional Presentation	3	3,33	Layak
	Presentation Completeness	2	3,50	Layak
	Motivation	3	3,00	Layak
	Design and Illustrations	6	3,50	Layak
	Layout	3	3,66	Layak
Rata-rata Keseluruhan Ahli Media		**20**	**3,45**	**Layak**

Based on Table 1, the overall mean score from the subject matter expert assessment was 3.92 (categorized as "Feasible"), while the overall mean score from the media expert assessment was 3.45 (categorized as "Feasible"). According to Nieveen's conversion criteria, all assessed aspects fell within the range of 3.41–4.20. Therefore, ZakatMedia was considered suitable for use in Fiqih Zakat instruction.

The iterative reconstruction process across five cycles was systematically documented in the Designer Log. A summary of the evolution of the design reconstruction and its scientific justifications is presented in Table 2.

Table 2. Summary of ZakatMedia Design Reconstruction Based on Iterative DBR Cycles

Cycle	Design Component	Evaluation Findings	Design Reconstruction Actions	Theoretical Basis and Justification
Cycle I	Interface and Language	The opening text and audio were not synchronized; the language style was rigid; the "Check Answer" button was reversed.	Synchronizing text and audio in Android Studio; personalizing the language using a conversational style; correcting the XML layout.	Spatial Contiguity Principle and Personalization Principle (Mayer); Eight Golden Rules (Shneiderman).
Cycle II	Content and Depth of Material	Explanatory narratives were excessively lengthy; explanations of Zakat on Professional Income and Livestock lacked specificity.	Condensing non-essential text into bullet points; expanding the details on the nisab for professional income zakat.	Coherence Principle (Mayer); Essential Processing Management (Sweller).
Cycle III	Quiz and Mobile Navigation	The quiz feedback display was monotonous; calculation audio was complex; a bug in the "Back" button caused the quiz to reset. Female students experienced cognitive difficulties in understanding zakat calculations presented in decimal percentage format (2.5%).	Creating expressive visual feedback pop-ups using CorelDRAW and XML AlertDialog; simplifying the audio; fixing the Kotlin logic. Converting zakat calculation figures from decimal percentages to concrete fractions (1/40).	*ARCS Motivation Model (Keller); User Control and Freedom (Nielsen); Modality Principle. Triple Code Model (Dehaene, 1992).*
Cycle IV	Calculation Flow and UI Terminology	Numbered calculation steps were difficult to process; the terms "Glossary" and "Home" were unfamiliar to female students.	Replacing numbered steps with a visual arrow-based flow; changing UI terms to "Kamus Istilah" and "Beranda".	*Signaling Principle* (Mayer); *Match Between System & Real World* (Nielsen).
Cycle V	Error Correction System and Soft Keyboard	The system rigidly flagged spacing errors; the keyboard covered the input box; the uniform quiz lacked challenge.	Normalizing text in Kotlin; adjusting the soft keyboard window and font size; enabling quiz levels in Firebase.	*Error Tolerance & Visibility of System Status* (HCI); Flow Theory (Csikszentmihalyi).

Note: The effectiveness of fraction-based representation (Cycle III) was consistently confirmed in improving students' understanding of zakat calculations during the full-class implementation in Cycle V. Meanwhile, the effectiveness of quiz feedback pop-ups (Cycle III) was confirmed through improvements in the classroom atmosphere observed during the full-scale non-participant observation in Cycle IV.

Students' learning outcomes were analyzed by comparing the pretest and posttest scores of 28 female students from Class VIII C. A summary of the descriptive statistics and the results of the Shapiro–Wilk normality test is presented in Table 3.

Table 3. Descriptive Statistics and Results of the Shapiro–Wilk Normality Test for Pretest and Posttest Scores

Statistical Parameter	Pretest (A)	Posttest (B)
Number of Subject (N)	28	28
Average	**60,9**	**81,4**
Median	62,5	80,0
Standard Deviation	21,5	8,48
Minimum Score	10	55
Maximum Score	90	95
Shapiro-Wilk Statistic Value	0,926	0,903
Normality Significance (*p-value*)	**0,049**	**0,013**
Data Distribution Conclusion	**Abnormal (p < 0,05)**	**Abnormal (p < 0,05)**

Based on Table 3, the mean score of the female students increased significantly from 60.9 on the pretest to 81.4 on the posttest. The significance values of the Shapiro–Wilk normality test for the pretest (p = 0.049) and posttest (p = 0.013) were below 0.05, indicating that the data were not normally distributed. Therefore, the hypothesis testing for differences was conducted using the non-parametric Wilcoxon Signed-Rank Test in Jamovi, with the statistical results summarized in Table 4.

