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AN AI-BASED FRAMEWORK FOR ASSESSING ENGLISH LANGUAGE GAME-BASED LEARNING APPLICATIONS FOR KINDERGARTEN EDUCATION IN THE UAE

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Abstract:
The integration of game-based learning into educational applications has revolutionized traditional pedagogical approaches by enhancing engagement and learning outcomes. This study presents an assessment platform for game-based educational applications, evaluating their effectiveness through a structured framework based on design, usability, engagement, and learning impact. A systematic literature review and meta-analysis were conducted to identify key assessment criteria, ensuring a rigorous evaluation methodology. The findings highlight best practices, challenges, and recommendations for optimizing educational game development. The proposed framework aims to guide educators, developers, and policymakers in implementing high-quality, engaging, and pedagogically effective educational games.

Keywords: artificial intelligence; game-based learning; English language learning; educational technology evaluation; early childhood education

1. Introduction

The rapid development of digital technologies has significantly transformed educational practices, particularly in early childhood education. Traditionally, learning in kindergarten environments relied primarily on face-to-face instruction, structured classroom activities, and teacher-centered approaches. While this model has been effective for foundational education, it often struggles to accommodate the diverse learning needs and engagement levels of young learners. Digital learning technologies,

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especially mobile devices and educational applications, have increasingly been introduced to complement traditional teaching methods and provide more interactive learning opportunities (Mueller *et al.*, 2020). The integration of digital tools in early childhood education has enabled children to access learning materials beyond the physical classroom, allowing greater flexibility and supporting individualized learning experiences.

2. Literature Review

Smartphones and tablets have played a key role in expanding access to digital learning resources for young learners. Mobile technologies provide portable and interactive platforms that enable children to engage with educational content anytime and anywhere. These technologies have contributed to the rapid growth of educational applications designed specifically for early childhood learning. Research indicates that mobile learning environments can enhance children's motivation, engagement, and autonomy by providing interactive multimedia content and immediate feedback (Papadakis, 2021). In addition, mobile applications designed for early learners often incorporate multimodal learning features—such as audio, animation, and touch interaction—that support different learning styles and improve knowledge retention (Hirsh-Pasek *et al.*, 2015).

One of the most influential developments in digital learning environments is the use of game-based learning (GBL). Game-based learning refers to the use of game design principles and interactive elements to facilitate learning processes and improve learner engagement. By integrating elements such as challenges, rewards, storytelling, and progress tracking, game-based learning environments create immersive learning experiences that motivate learners to actively participate in the learning process (Plass *et al.*, 2020). Research has consistently shown that digital game-based learning can improve learners' motivation, engagement, and academic performance across various educational levels (Sung *et al.*, 2021). In early childhood education, game-based learning is particularly effective because it aligns with children's natural learning behaviors, which often involve exploration, play, and experimentation.

Play is widely recognized as a fundamental mechanism through which young children develop cognitive, linguistic, and social skills. Digital games extend traditional play by creating structured environments where children can practice language skills in interactive and feedback-rich contexts. For language learning in particular, educational games provide opportunities for repeated exposure to vocabulary, pronunciation practice, and contextualized language use. Research on digital game-based learning for language education suggests that interactive learning environments can enhance vocabulary acquisition, listening comprehension, and language retention among young learners (Samur, 2019). Educational games also support learners' motivation and confidence by allowing them to practice language skills in low-risk environments where mistakes are treated as part of the learning process.

High-quality game-based learning environments typically focus on specific learning outcomes such as phonological awareness, vocabulary development, listening comprehension, and narrative understanding. Multimedia learning features—including visual animation, audio feedback, and interactive tasks—support young learners in processing and retaining new information. Empirical research has demonstrated that mobile educational games can significantly improve children's vocabulary learning and motivation in language learning contexts (Elaish *et al.*, 2019). These findings highlight the potential of game-based learning applications as effective tools for supporting early language development.

