

Enhancing L2 Arabic Writing: Development and Evaluation of a Morphologically-Aware 3D Game

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Abstract: This study examines the effectiveness of the URUBAH game as an Android-based Arabic learning application developed using the ADDIE instructional model and Unity 3D software, with the aim of improving second-language (L2) learners' Arabic writing proficiency. The game was designed to support Indonesian learners of Arabic who experience difficulties in spelling, grammar, and sentence structure. It addresses these challenges by focusing on the morphological and syntactic features of Arabic while considering structural differences between Arabic and English writing systems. The objectives of this research are twofold: first, to develop an interactive digital learning tool that enhances Arabic writing skills through gamification; and second, to evaluate its effectiveness in comparison with traditional teaching methods. A mixed-methods approach was employed, integrating quantitative data derived from pre- and post-tests with qualitative insights gathered from surveys and learner feedback. The findings indicate that the game positively improves writing outcomes, including learners' accuracy, fluency, and overall engagement. In addition, learners' motivation increased, accompanied by reduced anxiety when practicing Arabic writing through the interactive platform. In conclusion, the URUBAH game presents a promising instructional approach with practical applications for teaching Arabic as a second language. It also demonstrates the potential of integrating advanced digital technology into language classrooms to enhance learning experiences

Keywords: Arabic writing, game-based learning, learning media, morphology awareness, unity 3D

1. Introduction

Arabic is a widely spoken language and is commonly learned in Indonesia, a Muslim-majority country. However, learning Arabic in Indonesia presents unique challenges for many learners. Said (2023) stated that the main challenges faced by L2 learners include writing, pronunciation, sentence structure, and cultural adaptation. Similarly, Khasawneh and Khasawneh (2022) highlighted additional difficulties, such as differences in writing strategies, prepositional knowledge, and collocational patterns. Harbi (2022) further stated that the dominance of colloquial Arabic, inadequate curriculum design and presentation, and the interaction of Arabic with foreign languages can hinder effective language teaching. Al-Sulaim et al. (2024) reported that learners whose first language, such as English, has a linear morphological structure commonly struggle with Arabic's root-and-pattern morphological system. Furthermore, Berrebi, Bat-El and Meltzer-Asscher (2023) and Alsariera and Alsarairah (2024) concluded that students' ability to write

fluently and accurately depends on their ability to derive words, apply agreement rules, maintain grammatical accuracy, and master linguistic knowledge.

Zaid et al. (2023) identified the absence of adequate learning infrastructure as a significant challenge in learning and teaching Arabic. This includes the shortage of textbooks, teaching media, and modern instructional materials. Anis, Malik and Setiyadi (2022) found that existing resources often lack comprehensive coverage of Arabic grammar and vocabulary, making it challenging for learners to gain a deep understanding of the language. Moreover, Yue (2024) concluded that many textbooks and instructional materials are outdated or do not incorporate modern teaching techniques. In addition, Mnisi (2023) pointed out that the limited availability of Arabic digital and multimedia learning resources restricts learners' access to and engagement in interactive and technology-driven learning processes. Consequently, the development of innovative educational resources is urgently needed to accommodate the needs and preferences of Arabic language learners. The development of Arabic language instruction through digital technologies, game-based learning, and multimedia platforms can improve the accessibility, engagement, and effectiveness of Arabic language learning.

To address these challenges, researchers such as Abdul Ghani et al. (2022), Cummins (2024), and Liao, Chang and Chan (2024) developed innovative approaches to promote more effective Arabic language learning. One major focus has been the integration of educational games into language learning curricula, as these games have strong potential to engage students and support their learning outcomes. Dehghanzadeh (2021) found that game-based learning environments stimulate learners' motivation, leading to increased student engagement, persistence, and improved outcomes. Other studies on the use of games in learning Arabic consistently show positive effects on student motivation and achievement. For example, Liao et al. (2024) discovered that game-based learning improved both motivation and achievement, while Bakan, Han and Bakan (2022) reported positive student perceptions of its implementation. Likewise, Al-Razgan and Hind (2022) and Setiyadi et al. (2022) highlighted the positive impact of game-based approaches on student achievement in Arabic orthography, suggesting that such approaches are valuable tools for enhancing students' learning experiences in Arabic language education.

Rukmini et al. (2023) stated that the transition from traditional to online and hybrid learning models after COVID-19 posed significant challenges for educational institutions in Indonesia, particularly in terms of digitalizing teaching materials. Although many schools are equipped with representative and modern learning media, the lack of digital learning resources remains a major obstacle. On the other hand, while schools may have physical resources such as textbooks, charts, and other educational aids, the shift to digital platforms is still difficult for many institutions. According to Sugianto and Ulfah (2020), the deficiency of digital learning materials significantly affects education, especially as online resources play a pivotal role in remote and blended learning experiences. Soto-Paredes and Sulla-Torres (2021) emphasized the need to digitalize language teaching materials, focusing on multimodal teaching and learning in the post-COVID-19 context.