Table 4. Results of the Non-Parametric Wilcoxon Signed-Rank Test for Pretest and Posttest Scores

Data Pair	Wilcoxon Statistic (W)	p-value (2-tailed)	Effect Size (Rank-biserial)	Hypothesis Decision
Pretest vs Posttest	**8,50**	**< 0,001**	**-0,955**	**H0 Rejected (Significant)**

The Wilcoxon test results in Table 4 show a test statistic of W = 8.50 with a significance level of $p < 0.001$ ($p < 0.05$). These results demonstrate that H0 was rejected and Ha was accepted, indicating a statistically significant difference in cognitive understanding before and after the use of ZakatMedia. The effect size, measured using the rank-biserial correlation, was −0.955, indicating that the intervention had a very large effect.

The normalized effectiveness analysis using Hake's N-Gain Score formula yielded a mean N-Gain of 0.43. According to Hake's criteria, this value falls within the range of $0.3 \leq g \leq 0.7$, indicating a "Moderate" improvement. The frequency distribution of students' N-Gain categories showed that 5 female students (18%) achieved a "High" improvement, 18 female students (64%) achieved a "Moderate" improvement, and 5 female students (18%) fell into the "Low" improvement category.

DISCUSSION

The achievement of the "Feasible" category in both subject matter and media expert assessments, along with the clear improvement in female students' understanding between the pretest and posttest, methodologically reflects the fundamental nature of Design-Based Research (DBR). DBR does not require an artifact to be perfect from the initial design stage; rather, it positions the media as an embodiment hypothesis that is continuously tested and reconstructed through data-driven reflection cycles (Bannan-Ritland, 2003; Nieveen & Folmer, 2013). The statistically significant effectiveness of ZakatMedia, with an effect size in the very large category, was rooted in the successful elimination of extraneous cognitive load throughout each evaluation cycle. The Normalized Gain (N-Gain) score, which fell into the "Moderate" category according to Hake's (1998) criteria, further supports the consistency of the Wilcoxon hypothesis testing results, given that this metric specifically measures the magnitude of improvement in understanding relative to the maximum

possible improvement that students can achieve, rather than merely reflecting the difference between raw scores. The frequency distribution of N-Gain categories revealed an informative pattern: most female students achieved a moderate level of improvement, while the proportions of those in the high and low categories were relatively balanced. This indicates that the effectiveness of ZakatMedia was not yet fully uniform across all levels of student ability. This pattern is theoretically relevant to Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), suggesting that independent learning media without direct scaffolding from teachers have limitations in their effectiveness for students whose initial abilities differ substantially from the class average, whether those who already have a strong understanding of zakat or those who experience the most significant foundational difficulties before the intervention.

In addition to quantitative data, the effectiveness of ZakatMedia can also be explained through qualitative findings from the iterative cycles when examined from a cognitive theoretical perspective. The transformation of numerical representation from the decimal percentage of 2.5% to the concrete fraction of 1/40 in zakat maal calculations was first implemented in Cycle III in response to cognitive confusion observed among female students during the small-group trial. The effectiveness of this format change was only empirically and consistently confirmed in Cycle V, when female students in the full-class implementation demonstrated a more intuitive understanding of fraction-based representation than of percentage symbols. This phenomenon can be explained in depth through the Triple Code Model developed by Stanislas Dehaene (1992). Dehaene proposed that the human brain processes numerical information through three neural codes: the visual Arabic code, the auditory verbal code, and the analog magnitude representation, which is localized in the intraparietal sulcus (IPS). The percentage symbol 2.5% relies entirely on the visual Arabic code, which is abstract and arbitrary, thereby requiring sequential conversion steps that slow down processing. In contrast, the fraction-based representation of 1/40 directly activates the analog magnitude pathway through the mental representation of "1 out of every 40 parts of wealth," naturally reducing perceptual costs in working memory.

Consistent with the Triple Code Model, Cognitive Load Theory (Sweller et al., 2011) provides an explanation of why changing the numerical format from a decimal to a fraction does not alter the intrinsic cognitive load of the zakat material itself. The reduction in the subjective difficulty experienced by female students resulted solely from a decrease in extraneous cognitive load due to the presentation of numerical formats that were more compatible with the cognitive architecture of novice learners. By freeing working memory capacity from the burden of decoding abstract symbols, students' cognitive resources could be redirected toward generative processing, namely, connecting the concepts of nisab and haul with long-term knowledge schemas (Atkinson & Shiffrin, 1968; Baddeley & Hitch, 1974).

In addition to numerical representation, changes to the audio component also have a strong theoretical basis. The transformation of audio narration in Cycle III provided empirical evidence for Mayer's (2009) Modality Principle and Personalization Principle. When the initially convoluted audio narration was simplified into familiar everyday conversational language, using expressions such as "you" and "let's," the female students' auditory channel was less likely to experience channel overload. The approachable audio explanations activated social agency, making students feel as though they were being guided by a real interaction partner, which significantly enhanced motivation and generative mental effort.