Despite the educational benefits of digital game-based learning, several challenges remain regarding the selection and evaluation of educational applications. The rapid growth of mobile educational applications has created a large and diverse marketplace in which the quality of educational content varies widely. Some applications prioritize entertainment over educational value, while others lack effective instructional design or user-friendly interfaces. Studies on educational application design emphasize that usability, instructional quality, and engagement mechanisms are critical factors influencing the effectiveness of digital learning tools (Hirsh-Pasek *et al.*, 2015). Consequently, educators and institutions face increasing difficulties in identifying applications that effectively support learning objectives.

Another important consideration is the role of artificial intelligence (AI) in educational technologies. AI technologies have increasingly been integrated into digital learning environments to provide adaptive learning experiences, automated feedback, and personalized instruction. AI-driven educational systems can analyze learner behavior and performance data to adapt learning activities to individual learners' needs. Research on AI in education highlights the potential of intelligent learning systems to improve learning outcomes by providing personalized support and data-driven insights into learner progress (Zawacki-Richter *et al.*, 2019). In the context of game-based learning, AI technologies can enhance educational games by adjusting task difficulty, tracking learner progress, and providing adaptive feedback.

The integration of AI into educational technology has also led to the development of intelligent decision-support systems that assist educators and institutions in evaluating digital learning tools. Multi-criteria decision-making (MCDM) methods have been widely used to assess complex systems involving multiple evaluation criteria. These methods enable researchers and decision-makers to evaluate alternatives based on several attributes simultaneously and determine the most appropriate option for a given context. Distance-based decision-making approaches, such as the Evaluation based on Distance from Average Solution (EDAS) method, allow objective comparison of alternatives by measuring their relative distance from an ideal solution (Keshavarz-Ghorabaee *et al.*, 2016). Such approaches can significantly improve the reliability and transparency of evaluation processes.

In the context of the United Arab Emirates, English language learning plays an important role in early childhood education due to the country's multicultural

environment and global educational orientation. English is widely used as a medium of instruction and communication in many educational and professional contexts. However, traditional classroom instruction alone may not always provide the interactive and individualized learning experiences needed for effective language acquisition among young learners. Game-based learning applications offer an opportunity to enhance language learning by providing engaging and interactive environments where children can practice language skills through play.

Despite the increasing availability of English language learning applications for young learners, there remains a significant gap in systematic methods for evaluating the quality and suitability of these applications. Existing research highlights the importance of structured evaluation frameworks that consider pedagogical effectiveness, usability, engagement mechanisms, and technological performance. Without such frameworks, educators and decision-makers may struggle to identify high-quality applications that effectively support learning outcomes. Therefore, the development of an AI-based assessment framework represents an important step toward improving the evaluation and selection of English language educational games for kindergarten education.

Overall, the literature suggests that combining game-based learning principles with artificial intelligence and systematic evaluation methods can significantly enhance digital learning environments. By integrating pedagogical considerations, technological capabilities, and structured evaluation techniques, AI-based frameworks have the potential to improve the design, assessment, and implementation of educational game applications for early childhood language learning.

In order to set the direction of this research, the following research questions are raised:

1) What specific requirements should be considered when developing an AI-based framework assessment methodology tailored for English language educational games designed for **kindergarten** learners in the UAE?
2) To what extent does the proposed AI-based framework assessment methodology enhance the evaluation and selection of English language educational games for **kindergarten** education in the UAE?

