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Game Attribute Design Guideline for Game-Based Arabic Language Learning (GBALL) for Dyslexic Children

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ABSTRACT

Dyslexia is a learning disorder that affects reading, writing, and spelling abilities, making it challenging for children to learn a new language. Game-Based Arabic Language Learning (GBALL) has the potential to support dyslexic children's experience of Arabic language learning by providing engaging and immersive learning activities. However, to make GBALL effective, it is essential to design game attributes that equip the unique learning needs and challenges of dyslexic children. This paper proposes a set of design guidelines for game attributes that can enhance the effectiveness and enjoyment of GBALL for dyslexic children. The list of guidelines and recommendations was obtained using a combination of Systematic Literature Reviews (SLR) and the Fuzzy Delphi Method (FDM). Firstly, this study reviews the related literature on dyslexia and game-based learning to identify the key effective game attributes for dyslexic learners. At this stage, eleven design guidelines for GBALL game attributes include goal, challenge, feedback, rule, player autonomy, repetition, genre, fantasy, teamwork, navigation, and tangibility. Subsequently, it examines the proposed guidelines by thirteen selected experts, including three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts. Other than that, the FDM is employed to establish an expert agreement on the guideline. A total of forty-four guidelines were identified and categorized into three main categories as proposed in the guidelines. The output of this study proposes a set of design guidelines for game attributes, enhancing the effectiveness and enjoyment of GBALL for dyslexic children. Correspondingly, these are analyzed through a literature review and confirmed by the experts.

1. Introduction

Dyslexia is a condition that affects 5% to 12% of youngsters and is defined as an unexplained difficulty reading words or fluency in reading and writing [1]. Despite adequate intelligence and

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educational opportunities, it is characterized by reading, writing, and spelling difficulties. Furthermore, dyslexia can significantly impact language learning, making it challenging for children to acquire a new language, such as Arabic, which has a complex writing system and pronunciation rules [2].

Arabic is among the six official languages of the United Nations. It is used for prayer sermons by over 1.2 billion non-Arabic Muslims, as well as for formal reading and writing. It is also used for international and national news broadcasts and is adopted by educated Arabs [3]. Furthermore, Quranic verses are recited in Muslim prayers, and the Quran is a holy book that every Muslim should learn to read [4].

Despite the introduction of the Arabic language in Malaysia decades ago, there is a concern about the mastery level of the language among Malaysians. In Malaysia, learning Arabic is considered an integral part of the religious duties of Malay Muslims [5]. However, many students view the Arabic language as a difficult subject.

A research study by Zaini *et al.,* [6] identified several factors contributing to the lack of student interest in the Arabic language, such as textbooks, curriculum structure, teaching methods, instructional aids, and teachers' lack of proficiency in Arabic. According to [7], the teaching and learning of the Arabic language in Malaysia face significant challenges, as most Arabic language teachers still employ traditional, teacher-centered approaches. This situation results in a lack of interest and makes the subject undesirable for Malay learners [8] due to poor motivation [9]. Students may believe that they will not understand what is being taught, leading to lower achievement in Arabic compared to other subjects. This difficulty is also experienced by dyslexic children, as they are slow learners.

There is a lack of research in Malaysia regarding whether Muslim dyslexic children would face difficulties in reading the Holy Quran [4] and learning other basic principles of Islam [5], which are in Arabic. Therefore, efforts need to be strengthened to assist educational institutions in addressing the challenges faced by dyslexic students in the era of information technology.

Dyslexia results in low academic achievement [10] due to the inability of individuals with dyslexia to effectively motivate themselves [11], as well as difficulties in attention [12], preventing them from aligning their education with that of typically developing children. Holmes [13] emphasizes the potential benefits of game-based learning for children with dyslexia, while El Kah and Lakhouaja [10] state that games offer an effective and exciting learning experience, especially when they incorporate multisensory features. Additionally, assistive technology systems, such as computer-based tools and software, have the potential to assist children with disabilities in learning, communication, play, and achieving greater independence in their lives [14]. Consequently, the use of multisensory, interactive, and effective games can be beneficial in helping children with dyslexia.

GBALL has the potential to provide an engaging and immersive learning experience for dyslexic children and support their language learning [10]. However, designing game attributes that equip the unique learning needs and challenges of dyslexic children is essential to create GBALL effectively. There is a lack of comprehensive guidelines for designing GBALL programs for dyslexic children [15-17]. Hence, this paper proposes a set of design guidelines for game attributes that can enhance the effectiveness and enjoyment of GBALL for dyslexic children.

2. Methodology

To compile the list of guidelines and recommendations for GBALL for dyslexic students, a combination of SLR and the FDM was utilized as Figure 1.