However, Sánchez-Cruzado et al. (2021) noted that this transition requires significant improvement in teachers' digital literacy. Idris, Weda and Fansury (2023) found that using digital content, such as videos and online platforms, can effectively enhance student motivation and interest in language learning.

This research aims to address the challenges faced by Nurussalam Islamic Boarding School in Indonesia, where students' proficiency in Arabic writing has declined since the implementation of distance learning during the pandemic. One major reason, as indicated by the school principal, is the lack of technology-based teaching resources for hybrid learning. Therefore, traditional teaching resources such as textbooks and other printed materials need to be digitalized, with particular focus on engaging digital learning tools such as educational games.

Unity 3D software was used to create the educational game for Android. Since its initial release in 2005, Unity, developed by Unity Technologies, has become a widely used multi-platform game engine that supports development for desktop, mobile, console, and virtual reality platforms (Takoordyal 2020). Wang (2017) and Lee (2024) reported that its adaptability and accessibility allow even developers with limited technical experience to use Unity to produce engaging iOS and Android games. As a result, Unity is well suited for educators, as it enables them to design dynamic and appealing learning applications with little or no programming experience. Teachers can use Unity through its user-friendly interface and extensive online resources to create personalized games that address language challenges such as root identification, derivational patterns, agreement rules, and sentence structuring (Wang 2017; Lee 2024). These features directly address the contrastive difficulties between the linear word formation of English and the root-pattern morphology of Arabic, which frequently hinder the writing fluency of L2 learners.

2. Literature review

2.1 Second language output hypothesis

Second Language Acquisition (SLA) provides the basic linguistic foundation for integrating Arabic writing tasks into a game-based environment (Alsheheri and Alsalmi 2025). According to Hymes (1972), communicative competence involves not only grammatical accuracy but also the ability to use language appropriately in real contexts. In this regards, Anis et al. (2022) and Shahbari-Kassem, Schiff, and Saiegh-Haddad (2024) explained that Arabic writing is not merely about producing correct sentences; it also enables learners to express meaning, organize ideas, and respond to communicative situations. Swain (1985) suggested that language production, through speaking or writing, helps learners notice gaps in their knowledge, reflect on language structures, and experiment with new forms. This reflective process is essential in writing tasks, as learners are required to actively draw upon vocabulary, grammar, and discourse knowledge to convey meaning.

A Unity 3D-based educational Android game can provide students with an authentic communicative platform in which they must write in Arabic to progress through different levels. Such meaningful interaction encourages students to engage in active communication and linguistic development, as emphasized in

Long's interaction hypothesis (1996). Integrating writing prompts into computer programs, technology-based learning, and gameplay – such as reporting events, describing objects, or completing dialogues – provides students with genuine opportunities to use and discuss language appropriately, as highlighted by Faiz (2023), Hamdan and Abu Jaber (2009), and Griffin et al. (2020). These scholars stated that games give students a real reason to produce written work. In addition, Cavalcanti et al. (2021) and Shadiev and Feng (2023) reported that real-time feedback features in digital learning games enable learners to identify linguistic errors and improve their writing immediately. This process encourages learners to modify their output, which aligns with Swain and Lapkin (2005) concept of “pushed output,” whereby learners are prompted to produce more accurate and linguistically complex language. In conclusion, SLA theory emphasizes that writing development requires multiple opportunities for meaningful and accurate output.

2.2 Morphological awareness and L2 writing

Shamsan and Attayib (2015) and Setiyadi (2024) explained that morphological awareness (MA) has been linked in a growing body of research to higher-order literacy outcomes in Arabic diglossic contexts and L2 settings, including vocabulary development, sentence construction, and written composition. Developmental research by Shahbari-Kassem et al. (2024) indicated that MA in Arabic is sensitive to differences between spoken and standard varieties. As learners' MA increases, they become more skilled in handling inflectional and derivational processes. Furthermore, Asaad (2024) and Asli-Badarneh and Asadi (2023) found that higher MA predicts fewer agreement and derivation errors, improved cohesion, and better lexical precision in academic writing. Khan (2023) concluded that Arab learners' morpho-lexical development can be accelerated through explicit instruction, supporting targeted intervention strategies. These findings highlight the importance of MA tasks, such as root identification, pattern application, and agreement, in learning environments that emphasize writing.

Mansouri (2005) documented a staged development of agreement morphology (e.g., subject-verb agreement and gender/number agreement) in Arabic SLA studies, with high error rates and delayed stabilization under production pressure. Nassif et al. (2022) and Othman and Zepp (2025) demonstrated through eye-tracking data that focusing on verbal morphology helps students learn; however, generalizing this knowledge to new verb classes and writing tasks requires consistent practice. In addition, Eldin (2025) and Almirabi (2025) concluded that writing accuracy and fluency are negatively affected by derivation errors, tense-aspect-mood mismatches, and word-order intrusions, often due to cross-linguistic transfer. According to the error-analysis tradition, these issues are key targets for morphologically-aware interventions.