3. Material and Methods

This study employs a mixed-method, multi-phase research design to develop and validate an AI-based framework for assessing English language game-based learning (GBL) applications used in kindergarten education in the UAE. The design integrates an exploratory component (systematic investigation of scholarly literature and real-world apps), a descriptive component (structured expert input and document analysis), and an analytical component (fuzzy logic and multi-criteria decision-making computations). Methodologically, the study follows a top-down pipeline in which evidence and expert judgments are transformed into a reproducible evaluation model using Fuzzy Delphi for criteria confirmation (Ishikawa *et al.*, 1993), FWZIC for consistent criterion weighting

(Mohammed *et al.*, 2022), and CODAS for app evaluation and ranking based on distance from a negative-ideal solution (Ghorabaee *et al.*, 2016). This combination is suitable for early childhood app assessment because it systematically converts subjective linguistic judgments into mathematically tractable values while maintaining transparency and replicability in the final ranking outcomes (Ishikawa *et al.*, 1993; Ghorabaee *et al.*, 2016).

The UAE context reinforces the relevance of an AI-enabled quality assurance approach, as national policy promotes AI integration in public services and education, including the development of evaluative and decision-support capabilities for digital transformation (UAE AI Office, 2017/updated; UAE Government, 2024). In addition, early childhood education guidance in Dubai emphasizes structured quality dimensions that are closely aligned with app evaluation concerns (e.g., learning experiences, inclusion, and developmentally appropriate practices), supporting the need for a systematic framework that can be used by educators and stakeholders to appraise learning technologies consistently (KHDA, 2026). Accordingly, the methodology is designed to produce an evaluation framework that is both context-sensitive to UAE kindergarten priorities and algorithmically validated to minimize inconsistency and bias in decision-making (Mohammed, 2022; UAE AI Office, 2017/updated).

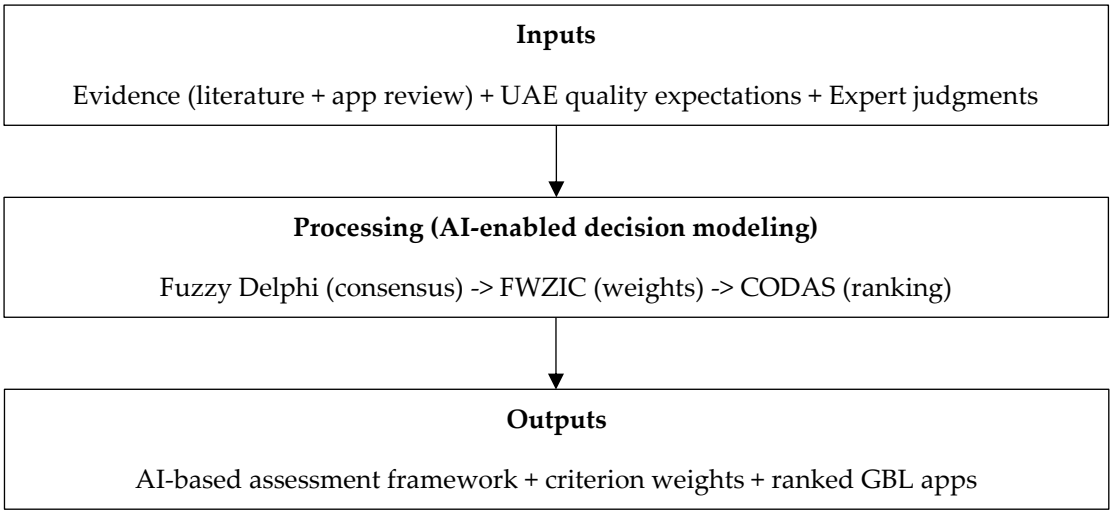
3.1 Research design framework and sequential phases

The research is organized into **five sequential phases** that move from criteria discovery to computational validation. Phase 1 identifies candidate evaluation criteria through structured review and content analysis, while Phase 2 refines and confirms those criteria through expert consensus using fuzzy integration to handle uncertainty in linguistic responses (Ishikawa *et al.*, 1993). Phase 3 determines the relative importance of each criterion using FWZIC, a weighting approach designed to reduce inconsistency in expert-derived weights and to produce stable normalized coefficients for downstream evaluation (Mohammed, 2022). Phase 4 constructs the operational framework by integrating the weighted criteria into core assessment modules, creating an interpretable scoring logic suitable for practical app assessment. Phase 5 validates applicability by ranking real GBL applications using CODAS, which compares alternatives using Euclidean distance as the primary measure and Taxicab distance as a secondary measure when Euclidean distances are too similar to discriminate reliably (Ghorabaee *et al.*, 2016). This phased design strengthens methodological coherence by ensuring that the criteria are evidence-driven, expert-validated, and algorithmically tested before final interpretation and recommendations are produced (Ishikawa *et al.*, 1993; Ghorabaee *et al.*, 2016).