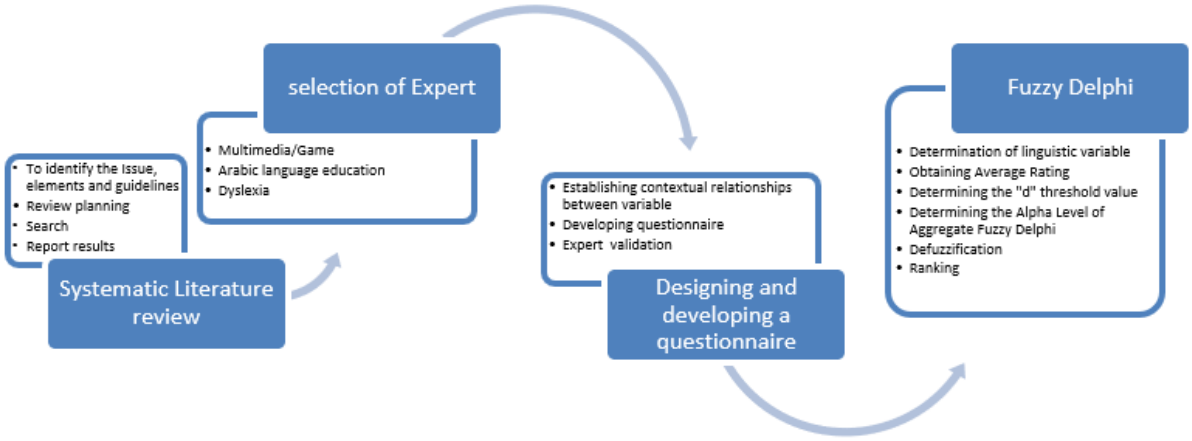

Fig. 1. Research methodology

2.1 Systematic Literature Reviews

According to Kitchenham's [18] recommendations, an SLR was conducted to identify the themes and issues associated with the game attribute design guidelines for GBALL for dyslexic students. The following steps were implemented to conduct the literature review:

i) Review planning
   a) Develop the main question and sub-questions for the review
   b) Define the preliminary categories for analysis

ii) Search
   a) Determine the sources for the literature search
   b) Establish inclusion and exclusion criteria
   c) Define search criteria
   d) Conduct a literature search
   e) Select the literature
   f) Analysis
   g) Read selected literature
   h) Extract and code data

iii) Results report
   a) Interpret the findings
   b) Generate the review report

2.1.1 Quality assessment

Four Quality Assessment (QA) questions, adapted from Kitchenham's [19] recommendations, were utilized to evaluate each SLR. These questions included:

QA1: Did the literature search have the potential to identify all relevant studies?
QA2: Are the assessments of the quality and validity of the studies dependable?
QA3: Does the study offer specific game attribute guidelines for Game-Based Arabic language Learning (GBALL) for dyslexic children?

QA4: Do the findings meet the research objective?

Table 1 presents the categorization and evaluation of the questions. Scores were determined by assigning a value of 1 to responses marked as "Yes," 0.5 to "Partially," and 0 to "No/Unknown." These scores indicated the articles' quality and relevance to the research questions.

Table 1
The specifics regarding the questions used to evaluate the quality

Scoring Question	Yes (Y) = 1	Partly (P) = 0.5	No (N)/Unknown = 0
QA1	The authors utilized supplementary search algorithms, searched four or more digital libraries, or identified and referred to all relevant journals in the field.	The authors either searched three to four digital libraries without employing any supplementary search algorithms or examined a restricted selection of articles and conference proceedings.	The authors acquired a severely restricted assortment of journals.
QA2	Quality considerations were a fundamental aspect of the research question.	As part of the research question, the study examines quality concerns.	An explicit assessment of the quality of individual primary studies has not been made.
QA3	The study explained the components and recommendations for using GBALL for dyslexic children.	The study did not fully outline the elements or guidelines for GBALL for dyslexic children and only provided a summary.	The study lacks any detailed explanation of the components or recommendations for GBALL for dyslexic children.
QA4	The study aligns with and directly addresses the clearly stated research objective.	The study findings are closely linked to the explicitly stated research objective.	The findings are ambiguous and not easily deducible.