2.3 Game-based language learning motivation

Game-Based Learning (GBL), as discussed by Liao, Chang and Chan (2018), and Liao et al. (2024), demonstrates how games can improve motivation, engagement,

and persistence, which in turn can transform the learning process. Research by De Freitas et al. (2012) and Sailer et al. (2017) summarized that games combine challenge, feedback, and reward in ways that naturally sustain attention, making them effective tools for learning. Gee (2003) emphasized that games provide a low-anxiety environment for language learners to experiment with language without fear of judgment, thereby increasing their willingness to take linguistic risks. Furthermore, Waked, El Alaoui, and Pilotti (2023) and Zhou et al. (2022) concluded that games are especially valuable for L2 writers, who frequently struggle with confidence and anxiety. Incorporating writing tasks into game levels ensures that students develop their language skills in an engaging and productive environment.

According to Deci and Ryan (1985), in Self-Determination Theory, games can serve as an effective instrument for motivating language learners. When students feel autonomous, competent, and connected to a community, their motivation increases. In this study, the Unity 3D-based game incorporates these motivational components: students choose their own avatars (autonomy), receive immediate feedback on writing tasks (competence), and interact with peers or in-game characters (relatedness). While mastering new writing techniques provides intrinsic motivation, points, achievements, and progressive challenges function as extrinsic motivators. By integrating motivational theory with game mechanics, the game creates a meaningful and enjoyable language-learning environment.

2.4 Cognitive multimedia learning theory

The Cognitive Theory of Multimedia Learning, proposed by Mayer (2014), offers principles and guidelines for designing educational materials that effectively integrate verbal and visual content. According to this theory, learners absorb information more effectively when it is presented through both words and images, as this approach engages two different cognitive processing channels. When such principles and guidelines are applied to writing and multimedia technologies, they can provide rich contextual input such as pictures, sounds, and animations that enhances concept organization, sentence structure, and vocabulary recall (Syarifudin 2023; Hua et al. 2024; Sural and Sağlık 2024). For instance, a game level might depict an Arabic marketplace, requiring learners to compose a descriptive paragraph using appropriate language, thereby activating both visual and verbal processing pathways.

Mayer's framework (2002) also emphasized the importance of preventing cognitive overload by organizing content into manageable segments and aligning media elements with learning objectives. In the Android game developed using Unity 3D, each writing task is embedded within a storyline that contextualizes language use, helping learners avoid feeling overwhelmed by isolated and decontextualized drills. In line with Moreno and Mayer's (2007) principle of contiguity, the game provides direct feedback that allows learners to adjust their writing without losing focus. By incorporating visual, auditory, and textual elements, the game is designed according to multimedia learning principles, ensuring an integrated approach that supports and enhances learners' writing skills.

Despite considerable research on communicative competence, morphological awareness, game-based learning, and multimedia approaches in L2 acquisition, significant gaps remain. Previous studies have largely emphasized Arabic writing development through traditional or paper-based instruction. However, there is limited exploration of digital game-based environments tailored specifically to the unique morphological and syntactic features of Arabic. Furthermore, although the motivational benefits of digital games have been documented for language learners in general, there is a lack of empirical evidence on how such platforms – especially those developed using Unity 3D – can directly enhance Arabic root-pattern awareness, agreement, and writing fluency among young L2 learners. This study addresses these gaps by investigating the effectiveness of a morphologically-aware, multimedia-rich educational game in improving Arabic writing proficiency, thereby bridging the gap between linguistic theory, instructional technology, and practical classroom application.

Therefore, this study aims to develop a morphologically-aware, multimedia-based Android game using Unity 3D and to investigate its effectiveness in enhancing Arabic L2 writing proficiency among young learners. It begins by examining the integration of SLA principles and communicative competence in supporting meaningful written output, determining the impact of embedded morphological awareness tasks on accuracy and derivational control, evaluating the role of game-based motivational elements in fostering engagement and persistence, and assessing how multimedia learning principles facilitate cognitive processing and writing development.

3 Method

This research employed a research and development (R and D) approach using the ADDIE model, which consists of five sequential steps, as illustrated in Figure 1.

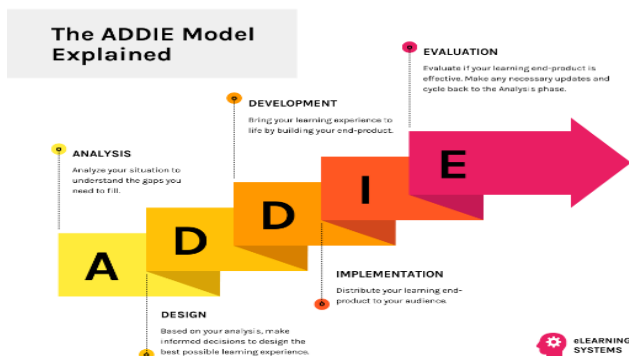


Figure 1. Research phase and procedures

The diagram illustrated the phases of the research, which were designed to answer the central research questions of this study: (1) what were the specific needs and challenges faced by students and teachers in Arabic language learning? and (2)

how effective was this interactive learning media in improving students' Arabic language skills? The first phase of the instructional design process involved a comprehensive needs analysis, focusing on the challenges encountered by both students and educators in Arabic learning. This phase utilized systematic observation, in-depth interviews, and an extensive review of relevant literature.