Table 1: Phases, methods, and outputs (integrated)

Phase	Purpose	Core method(s)	Main output
Phase 1: Investigation	Identify candidate criteria from evidence and practice	Literature/app content analysis	Preliminary criteria set
Phase 2: Criteria validation	Confirm relevance and remove redundancy through consensus	Fuzzy Delphi (Ishikawa *et al.*, 1993)	Final validated criteria
Phase 3: Weighting	Compute consistent importance weights	FWZIC (Mohammed, 2022)	Normalized criterion weights
Phase 4: Framework development	Build the framework modules and scoring logic	Criteria-to-module integration	Operational framework model
Phase 5: Validation/ranking	Evaluate and rank apps to test framework utility	CODAS (Ghorabaee *et al.*, 2016)	Ranked apps + validation evidence

Figure 1: Methodological flow (inputs → processing → outputs)



3.2 Phase procedures

Phase 1 (Investigation) establishes the evidence base by synthesizing peer-reviewed research and examining commonly used English-learning GBL applications for kindergarten learners. This phase produces candidate criteria by identifying recurring quality dimensions and gaps in existing evaluation approaches. The emphasis on UAE alignment is justified because national strategies encourage AI-supported transformation in education systems and the broader public sector, implying a policy-driven need for structured evaluation tools (UAE AI Office, 2017/updated; UAE Government, 2024). In parallel, early childhood quality frameworks emphasize developmentally appropriate, inclusive, and structured learning experiences, which provide a credible reference point for shaping app criteria and modules (KHDA, 2026).

Phase 2 (Criteria validation) applies the **Fuzzy Delphi Method**, which strengthens the traditional Delphi process by integrating fuzzy set theory to convert linguistic ratings (e.g., "important," "very important") into fuzzy numbers that can be aggregated and defuzzified to determine consensus-level inclusion decisions (Ishikawa *et al.*, 1993). This is particularly appropriate for app-quality criteria such as usability, engagement, and appropriateness, because expert opinions often involve uncertainty and subjective interpretation that must be captured without forcing overly precise judgments (Ishikawa *et al.*, 1993). The output of this phase is an expert-validated set of criteria suitable for weighting and ranking.

Phase 3 (Weighting) uses **FWZIC** to compute relative criterion importance. FWZIC is applied because it is designed to reduce inconsistency that can occur when experts assign different importance levels across criteria, and it produces normalized weights that are stable for downstream MCDM evaluation (Mohammed, 2022). The resulting weights serve as the core quantitative representation of expert priorities in the UAE kindergarten English GBL assessment context, enabling the framework to reflect human judgment while remaining computationally consistent (Mohammed, 2022).

Phase 4 (Framework development) integrates validated criteria and FWZIC weights into an operational framework architecture. The framework is structured into practical assessment modules so that results are interpretable for educators and decision-makers, rather than remaining purely algorithmic. This design choice reflects the applied purpose of the study: to deliver a tool that supports quality assurance decisions consistent with UAE digital transformation priorities (UAE AI Office, 2017/updated; UAE Government, 2024) and early childhood quality expectations (KHDA, 2026).