2.2 Fuzzy Delphi Technique

To assess the game attribute guideline of GBALL for dyslexic children, the researcher utilized the FDM from Kaufman & Gupta [20] and Mohd Ridhuan [21], which involves obtaining high-level responses from a group of experts. This technique was chosen due to its effectiveness in obtaining expert consent in decision-making, comprising seven data analysis steps.

i) Step 1: Selection of Experts
It starts with selecting experts in the relevant fields. In this study, thirteen experts with more than five years of experience in Arabic learning, game-based learning, and dyslexia were chosen.

ii) Step 2: Determination of Linguistic Variables
The linguistic variables were then determined and transformed into triangular fuzzy integers, followed by obtaining average ratings and determining a threshold "*d*" value to gauge the level of agreement among specialists. Subsequently, the alpha level of an aggregate of fuzzy assessments was identified, and defuzzification was performed to determine the fuzzy score for each element. Finally, the elements are ranked based on the defuzzification value and level of agreement among experts.

iii) Step 3: Obtaining Average Rating
After receiving a response from the assigned specialist, the researcher must convert all Likert scale responses into a fuzzy scale. This involves calculating the average response for each fuzzy number, known as fuzzy averaging, expressed in Eq. 1:

$$M = \frac{\sum_{i}^{n}=1mi}{n} \quad (1)$$

iv) Step 4: Determining the "*d*" Threshold value
The value of threshold "*d*" is critical in assessing the level of agreement among specialists during the evaluation process, which is determined by the chosen method [22]. The formula for calculating the distance between each fuzzy number, $m = (m_1, m_2, m_3)$, and $n = (m_1, m_2, m_3)$, depends on the threshold value. Apart from that, the expert agreement is typically indicated by a threshold value of 0.2 or lower [23]. For each item, the overall agreement or group consensus should exceed 75%. Otherwise, a second round of evaluation should be conducted [24].

v) Step 5: Determining the Alpha Level of Aggregate of Fuzzy Assessments
Once the expert agreement is established, the alpha aggregate level of fuzzy assessment is calculated by adding the fuzzy numbers for each item. A consensus of 75% is required to demonstrate expert agreement [24]. If the level of agreement among experts falls below 75%, the process should be repeated until the experts reach at least 75% consensus. The formula for determining fuzzy values is A_{max} = / ($m_1 + 2m_2 + m_3$).

vi) Step 6: Defuzzication
This analysis determines an element's fuzzy score (*A*). The value of *A* must be greater than or equal to the median value (α-cut value) of 0.5 to meet the third criterion, indicating that a group of experts has agreed on the element [25]. Correspondingly, *A* can be applied to prioritize an element based on the experts' opinions. The formula for calculating the fuzzy score (*A*) is as follows: $A = (1/3) * (m_1 + m_2 + m_3)$.

vii) Step 7: Ranking
Based on the defuzzification value and the level of agreement among experts, the element with the highest value is selected as the most significant position [25].

3. Results and Findings

3.1 Results of Systematic Literature Reviews (SLR)

The following section pertains to the study's findings on SLR. The researchers thoroughly analyzed the current literature on GBALL's game attribute guidelines for dyslexic children. Here, eighteen publications related to the topic were selected from various databases. The study revealed that the key elements are goal, challenge, feedback, rule, player autonomy, repetition, genre, fantasy, teamwork, navigation, and tangibility.

3.1.1 Data extraction

The test configuration for this experiment is presented in Table 1. Nevertheless, for the experiment at a Reynolds number of 2×10^6, the angle of attack was limited to $\alpha = 23°$ only.

Furthermore, the papers assessed for quality based on predefined questions, and the results tabulated in Table 2 display the average quality scores for studies conducted each year.

Table 2
Details and quality assessment scores of the papers retrieved

ID	Title	Author	Year	Q1	Q2	Q3	Q4	Total score
S1	Educational Software for Dyslexic Children: A Systematic Literature Review	[26]	2021	1	1	0.5	0.5	3
S2	Dyslexic Arabic Students in the Arab Countries: A Systematic Review of Assistive Technology Progress and Recommendations	[27]	2021	1	1	0.5	1	3.5
S3	Exploring the Use of the ICT in Supporting Dyslexic Students' Preferred Learning Styles: A Preliminary Evaluation	[28]	2017	1	1	1	1	4
S4	RALF: an adaptive reinforcement learning framework for teaching dyslexic students	[29]	2022	1	1	1	1	4
S5	Game-Based Interventions as Support for Learning Difficulties and Knowledge Enhancement in Patients with Dyslexia: A Systematic Literature Review	[30]	2022	1	1	0.5	0.5	3
S6	Strengthening Jawi Writing for Dyslexia Students through Online Games - Analysis of E-Jawi Games Online in Malaysia	[31]	2015	1	1	1	1	4
S7	Measuring the Impact of Developing a Game-Based Mobile Application to Increase Reading Skills Levels for Dyslexic Students at Primary Schools In Saudi Arabia	[32]	2022	1	1	0	1	3
S8	An Approach to Digital Game-Based Learning: Video-Games Principles and Applications in Foreign Language Learning	[33]	2018	1	1	1	1	4
S9	Game User Interface Criteria for Dyslexic Children	[34]	2021	1	0.5	1	1	3.5
S10	Developing effective, educative games for Arabic children, primarily dyslexic	[35]	2018	1	1	1	1	4
S11	"Let's Play a Game!" Serious Games for Arabic Children with Dictation Difficulties	[36]	2020	1	1	1	1	4
S12	Understanding the Needs of Arab Learners with Dyslexia for Adaptive Systems	[37]	2022	1	1	1	1	4
S13	An Arabic Framework for Dyslexia Training Tools	[38]	2013	1	1	1	1	4
S14	YUSR: Speech Recognition Software for Dyslexics	[39]	2013	1	1	0.5	1	3.5
S15	Usability Features for Arabic Assistive Technology for Dyslexia	[40]	2018	1	1	1	1	4
S16	Computer-Assisted Learning Language for Learning Disabilities in The Arabic Language: Diagnosis, Training, and Assistance		2019	1	1	1	1	4
S17	Communication Technology for Users with Specific Learning Disabilities	[41]	2017	1	1	1	1	4
S18	Importance of Assistive Mobile Applications for Dyslexic Students in Saudi Arabia	[42]	2021	1	1	1	1	4