Subsequently, in the design phase, an audit chart was prepared and essential materials, such as images, videos, and audio elements, were compiled for integration into the learning media. The development phase then focused on creating the interactive learning medium using Unity 3D, in accordance with the design specifications established during the design stage.

The implementation stage involved a trial with fourth- and fifth-grade students at Nurussalam Islamic Boarding School. Pre-test and post-test assessments were administered to measure the effectiveness of the developed learning medium. Finally, the evaluation phase examined whether the learning medium met the intended outcomes based on student needs. Any deficiencies identified during this stage were addressed to refine the learning media, ensuring its effectiveness and efficiency in supporting teaching and learning activities.

3.1 Participants

The participants comprised all fourth- and fifth-grade students enrolled at Nurussalam Islamic Boarding School in Palembang, South Sumatra, Indonesia, with a total of 215 students. The researchers included all students in these grades, ensuring that the entire population was represented in the study. Prior to participation, consent forms were distributed to and collected from the parents of all students. The study followed ethical guidelines, including approval from the school administration. Student data were kept confidential, and participation was voluntary.

3.2 Data collection and data analysis

This study employed questionnaires, pre-tests, and post-tests as data collection instruments. The pre-test and post-test results were analyzed using three methods: descriptive statistical analysis, inferential analysis – including normality and homogeneity tests – and the Wilcoxon test to determine the differences in results between the fourth- and fifth-grade groups. All statistical analyses were conducted using SPSS version 25. Qualitative data were examined by describing features of the instructional materials and summarizing feedback from experts and teachers.

3.3 Result of need analysis

Before developing the educational media, specifically the electronic educational game, this study collected insights through interviews with key stakeholders in Arabic language education. Arabic language teachers participated in in-depth interviews and discussions to identify challenges in teaching, especially regarding students' difficulties in writing the alphabet. The school principal also provided input to clarify the specific needs of the students and the institution, particularly in improving Arabic language instruction and pedagogical practices.

The interviews revealed a shared view regarding the critical role of educational media in the learning process. The analysis showed that students primarily struggled with alphabet writing skills, while teachers lacked engaging and interactive tools to address this issue. Therefore, the main objective of this research was to develop effective educational media to support Arabic language teaching and help students overcome these identified challenges.

4. Results and discussion

4.1 Results

4.1.1 Result of designing phase

At this stage, the results of the needs analysis informed the design of the educational media, specifically the electronic educational game. The initial step involved creating an audit chart, or flowchart, to visually represent the programming flow during the application development. Kurniawan and Syakurah (2022) emphasized that such visual aids are crucial for understanding the details and processes of application development. The researchers utilized a well-known platform, namely SmartDraw.com, to construct the audit map.

A multimedia approach guided the design of the electronic game system by incorporating various components, including photography, graphics, animation, text, audio, and video. For image design, the researchers selected images from Freepik.com and refined them using Adobe Illustrator before converting the final versions into PNG format. The content map, which included these images, was also developed using Adobe Illustrator. For audio components, recordings were made using a smartphone and edited in Audacity, with the final files saved in MP3 or WAV forma.

4.1.2 Game development phase

The game was developed using Unity 2021 software, which involved several key phases: importing, organizing, and linking. The researchers imported images and audio files into the Unity program, transferring images to the Sprite category and audio files to the Audio Clip category. The images were organized according to the outlined content map, and the relevant audio was then linked to the corresponding images as required in the educational game.

The educational game was programmed in Visual Studio 2019, which facilitated the creation of instructions for each process. To increase user engagement, additional motion graphic modes and augmented animations were integrated into the Unity project.

After the development process was completed, the application was built for Android, following the structure defined in the audit map of the product development. The installation of the Software Development Kit (SDK) and Native Development Kit (NDK) was completed as required. The researchers then tested the application on the device and corrected any identified issues to ensure that the final product was fully functional and user-friendly on the Android platform.

4.1.3 Game display

To improve clarity, this study describes the user interface of the electronic game developed using the Unity program. The program features several distinct screens, each serving a specific purpose. The initial screen includes the Start screen and Student Information screen, as shown on the left side of Figure 2. A prominent button on this screen allows users to begin the game. Furthermore, the Main Screen, shown on the right side, marks the official start of the program. From this screen, users can navigate to the Degree Options screen by clicking a designated button. This feature enables players to select their desired options and proceed into the game.