Phase 5 (Validation and ranking) applies **CODAS** to evaluate and rank selected English GBL applications using the weighted criteria. CODAS is used because it assesses alternatives based on their distances from a negative-ideal solution, primarily using Euclidean distance and applying Taxicab distance when Euclidean values are not sufficiently discriminative (Ghorabaee *et al.*, 2016). This distance-based logic supports robust ranking, particularly when apps have similar performance across multiple criteria. The validation output is therefore not only a ranked list of applications but also evidence that the framework can generate meaningful discrimination and decision support consistent with the adopted weighting structure (Ghorabaee *et al.*, 2016; Mohammed, 2022).

4. Results and Discussion

4.1 What specific requirements should be considered when developing an AI-based framework assessment methodology tailored for English language educational games designed for kindergarten learners in the UAE?

The results of the framework development and criteria analysis identified seven essential requirements that should be incorporated into an AI-based framework for evaluating English language educational games for kindergarten learners. These requirements include design, time, score, progress, report, face validity, and usability. Each of these criteria contributes to assessing both the technical quality and educational effectiveness of learning applications designed for young children.

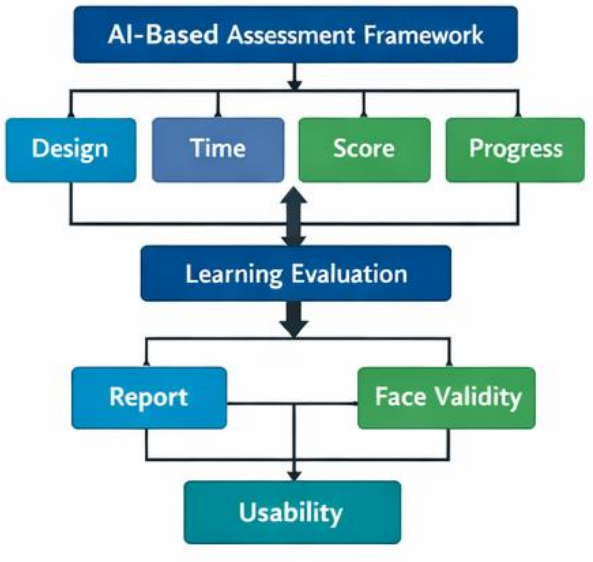
The design criterion evaluates the graphical interface, visual attractiveness, and interactive elements of the game. Since kindergarten learners rely heavily on visual cues and interactive engagement, the design must be intuitive, colorful, and child-friendly. The time criterion assesses how learning activities are structured within the game, ensuring that tasks are appropriate for the attention span and cognitive abilities of young learners. Educational games designed for kindergarten learners should present short, engaging activities rather than lengthy or complex tasks.

The score criterion focuses on the scoring system used within the application to measure learner performance. Scoring mechanisms often include rewards, points, badges, or other motivational elements that encourage continuous engagement. The progress criterion tracks learner development through levels, achievements, and completed tasks. This element is particularly important for monitoring learning advancement and maintaining learner motivation.

Another critical requirement is the report criterion, which provides feedback regarding learner performance. Reports may include information about completed tasks, accuracy levels, and areas requiring improvement. These reports are valuable for educators and parents who monitor children's learning progress. In addition, the face validity criterion ensures that the educational content of the game aligns with the intended English language learning objectives for kindergarten learners. Finally, usability evaluates the ease of use and accessibility of the application, including navigation simplicity and child-friendly interaction.

The integration of these seven criteria forms the core structure of the proposed framework. As illustrated in Figure 1, the proposed framework organizes the evaluation criteria into a structured hierarchy that collectively supports the comprehensive assessment of educational game applications. The figure shows that the evaluation begins with the AI-based assessment framework, which incorporates key game elements such as design, time, score, and progress. These elements influence the learning evaluation process, which subsequently generates feedback through reports while ensuring the educational content maintains face validity and usability. This hierarchical structure demonstrates that the framework evaluates not only the technical aspects of the game but also its pedagogical value and learner interaction quality.

Figure 1: Conceptual structure of the AI-based educational game assessment framework.