3.1.1 Elements and Design guideline from SLR

Table 3 summarizes the analysis results for the game attributes of GBALL for dyslexic children. Meanwhile, the design guidelines are summarized in Table 4.

Table 3
Summary matrix of the game attributes of GBALL for dyslexic children

Elements	Paper ID																	
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Goal			/	/				/		/	/		/	/	/			/
Challenge			/	/	/	/					/		/	/	/			
Feedback				/			/	/			/	/	/	/	/			/
Rule				/				/					/					/
Player autonomy		/	/	/		/		/	/	/	/		/	/			/	/
Repetition				/					/	/	/	/	/		/		/	
Genre			/	/	/			/		/	/	/	/					/
Fantasy								/					/					
Teamwork and Competition					/			/					/					
Navigation		/					/	/			/	/	/	/	/			/
Tangibility		/	/			/		/		/	/	/	/	/	/	/	/	/

Table 4
The Game Attributes Guidelines for GBALL for dyslexic children

Elements	(Guideline code) Guidelines	
Goal	(Gol#1)	Game instructions should be clearly stated
	(Gol#2)	The objective of the game must be stated explicitly
	(Gol#3)	The objective of the game must be stated implicitly
	(Gol#4)	The game objective should be achievable according to the ability of children with dyslexia
	(Gol#5)	The objective of the game should be to develop the potential of dyslexic children
Challenge	(Chl#1.)	Increasing the difficulty level of the game should be in line with the level of dyslexic children's ability
	(Chl#2.)	Time allocation to complete certain challenges in games is suitable for dyslexic children
	(Chl#3.)	The content of the game should be arranged according to the level of learning difficulty
	(Chl#4.)	Dyslexic children like to learn using the game method
	(Chl#5.)	Challenges can develop the potential and skills of dyslexic children
Feedback	(FB#1)	Immediate game rewards are more appropriate for dyslexic children after they have successfully achieved game objectives
	(FB#2)	Delayed game rewards are suitable for dyslexic children after they have successfully achieved the game objectives
	(FB#3)	All types of game rewards are suitable to be given to dyslexic children after they have successfully achieved the game objectives
	(FB#4)	Feedback in the form of motivation is suitable for dyslexic children to achieve the objectives of the game
	(FB#5)	Sound effect feedback is suitable for dyslexic children in-game applications
	(FB#6)	An immediate game punishment is appropriate for dyslexic children if they fail to achieve the game objectives.
	(FB#7)	Delayed punishments are appropriate for dyslexic children if they fail to achieve the game objectives
	(FB#8)	Game feedback should guide dyslexic children to achieve game objectives
	(FB#9)	Progress bar increases motivation for dyslexic children in achieving game objectives
Rule and Player autonomy	(RAuto#1)	Dyslexic children prefer games that allow players to choose the game level freely
	(RAuto#2)	Dyslexic children prefer games that have many rules
	(RAuto#3)	Dyslexic children can follow the game rules