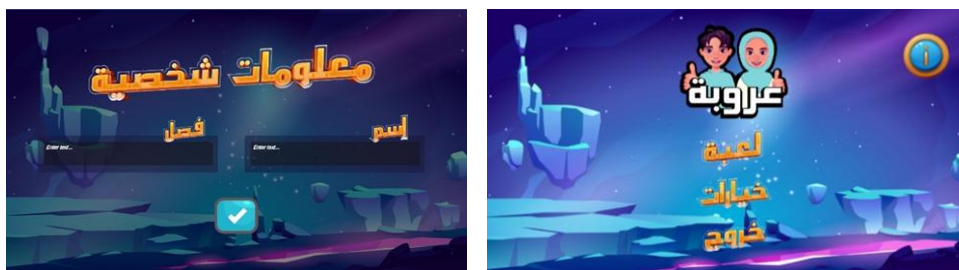


Figure 2. Start screen, student information, and main screen options

The subsequent display, shown in Figure 3, presents the Class or Ability Level selection screen and the Topic Options screen, which allows players to choose the lesson topic they wish to study. The first screen, shown on the left side, guides players through the necessary steps before entering the game. A dedicated classroom selection button provides access to the game options, allowing players to select their preferred level. The second screen, shown on the right side, supports easy navigation and ensures a smooth and user-friendly learning experience.

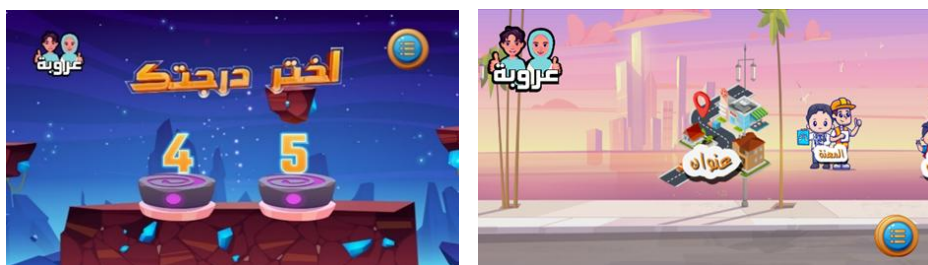


Figure 3. Level with class options and topic options of the lesson

The Learning Screen, shown in Figure 4, serves as a dedicated space to help students understand the lesson content. For example, it demonstrates the different

forms of the Arabic letter *Alif* at the beginning, middle, and end of words, as illustrated in the figure.

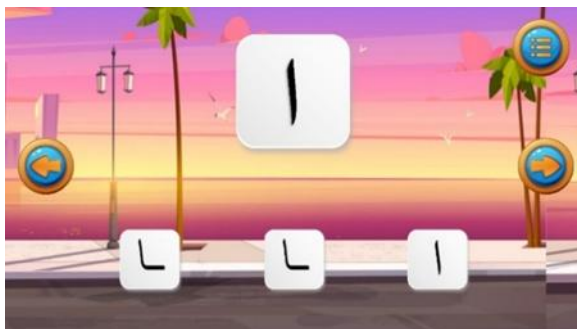


Figure 4. Lesson explanation sample

The Evaluation and Lesson Review Screen, shown in Figure 5, organizes educational materials for easy access. Students can navigate through the content using next and back buttons or by interacting with on-screen items. This screen allows students to conduct a comprehensive review of the lessons they have learned.

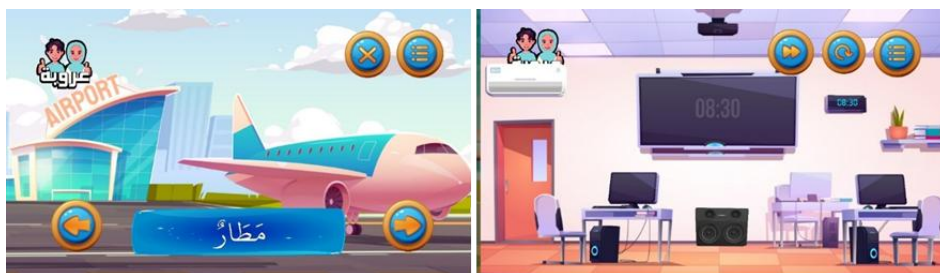


Figure 5. Lesson evaluation

The Game Screen features three interactive games designed to engage students. The first game, “Coin Catcher,” challenges players to collect coins using in-game markers. The second game, “Arrange the Word,” requires players to arrange alphabet letters to match a given picture. The third game, “Connect,” asks students to drag letter images to predetermined positions on subject images according to color. This sequence of activities creates a structured and enjoyable educational experience, as shown in Figure 6.



Figure 6. Game screen “Coin Catcher”

4.1.4 Implementation result

After the design process was completed, the product underwent expert validation and a feasibility test. Experts in design, educational curriculum content, and language were interviewed to assess the validity of the program. The results indicated that the learning media was highly effective, with an average score of 94 percent (categorized as very valid), and could be implemented with only minor modifications. The following section summarizes these results.