5.2 To what extent does the proposed AI-based framework assessment methodology enhance the evaluation and selection of English language educational games for kindergarten education in the UAE?

The results show that the proposed AI-based framework significantly improves the evaluation and selection process of English language educational games by incorporating advanced multi-criteria decision-making techniques. Specifically, the framework integrates the Fuzzy-Weighted Zero-Inconsistency (FWZIC) method and the Combinative Distance-Based Assessment (CODAS) method.

The FWZIC method is applied to determine the relative importance of evaluation criteria. This method eliminates inconsistencies in expert judgments and produces reliable weights for each criterion. By using fuzzy logic principles, the FWZIC method converts qualitative expert opinions into quantitative values, ensuring that the weighting process accurately reflects expert consensus.

After determining the weights of the evaluation criteria, the CODAS method is applied to rank the educational applications. CODAS evaluates alternatives by measuring their distance from an ideal solution, allowing for objective comparison among applications. Applications with shorter distances from the ideal solution are considered more suitable for educational purposes.

Figure 2: Evaluation process of the AI-based framework using FWZIC and CODAS

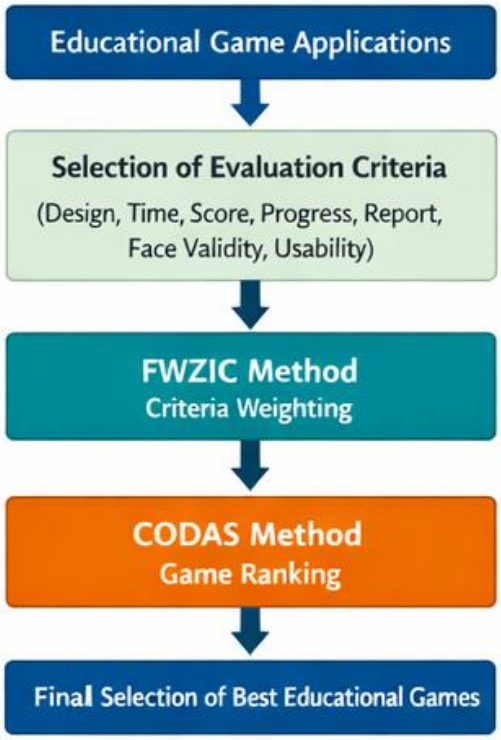


Figure 2 illustrates the step-by-step evaluation process of the proposed framework. The process begins with identifying educational game applications and defining evaluation criteria. These criteria are then weighted using the FWZIC method. After weighting, the CODAS method is used to rank the educational applications based on their performance across the selected criteria. The final outcome is the identification of the most suitable educational games for kindergarten English language learning.

Figure 3: AI-based decision-making model for ranking educational game applications

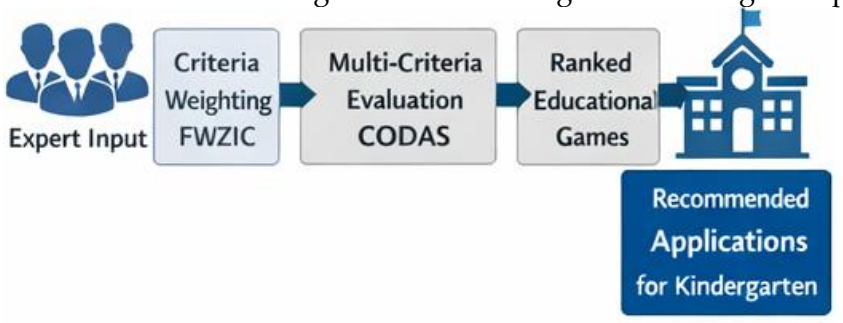


Figure 3 illustrates the decision-making architecture of the proposed framework. The model begins with expert input, which is used to determine the weights of evaluation criteria through the FWZIC method. The weighted criteria are then applied within a multi-criteria evaluation process using the CODAS method. The model ultimately produces a ranked list of educational games, allowing educators and policymakers to identify the most appropriate applications for kindergarten education. The integration of

FWZIC and CODAS ensures that the evaluation process is systematic, transparent, and data-driven. By transforming expert judgments into measurable values and applying a structured ranking mechanism, the proposed framework enhances the reliability and objectivity of selecting English language educational games for kindergarten learners in the UAE.