	(RAuto#4)	Clear game rules can help dyslexic children to perform activities and achieve the game objectives set
Repetition	(Rpt#1)	The game-based learning needs to provide a button to repeat the audio
	(Rpt#2)	The game-based learning needs to provide a button to repeat the video
	(Rpt#3)	The repetition function helps dyslexic children remember lessons
	(Rpt#4)	The repetition function helps dyslexic children to identify the alphabet
	(Rpt#5)	The repetition function can strengthen the memory of dyslexic children
	(Rpt#6)	The repetition function can improve the quality of learning for dyslexic children
	(Rpt#7)	The repetition function can improve the experience of learning for dyslexic children
Fantasy	(Fntcy1)	Storytelling Elements can reduce the rate of reading errors among dyslexic children
	(Fntcy2)	Storytelling Elements in game-based learning need to be increased to improve the quality of learning for dyslexic children
	(Fntcy3)	Storytelling Elements can improve lesson comprehension among dyslexic children
	(Fntcy4)	The design of fantasy worlds, characters, or stories in games as a metaphor (mirror) to the real world is suitable for use among dyslexic children
Teamwork and	(t.wrk#1)	Competition in game-based language learning can increase the motivation of dyslexic children
Competition	(t.wrk#2)	Dyslexic children love to play in groups
	(t.wrk#3)	Game-based language learning can help dyslexic children develop group working skills
	(t.wrk#4)	Game-based language learning can help dyslexic children develop social skills
Navigation	(Nav#1)	Game-based language learning for dyslexic children need to have easy and clear navigation buttons
	(Nav#2)	Game-based language learning interface design for dyslexic children needs to be user-friendly (easy to use)
	(Nav#3)	A help button should be provided in game-based language learning for dyslexic children
	(Nav#4)	A user guide in game-based language learning for dyslexic children is needed to aid and facilitate the user
Tangibility	(tan#1)	Game-based language learning for dyslexic children should be accompanied by physical activity
	(tan#2)	Game-based language learning for dyslexic children needs to be paired with sensory activities.

3.2 Fuzzy Delphi Technique

This following section presents the FDM outcomes that were utilized to assess the proposed guideline. Note that the study involved thirteen experts, comprising three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts, all of whom were directly involved in the research.

3.2.1 Goal

Table 5 summarizes the findings for goals guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. A total of thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 5
Summaries of the final findings of experts' consensus on the goal element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(Gol#1)	0.040	100.0%	0.869	0.985	1.000	0.951	Accepted	0.951	1
2	(Gol#2)	0.096	92.3%	0.792	0.938	0.992	0.908	Accepted	0.908	4
3	(Gol#3)	0.460	38.5%	0.208	0.300	0.438	0.315	Rejected	0.315	5
4	(Gol#4)	0.082	92.31%	0.838	0.962	0.992	0.931	Accepted	0.931	2
5	(Gol#5)	0.082	92.31%	0.838	0.962	0.992	0.931	Accepted	0.931	2

The experts accepted four items, while only one from the element(s) was rejected, as stated in Table 5 above. The table also presents the ranking for all the items selected out of five goal components in Game Elements. However, two items scored the same, sharing the same rank. According to the analysis conducted, the importance of each item for the foundation of games in Game Elements based on experts' consensus and opinion is determined. The ranking of the items is as follows:

i) Game instructions should be clearly stated.
ii) The game objective should be achievable according to the ability of children with dyslexia.
iii) The objective of the game should be to develop the potential of dyslexic children.
iv) The objective of the game must be stated explicitly.

3.2.2 Challenge

Table 6 summarizes the final findings for challenge guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. A total of thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 6
The final findings of experts' consensus on the challenge element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(Chl#1.)	0.054	100.0%	0.854	0.977	1.000	0.944	Accepted	0.944	2
2	(Chl#2.)	0.311	69.2%	0.669	0.815	0.892	0.792	Rejected	0.792	5
3	(Chl#3.)	0.056	92.3%	0.869	0.977	0.992	0.946	Accepted	0.946	1
4	(Chl#4.)	0.095	92.31%	0.808	0.946	0.992	0.915	Accepted	0.915	3
5	(Chl#5.)	0.168	92.31%	0.746	0.892	0.962	0.867	Accepted	0.867	4

*Please refer to Table 4

The experts accepted four items, while only one from the element(s) was rejected, as presented in Table 6 above. The table also exhibits the ranking for all the items selected out of five for Challenge components in Game Elements. According to the analysis, each item's importance for Challenge in

Game Elements based on experts' consensus and opinion is determined. The ranking of the items is as follows:

i) The content of the game should be arranged according to the level of learning difficulty.
ii) Increasing the difficulty level of the game should align with the level of dyslexic children's ability.
iii) Dyslexic children like to learn using the game method.
iv) Challenges can develop the potential and skills of dyslexic children.

3.2.3 Feedback

Table 7 summarizes the final findings for feedback guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The element(s) in red indicate the value of the agreement not agreed upon by the expert. Thirteen experts were selected as respondents for this questionnaire, including three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia experts for dyslexia.