Table 1. Validator assessment results

| No | Validator (N) | Score (X) % | Quality |
|----|----------------------------|-------------|------------|
| 1 | Validator – 1 (Design) | 94 | Very Valid |
| 2 | Validator – 2 (Language) | 96 | Very Valid |
| 3 | Validator – 3 (Content) | 97 | Very Valid |
| 4 | Validator – 4 (Instructor) | 95 | Very Valid |
| | Average | 96,4 | Very Valid |

The product was then implemented in the teaching and learning process. The implementation consisted of seven steps, beginning with an introduction and ending with assessment and reflection. The following images illustrate these steps.

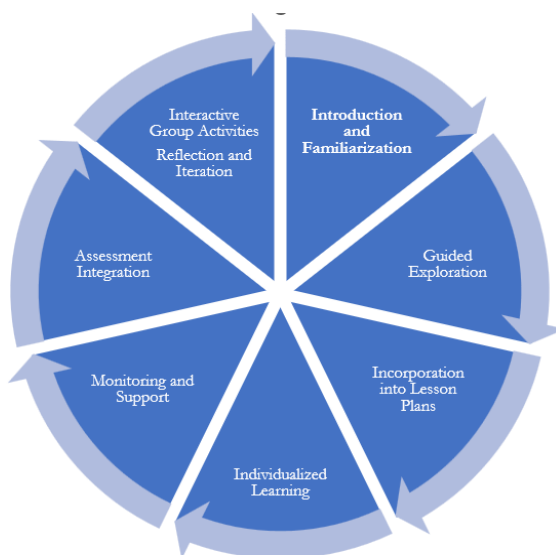


Figure 7. Teaching and learning process

Figure 7 showed the initial phase of integrating URUBAH into the Arabic language curriculum. The teacher began with a comprehensive introduction, explaining the platform's purpose and highlighting its interactive features. The connection between URUBAH and curriculum goals was emphasized to enhance student engagement in the learning experience.

In the following phase, the teacher led a guided exploration of URUBAH's features, demonstrating how to navigate the platform and access its educational materials. This phase ensured that students were able to use the platform effectively. URUBAH was then incorporated into lesson plans, assisting teachers in identifying specific topics and language skills to reinforce through interactive content. As a result, the lessons became more engaging and dynamic.

By recognizing students' diverse learning needs, teachers encouraged individualized use of URUBAH, allowing students to explore topics at their own pace. Teachers monitored student progress directly, identified strengths and areas for improvement, and provided targeted support when necessary.

Assessment on the URUBAH platform was conducted using pre-tests and post-tests to measure students' comprehension and progress. The results of students' tests informed instructional adjustments for both individuals and groups. Collaborative features within URUBAH supported group activities and encouraged teamwork and communication skills among students. Students regularly provided feedback on their experience with URUBAH, and teachers used this feedback to refine lesson plans and improve the platform's integration into instruction. Reflection sessions were also held to discuss students' learning experiences and to make ongoing adjustments to lesson plans and instructional strategies. These processes ensured that the use of URUBAH remained dynamic and responsive, ultimately enriching students' learning journey.

4.1.5 Implementation result

The implementation of the URUBAH game resulted in a substantial improvement in student performance. The mean score increased from 5.12 on the pre-test ($M = 5.12$) to 7.76 on the post-test ($M = 7.76$). This positive shift underscores the game's effectiveness in enhancing students' Arabic language proficiency. The improvement is further supported by an increase in median values from 5.00 to 8.00.

Table 2 presents a comprehensive summary of the pre-test and post-test results. The pre-test yielded a mean score of 5.12 with a standard deviation of 1.549, whereas the post-test mean increased to 7.76 with a lower standard deviation of 1.394. The reduction in standard deviation indicates a more consistent performance among students following the intervention. Additional distribution measures, including skewness, mode, and median values, further illustrate the positive impact of the intervention on students' writing performance.

Table 2. Statistics of the pretest and posttest results

| | | <i>Pretest</i> | <i>Posttest</i> |
|---------------------------|---------|----------------|-----------------|
| <i>N</i> | Valid | 215 | 215 |
| | Missing | 0 | 0 |
| <i>Mean</i> | | 5.12 | 7.76 |
| <i>Std. Error of Mean</i> | | .239 | .215 |
| <i>Median</i> | | 5.00 | 8.00 |
| <i>Mode</i> | | 6 | 7 ^a |
| <i>Std. Deviation</i> | | 1.549 | 1.394 |

The Kolmogorov-Smirnov test presented in Table 3 indicates that both the pre-test data ($p = 0.005$) and post-test data ($p = 0.040$) were not normally distributed at the 0.05 significance level. However, the Shapiro-Wilk test showed that the pre-test data ($p = 0.069$) were approximately normally distributed, whereas the post-test data ($p = 0.021$) were not normally distributed.