In terms of motivation and learning engagement, changes to the quiz also produced effects that can be explained theoretically. The reconstruction of quiz feedback pop-ups using expressive visual characters was first implemented in Cycle III, while its impact on creating a more competitive and

conducive classroom atmosphere was only confirmed observationally in Cycle IV, when full-class implementation allowed interaction patterns to be observed more representatively than during the small-group trial in the preceding cycle. Based on Keller's (2016) ARCS-V Motivation Model, immediate visual feedback fulfills the Attention component through perceptual stimuli and the Satisfaction component through extrinsic rewards. Furthermore, the activation of progressively arranged quiz levels, from easy to difficult, in Cycle V helped sustain a state of flow (Csikszentmihalyi, 1990; Sweetser & Wyeth, 2005). Balancing quiz difficulty with students' increasing skills prevented boredom among faster learners and anxiety among slower learners, thereby sustaining situational interest (Hidi & Renninger, 2021).

Based on the entire discussion above, as the main theoretical contribution of this DBR study, the synthesis of the design evolution documented in the Designer Log was consolidated into three final instructional design principles that can be generalized to the development of Android-based Fiqih learning media. The first principle is concrete numerical representation, which emphasizes that when designing interactive learning media for Fiqih topics involving procedural calculations, numerical representation should not be regarded merely as a visual aesthetic choice. Numbers should be presented in a format that most closely aligns with students' concrete thinking, namely, a format that directly reflects quantities or proportional relationships, such as the fraction 1/40, rather than abstract decimal or percentage symbols such as 2.5%, which require multiple stages of mental conversion. This is because concrete numerical formats reduce perceptual costs in working memory and activate the brain's analog magnitude pathway, thereby minimizing extraneous cognitive load and allowing students' mental capacity to focus on understanding the essence of Islamic legal principles.

The second principle is progressive levels and feedback, which emphasizes that when designing interactive assessment mechanics in mobile media, quiz questions should not be presented in a single, uniform linear sequence. Quizzes should be developed with progressively increasing levels of difficulty to maintain a balance between students' challenges and skills within the flow framework. This progression must be combined with immediate, expressive, and emotionally engaging visual feedback as a form of rewarding feedback that fulfills affective needs, thereby encouraging students to continue allocating mental effort, or germane load, to independent learning and content processing.

The third principle is media as a catalyst, which emphasizes that the development of interactive mobile-based multimedia should not assume that it can fully replace the role of teachers. The primary function of digital applications is to present basic concepts concisely, visually, and interactively as an initial trigger that opens opportunities for students to engage in critical thinking within their Zone of Proximal Development (ZPD). Meanwhile, further exploration of complex, dynamic, and morally nuanced contextual questions should be facilitated by teachers as More Knowledgeable Others (MKOs), because social interaction and teacher scaffolding are essential for correcting misconceptions and fostering the comprehensive internalization of religious values.

These three design principles are integrated into a Local Instructional Theory for Android-based Fiqih Zakat learning (Gravemeijer & Cobb, 2006). This theory posits that the understanding of Fiqih Zakat among secondary-level students can be optimized when numerical decoding demands are eliminated through concrete representation, independent learning engagement is sustained through progressive quiz challenges and affective feedback, and digital applications function as catalysts for critical dialogue that is further developed through teachers' social scaffolding in the classroom. These three elements support one another, as reflected in the N-Gain pattern, which was not yet fully uniform across all levels of student ability. This finding underscores that digital media such as

ZakatMedia serve most effectively as supplementary instruments integrated with the active role of teachers, rather than as the sole replacement for the overall Fiqih Zakat learning process.

CONCLUSION

The development of ZakatMedia through the Design-Based Research (DBR) methodology using the Integrative Learning Design Framework (ILDF) successfully completed five iterative evaluation cycles, which demonstrably improved both the physical quality of the media and conceptual clarity. This process also yielded three final instructional design principles that can be generalized: the Concrete Numerical Representation Principle, the Progressive Levels and Feedback Principle, and the Media as a Catalyst Principle. ZakatMedia was deemed suitable for use based on the subject matter and media expert validation results, both of which fell into the "Feasible" category. Furthermore, it was demonstrated to be significantly effective in improving the cognitive understanding of Grade VIII C female students at MTs X regarding Fiqih Zakat, as indicated by a statistically significant increase in pretest and posttest scores, a very large effect size, and a moderate normalized gain. These findings confirm that Android-based interactive learning media serve most optimally as catalysts for independent learning while still requiring face-to-face teacher scaffolding, particularly for female students whose initial abilities differ substantially from the class average. Further research is recommended to examine the long-term retention of students' understanding through post-intervention retention assessments and to expand the study population to other madrasahs with different population characteristics to test the generalizability of the three resulting design principles.

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