Table 7
The final findings of experts' consensus on feedback guidelines

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(FB#1)	0.082	92.3%	0.838	0.962	0.992	0.931	Accepted	0.931	1
2	(FB#2)	0.340	38.5%	0.308	0.477	0.662	0.482	Rejected	0.482	7
3	(FB#3)	0.234	84.6%	0.669	0.823	0.923	0.805	Accepted	0.805	6
4	(FB#4)	0.237	92.31%	0.738	0.869	0.931	0.846	Accepted	0.846	5
5	(FB#5)	0.119	100.00%	0.792	0.931	0.985	0.903	Accepted	0.903	3
6	(FB#6)	0.375	46.15%	0.177	0.308	0.477	0.321	Rejected	0.321	9
7	(FB#7)	0.402	30.77%	0.315	0.469	0.638	0.474	Rejected	0.474	8
8	(FB#8)	0.082	92.31%	0.838	0.962	0.992	0.931	Accepted	0.931	1
9	(FB#9)	0.133	100.00%	0.746	0.900	0.977	0.874	Accepted	0.874	4

*Please refer to Table 4

The experts accepted six items, while three items from the element(s) were rejected, as portrayed in Table 7 above. The table indicates the ranking for all the items selected out of nine for Feedback components in Game Elements. Nevertheless, two items scored the same, sharing the same rank. According to the analysis, the importance of each item for Feedback components in Game Elements is determined based on experts' consensus and opinion. The ranking of the items is as follows:

i) Immediate game rewards are more appropriate for dyslexic children after successfully achieving game objectives.
ii) Game feedback should guide dyslexic children to achieve game objectives.
iii) Sound effect feedback is suitable for dyslexic children in-game applications.
iv) The progress bar increases motivation for dyslexic children to achieve game objectives.
v) Feedback in the form of motivation is suitable for dyslexic children to achieve the game's objectives.

vi) All types of game rewards are suitable for dyslexic children after successfully achieving the game objectives.

3.2.4 Rules and player autonomy

Table 8 summarizes the final findings for Rules and Player Autonomy guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. Thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 8
The final findings of experts' consensus on rules and player autonomy element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(RAuto#1)	0.196	92.3%	0.715	0.869	0.946	0.844	Accepted	0.844	2
2	(RAuto#2)	0.413	30.8%	0.192	0.315	0.477	0.328	Rejected	0.328	4
3	(RAuto#3)	0.211	76.9%	0.508	0.677	0.838	0.674	Accepted	0.674	3
4	(RAuto#4)	0.139	100.00%	0.762	0.908	0.977	0.882	Accepted	0.882	1

*Please refer to Table 4

The experts accepted three items, while only one from the element(s) was rejected, as stated in Table 8 above. The table also shows the ranking for all the items selected out of four. According to the analysis, each item's importance for Rules and Player Autonomy components in Game Elements is determined based on experts' consensus and opinion. The ranking of the items is as follows:

i) Clear game rules can help dyslexic children to perform activities and achieve the game objectives set.
ii) Dyslexic children prefer games that allow players to choose the game level freely.
iii) Dyslexic children can follow the game rules.

3.2.5 Repetition

Table 9 summarizes the final findings for Repetition guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. Thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 9
The final findings of experts' consensus on the repetition element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(Rpt#1)	0.091	92.3%	0.823	0.954	0.992	0.923	Accepted	0.923	2
2	(Rpt#2)	0.082	92.3%	0.838	0.962	0.992	0.931	Accepted	0.931	1
3	(Rpt#3)	0.091	92.3%	0.823	0.954	0.992	0.923	Accepted	0.923	2
4	(Rpt#4)	0.148	92.31%	0.792	0.923	0.969	0.895	Accepted	0.895	5
5	(Rpt#5)	0.111	84.62%	0.823	0.946	0.985	0.918	Accepted	0.918	4
6	(Rpt#6)	0.183	92.31%	0.777	0.908	0.954	0.879	Accepted	0.879	7
7	(Rpt#7)	0.142	100.00%	0.777	0.915	0.977	0.890	Accepted	0.890	6

*Please refer to Table 4

The experts, as presented in Table 9 above, accepted all items. The table also demonstrates the ranking for all the items selected out of seven elements. However, two items scored the same, sharing the same rank. According to the analysis, each item's importance for Repetition in Game Elements is determined based on experts' consensus and opinion. The ranking of the items is as follows:

i) The game-based learning needs to provide a button to repeat the video.
ii) The game-based learning needs to provide a button to repeat the audio.
iii) The repetition function helps dyslexic children remember lessons.
iv) The repetition function can strengthen the memory of dyslexic children.
v) The repetition function helps dyslexic children to identify the alphabet.
vi) The repetition function can improve the experience of learning for dyslexic children.
vii) The repetition function can improve the quality of learning for dyslexic children.