Table 3. Tests of normality for pretest and posttest data

| | <i>Kolmogorov-Smirnov^a</i> | | | <i>Shapiro-Wilk</i> | | |
|-----------------|---------------------------------------|-----|------|---------------------|-----|------|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| <i>Pretest</i> | .168 | 215 | .005 | .951 | 215 | .069 |
| <i>Posttest</i> | .139 | 215 | .040 | .936 | 215 | .021 |

a. Lilliefors Significance Correction

Although some deviation from normality was observed, the relatively large sample size allowed greater emphasis on central tendency measures. Furthermore, Levene's Test for Homogeneity of Variances indicated no significant difference in

error variance between the pre-test and post-test scores, suggesting that the assumption of homogeneity was satisfied. The results of the homogeneity test are presented in the following table.

Table 4. Result of Levene's test for homogeneity of variances

| | | <i>Levene Statistic</i> | <i>df1</i> | <i>df2</i> | <i>Sig.</i> |
|--|---|-----------------------------|------------|------------|-------------|
| <i>Result</i> | Based on Mean | .633 | | 82 | .428 |
| | Based on Median | .750 | | 82 | .389 |
| | Based on Median and with adjusted df | .750 | | 81.995 | .389 |
| | Based on trimmed mean | .678 | | 82 | .413 |
| <i>Tests the null hypothesis that the error variance of the dependent variable is equal across groups.</i> | | | | | |
| <i>a. Dependent variable: result</i> | | | | | |
| <i>b. Design: Intercept + Test</i> | | | | | |

To determine whether there was a statistically significant difference between pre-test and post-test scores, the Wilcoxon Signed-Ranks Test was employed. As shown in Table 5, the analysis revealed a significant difference between the two sets of scores ($Z = -5.386$, $p < 0.001$). The decision to use this non-parametric test was based on the normality results: while the pre-test scores were approximately normally distributed (Shapiro-Wilk $p = 0.069$), the posttest scores deviated significantly from normality (Shapiro-Wilk $p = 0.021$). Therefore, the Wilcoxon test, which does not require the assumption of normal distribution, was considered the most appropriate statistical procedure for this analysis.

Additionally, the effect size was calculated to determine the practical significance of the findings. Using the formula ($r = \frac{Z}{\sqrt{N}}$), where $Z = -5.386$ and $N = 42$, the effect size was found to be ($r = \frac{-5.386}{\sqrt{42}} \approx -0.83$). This value indicates a large effect size. Although the negative Z value reflects the direction of the difference (post-test scores exceeding pre-test scores), the magnitude of r confirms a substantial improvement in student performance following the intervention. This large effect demonstrates the strong practical impact of the URUBAH game on learners' Arabic writing development. These findings suggest the importance of further exploring the game's features and its integration into instructional methodologies to better understand how it enhances learning outcomes.

In conclusion, the results confirm that the URUBAH game effectively improves L2 Arabic writing skills by increasing learners' awareness of word formation and morphological structure. Both descriptive and inferential analyses revealed significant improvements in students' ability to manipulate roots, apply

derivational patterns, and maintain grammatical agreement, resulting in greater accuracy and fluency in writing.

Table 5. Test of Wilcoxon Signed Ranks result

| <i>Test Statistics^a</i> | |
|--------------------------------------|---------------------------|
| | <i>Posttest - Pretest</i> |
| <i>Z</i> | <i>-5.386^b</i> |
| | |
| <i>Asymp. Sig. (2-tailed)</i> | <i><.001</i> |
| <i>a. Wilcoxon Signed Ranks Test</i> | |
| <i>b. Based on negative ranks.</i> | |

The Unity 3D-based Android game successfully addresses the challenges posed by Arabic's root-pattern morphology, which differs fundamentally from English's predominantly linear word formation system. By incorporating these linguistic features and interactive writing activities, the game bridges an important gap in cross-linguistic pedagogy.

These findings validate the effectiveness of the developed game in supporting Arabic writing development among fourth- and fifth-grade students at Nurussalam Islamic Boarding School. Furthermore, they highlight the potential of morphologically-aware, game-based learning as a powerful pedagogical approach. Future enhancements may include the integration of more advanced syntactic and stylistic components, further combining contrastive linguistic insights with digital learning technologies.

4.2 Discussion

The development of the URUBAH game using Unity 3D represents an innovative and transformative approach to contemporary Arabic language learning. By integrating images, sounds, text, and animations, the game creates a multimodal and sensory-rich learning environment that supports effective language acquisition. With a particular focus on writing skills aligned with the school curriculum, the game enhances linguistic proficiency among non-native learners of Arabic. This finding aligns with Kaplan-Rakowski et al. (2024), who emphasize the effectiveness of sensory-rich digital environments in facilitating language acquisition.