The findings of this study demonstrate that evaluating English language game-based learning applications for kindergarten learners requires a multidimensional framework that integrates pedagogical, technological, and usability considerations. The results identified seven essential evaluation criteria—design, time, score, progress, report, face validity, and usability—which collectively ensure that educational games are both pedagogically meaningful and developmentally appropriate for young learners. These findings are consistent with research indicating that effective digital game-based learning environments must balance instructional quality with engaging interactive design to sustain learner motivation and support knowledge acquisition. In early childhood contexts, well-designed educational games can enhance language acquisition, cognitive development, and learner engagement when they incorporate clear learning objectives, appropriate feedback mechanisms, and visually stimulating interfaces (Plass *et al.*, 2020; Sung *et al.*, 2021).

The importance of design and usability highlighted in this study reflects the broader literature on digital learning environments, which emphasizes that interface quality and ease of interaction significantly influence learning outcomes, particularly among young learners who rely heavily on visual and intuitive cues. Educational applications designed for preschool children must provide simple navigation structures, engaging graphics, and immediate feedback to maintain attention and facilitate understanding. Research on early childhood digital learning environments has demonstrated that usability and interface design are among the strongest predictors of engagement and learning effectiveness in game-based learning systems (Hirsh-Pasek *et al.*, 2015; Papadakis, 2021). By including these dimensions within the proposed framework, the present study ensures that evaluation extends beyond instructional content to include the overall learning experience provided by the application.

A major methodological contribution of this study lies in the integration of artificial intelligence-supported multi-criteria decision-making (MCDM) techniques into the evaluation process. The framework employs the Fuzzy-Weighted Zero-Inconsistency (FWZIC) method to determine the relative importance of evaluation criteria and the Combinative Distance-Based Assessment (CODAS) method to rank alternative educational applications. MCDM approaches are increasingly used in educational technology evaluation because they allow researchers to assess complex systems that involve multiple attributes and competing evaluation dimensions. Scholars have emphasized that weighting methods such as FWZIC help reduce inconsistency in expert judgments and produce more reliable decision-making outcomes (Pamucar *et al.*, 2021; Mohammed *et al.*, 2024). Similarly, the CODAS method has been widely recognized as an effective ranking technique because it evaluates alternatives based on their distance from

an ideal solution, allowing objective comparisons between multiple options (Keshavarz-Ghorabaee *et al.*, 2016). By integrating these analytical techniques, the proposed framework transforms subjective expert assessments into quantifiable evaluation results, thereby enhancing the transparency and reliability of the evaluation process.

The results also highlight the growing role of artificial intelligence in educational technology and language learning applications. AI-driven systems can analyze learner behavior, provide adaptive feedback, and personalize learning experiences, which significantly enhances learning effectiveness. In language learning contexts, AI technologies can monitor learners' progress, identify learning difficulties, and adapt instructional content to individual learner needs. Recent studies have shown that AI-enabled game-based learning systems can significantly improve learners' engagement, motivation, and language acquisition outcomes by providing personalized learning pathways and real-time performance feedback (Zawacki-Richter *et al.*, 2019; Holmes *et al.*, 2022). The proposed AI-based evaluation framework, therefore, aligns with emerging trends in educational technology that emphasize intelligent learning systems capable of supporting data-driven instructional design and evaluation.