3.2.6 Fantasy

Table 10 summarizes the final findings for Fantasy guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. Thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 10
The final findings of experts' consensus on the fantasy element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(Ftcy#1)	0.230	92.3%	0.646	0.815	0.915	0.792	Accepted	0.792	4
2	(Ftcy#2)	0.241	92.3%	0.677	0.831	0.915	0.808	Accepted	0.808	3
3	(Ftcy#3)	0.088	100.0%	0.762	0.923	0.992	0.892	Accepted	0.892	2
4	(Ftcy#4)	0.094	100.00%	0.777	0.931	0.992	0.900	Accepted	0.900	1

*Please refer to Table 4

The experts, as indicated in Table 10 above, accepted all items. The table also shows the ranking for all the items selected out of four Elements. According to the analysis, the importance of each item for in-game fantasy elements based on experts' consensus and opinion is determined. The ranking of the items is as follows:

i) The design of fantasy worlds, characters, or stories in games as a metaphor (mirror) to the real world is suitable for dyslexic children.
ii) Storytelling Elements can improve lesson comprehension among dyslexic children.
iii) Storytelling Elements in game-based learning need to be increased to improve the quality of learning for dyslexic children.
iv) Storytelling Elements can reduce the rate of reading errors among dyslexic children.

3.2.7 Teamwork and Competition

Table 11 summarizes the final findings for the Teamwork and Competition guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. Thirteen experts were selected as respondents for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 11
The final findings of experts' consensus on teamwork and competition element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(t.wrk#1)	0.125	100.0%	0.731	0.892	0.977	0.867	Accepted	0.867	1
2	(t.wrk#2)	0.230	76.9%	0.608	0.785	0.908	0.767	Accepted	0.767	4
3	(t.wrk#3)	0.225	84.6%	0.654	0.815	0.923	0.797	Accepted	0.797	3
4	(t.wrk#4)	0.163	100.00%	0.700	0.862	0.962	0.841	Accepted	0.841	2

*Please refer to Table 4

The experts, as stated in the table above, accepted all items. The table also presents the ranking for all the items selected out of four elements. According to the analysis, each item's importance for Teamwork and Competition in Game Elements is determined based on experts' consensus and opinion. The ranking of the items is as follows:

i) Competition in game-based language learning can increase the motivation of dyslexic children.
ii) Game-based language learning can help dyslexic children develop social skills.
iii) Game-based language learning can help dyslexic children develop group working skills.
iv) Dyslexic children love to play in groups.

3.2.8 Navigation

Table 12 summarizes the final findings for Navigation guidelines of GBALL for dyslexic children subjected to experts' consensus and recommendations. The value of the agreement not agreed upon by the expert is indicated by the element(s) in red. Thirteen experts were selected as respondents

for this questionnaire, which are; three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia for dyslexia experts.

Table 12
The final findings of experts' consensus on the navigation element

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(Nav#1)	0.102	84.6%	0.838	0.954	0.985	0.926	Accepted	0.926	2
2	(Nav#2)	0.071	92.3%	0.854	0.969	0.992	0.938	Accepted	0.938	1
3	(Nav#3)	0.111	84.6%	0.823	0.946	0.985	0.918	Accepted	0.918	3
4	(Nav#4)	0.142	100.00%	0.777	0.915	0.977	0.890	Accepted	0.890	4

*Please refer to Table 4

The experts, as presented in Table 12 above, accepted all items. The table also indicates the ranking for all the items selected from four elements. According to the analysis, each item's importance for Navigation in Game Elements is determined based on experts' consensus and opinion. The ranking of the items is as follows:

i) Game-based language learning interface design for dyslexic children needs to be user-friendly (easy to use).
ii) Game-based language learning for dyslexic children need to have easy and clear navigation buttons.
iii) A help button should be provided in game-based language learning for dyslexic children.
iv) A user guide in game-based language learning for dyslexic children is needed to aid and facilitate the user.

3.2.9 Tangibility

Table 13 summarizes the final findings for the tangibility guidelines of GBALL for Dyslexic Children subjected to experts' consensus and recommendations. The element(s) in red indicate the value of the agreement not agreed upon by the expert. Thirteen experts were selected as respondents for this questionnaire, including three experts in Arabic language learning, three dyslexia teachers, two psychologists, and five multimedia experts for dyslexia.

Table 13
The final findings of experts' consensus on tangibility attribute

#	Guideline Code*	Conditions for *Triangular Fuzzy Numbers*		Conditions for *Fuzzy Evaluation Process*			Fuzzy Score *(A)*	Experts' Consensus	Elements ACCEPTED	Ranking
		Threshold Value, d	Percentage of Experts' Agreement, %	m1	m2	m3				
1	(tan#1)	0.185	100.0%	0.746	0.885	0.962	0.864	Accepted		0.864
2	(tan#2)	0.182	84.6%	0.777	0.908	0.954	0.879	Accepted		0.879

*Please refer to Table 4

The experts, as stated in the table above, accepted all items. The table also displays the ranking of all selected items out of two elements. Based on the analysis, the importance of each item for

Tangibility in Game Elements, according to experts' consensus and opinion, has been determined. The ranking of the items is as follows:

i) Game-based language learning for dyslexic children needs to be paired with sensory activities.
ii) Game-based language learning for dyslexic children should be accompanied by physical activity.