The results of this study further highlight the essential role of morphological awareness in improving L2 Arabic writing. Learners demonstrated significant improvement in recognizing Arabic roots, applying derivational patterns, expanding lexical repertoire, and increasing overall writing accuracy. These findings confirm that systematic engagement with the root-pattern system enhances vocabulary precision and writing coherence. This supports Shahbari-Kassem's (2024) claim that morphological awareness significantly predicts learning outcomes in Arabic.

Moreover, agreement-oriented exercises embedded in the game contributed to a noticeable reduction in common grammatical errors, particularly those related to subject-verb agreement and gender-number concord, a finding consistent with Mansouri (2005). Additionally, the provision of immediate feedback within the game reinforced correct inflectional choices and usage, supporting Asaad's (2024) assertion that timely corrective feedback strengthens morphological accuracy and learner retention.

The persistent cross-linguistic transfer difficulties related to word order were addressed through sentence-building tasks that incorporated derivation, agreement, and word-order modification. This approach assisted students in learning and mastering Arabic's flexible Verb-Subject-Object (VSO) and Subject-Verb-Object (SVO) patterns, thereby reducing transfer-related errors. Bobeck (2025) and Shalhoub-Awwad and Leikin (2016) argue that improvements in writing fluency are closely linked to learners' morphological competence. In addition, Asaad (2024) and Shahbari-Kassem et al. (2024) confirm that mastery of root-pattern processes improves lexical diversity and grammatical accuracy in writing.

Furthermore, the findings are consistent with Processability Theory, which posits a sequential development of inflectional features in second language acquisition. The results demonstrate that game-based learning can accelerate the language acquisition through enhancement of morphological awareness.

Regarding concerns about excessive screen time and digital safety for young learners, Martin et al. (2023) proposes practical solutions, including the implementation of content filters, usage limitations, and parental monitoring systems. Dehghanzadeh et al. (2021) found that game-based learning environments foster intrinsic motivation and enhance both engagement and persistence. Similarly, Liao et al. (2024), Qiao et al. (2022), and Abdul Ghani et al. (2022) reported that gamification positively influences academic achievement and learner motivation. Bakan et al. (2022) further highlighted positive student perceptions and measurable improvements in Arabic orthography through the use of educational games. Collectively, these studies reinforce the transformative potential of games such as URUBAH in language education.

The *URUBAH* game emphasizes usability and interactivity by incorporating an intuitive interface and engaging visual design. As noted by Thwairan (2024), such design principles can help overcome barriers to technology adoption in educational contexts. In addition, Hwang et al. (2024) and Tekin (2024) highlight the potential benefits of Mobile-Assisted Language Learning (MALL) in supporting flexible and accessible language instruction. In line with these perspectives, *URUBAH* integrates mobile-compatible features and real-time feedback mechanisms to enhance instructional effectiveness, broaden accessibility, and tailor learning experiences to students' individual needs.

Furthermore, the evaluation metrics from this study indicate that *URUBAH* is highly effective. Expert reviewers rated the application at 96.4 percent, while teachers and students assigned "very good" ratings of 89 percent and 89.5 percent, respectively. These findings align with Liao et al. (2018), Abdul Ghani et al. (2022),

and Richardson (2024), who report that well-structured and engaging educational games sustain learner interest and lead to improved academic outcomes.

5. Conclusion and recommendation

In conclusion, the innovative educational game URUBAH demonstrates promising outcomes for Arabic language learning. The positive impact on students' language proficiency is evidenced by significant improvements in test scores, strong effect size results, and high validation ratings from experts, teachers, and students. These findings underscore the potential of integrating technology into language education.

Despite these encouraging results, several limitations should be acknowledged. The study was conducted within a localized sample, the intervention period was relatively short, and the data relied primarily on quantitative measures. These limitations suggest the need for broader and more comprehensive research designs in future investigations. Nevertheless, the strong practical orientation of the game, combined with positive stakeholder feedback, positions URUBAH as a meaningful innovation in educational technology for Arabic language instruction. The study offers valuable insights for educators, researchers, and policymakers seeking to enhance language learning through interactive and engaging digital tools. Future research should expand the implementation of URUBAH to more diverse learner populations and educational contexts. Longer intervention periods are recommended to examine sustained improvements in Arabic language proficiency over time. Additionally, qualitative measures such as learner reflections, interviews, and classroom observations should be incorporated to provide deeper insight into the cognitive, linguistic, and motivational processes underlying performance gains. Teachers are encouraged to use the game as a supplementary instructional tool to provide interactive and enjoyable practice alongside traditional lessons, particularly to strengthen students' writing skills and morphological accuracy. For policymakers and curriculum developers, the findings highlight the importance of investing in technology-enhanced educational resources that address the distinctive linguistic features of Arabic, especially its root-pattern morphological system.

Finally, future studies may explore the game's adaptability across different proficiency levels, linguistic competencies, and cross-linguistic backgrounds. Such investigations would contribute to the expanding field of digital, game-based learning in Arabic as both a foreign and second language and further refine the integration of linguistic theory with educational technology.

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