From a theoretical perspective, the findings can be interpreted through constructivist learning theory and gamification principles. Constructivist theory emphasizes that learners actively construct knowledge through interaction with meaningful learning environments, while gamification research demonstrates that elements such as scoring systems, progress tracking, and feedback mechanisms can enhance motivation and engagement (Deterding *et al.*, 2011; Plass *et al.*, 2020). The evaluation criteria identified in this study reflect these principles by emphasizing interactive design, performance tracking, and feedback mechanisms that support meaningful learning experiences for kindergarten learners.

Overall, the proposed framework contributes to the literature by providing a systematic and AI-supported methodology for evaluating educational games in early childhood education. By integrating pedagogical evaluation criteria with advanced decision-making techniques, the framework enhances the objectivity and reliability of the evaluation process and supports informed decision-making in selecting high-quality English language learning applications for kindergarten education in the UAE. This approach is particularly valuable given the rapid expansion of digital educational tools and the need for rigorous evaluation methods that ensure educational technologies meet both pedagogical and developmental requirements.

5. Recommendations

Based on the findings of this study, several theoretical and practical recommendations can be proposed to guide the development and evaluation of AI-based educational game applications for kindergarten English language learning in the UAE.

From a theoretical perspective, future research should further integrate game-based learning theory, constructivist learning principles, and artificial intelligence–

driven adaptive learning models when designing and evaluating educational games. The results suggest that effective digital learning environments require a balance between instructional quality, learner engagement, and usability. Therefore, future theoretical frameworks should explore how AI-supported analytics and adaptive feedback mechanisms influence children's motivation, engagement, and language acquisition in early childhood learning contexts.

From a practical perspective, educators, policymakers, and educational technology developers should adopt systematic evaluation frameworks when selecting or developing educational game applications. The proposed AI-based framework provides a structured approach for assessing educational games based on pedagogical effectiveness, usability, learner engagement, and feedback mechanisms. Developers should also apply child-centered design principles that prioritize intuitive interfaces, visual engagement, and adaptive learning features appropriate for kindergarten learners. Integrating AI-supported educational games as complementary tools within early childhood curricula may enhance interactive learning and support language development.

For future research, additional studies should examine the effectiveness of AI-based evaluation frameworks across different educational settings and larger samples to improve generalizability. Longitudinal research is also recommended to investigate the long-term effects of game-based language learning on children's language proficiency and cognitive development. Moreover, future studies may explore advanced AI techniques such as learning analytics and intelligent tutoring systems to improve the personalization and evaluation of educational game applications.

Finally, the adoption of AI-based learning technologies requires careful consideration of social and cultural factors. Educational applications should align with the cultural context and educational values of the UAE while ensuring ethical use of learner data, digital safety, and equitable access to technological resources. Addressing these issues will help ensure that AI-supported educational games contribute positively to early childhood education and support inclusive learning opportunities for all learners.

6. Conclusion

This study proposed an AI-based framework for assessing English language game-based learning applications for kindergarten education in the UAE. It identified seven key evaluation criteria—design, time, score, progress, report, face validity, and usability—to evaluate the pedagogical effectiveness and usability of educational games for young learners. These criteria ensure that applications are technologically functional, developmentally appropriate, and aligned with early childhood learning objectives.

Integrating AI with multi-criteria decision-making methods, such as Fuzzy-Weighted Zero-Inconsistency (FWZIC) and Combinative Distance-Based Assessment (CODAS), enhances the reliability and objectivity of the evaluation process. By

transforming expert judgments into quantitative outcomes, the framework enables systematic comparison and ranking of educational game applications, supporting informed decision-making in selecting suitable learning tools.

The proposed framework contributes to the growing field of AI-supported educational technologies by providing a structured methodology for evaluating digital learning applications in early childhood education. It offers practical value for educators, policymakers, and developers seeking to identify or design effective educational games that support language learning, engagement, and interactive learning experiences. As digital technologies expand in educational environments, systematic evaluation frameworks like this one will ensure the quality and effectiveness of educational game-based learning tools.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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