Based on the above discussion, we propose a framework of Game Attribute Design Guideline for Game-Based Arabic Language Learning (GBALL) for Dyslexic Children as illustrated in Figure 2.

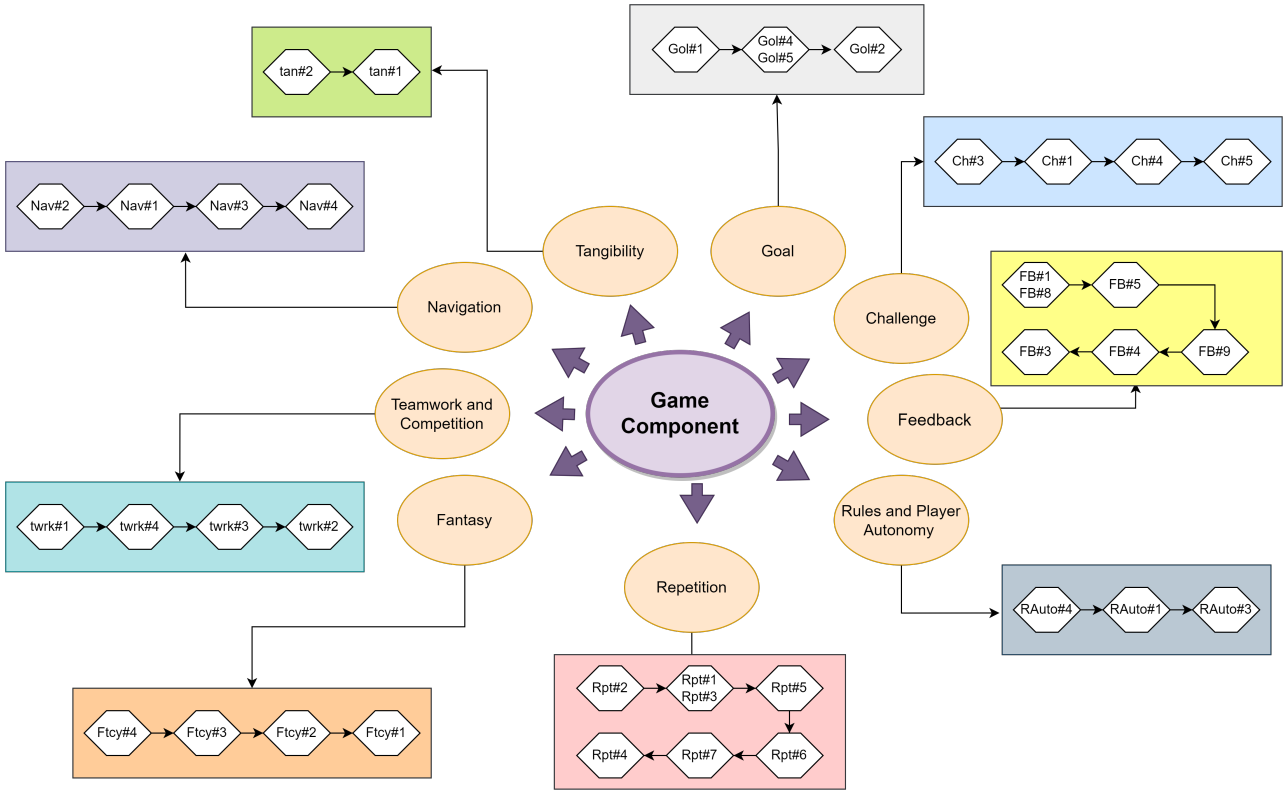

Fig. 2. Framework of Game Attribute Design Guideline for Game-Based Arabic Language Learning (GBALL) for Dyslexic Children

4. Conclusions

In conclusion, this combined SLR and FDM research study provides a comprehensive and evidence-based framework for designing GBALL games that are effective and accessible for dyslexic children. The SLR component of the study identified and synthesized the existing research on GBALL game attribute design guidelines for dyslexic learners. It highlights the potential of games to enhance language learning outcomes and identifies key design features that can contribute to this effectiveness. Other than that, the Fuzzy Delphi component of the study further validated and prioritized these attributes through expert consultation and consensus building, resulting in a set of attributes perceived as most relevant and feasible for supporting the language learning of dyslexic learners.

These attributes include but are not limited to clear instruction, explicit game objective, suitable game difficulty level, Immediate game reward, clear game rules, repetition function, multisensory

input, explicit feedback, adaptively, interactivity, and scaffolding. Furthermore, the combined results of the study provide a comprehensive and coherent set of guidelines that can inform the design and development of GBALL games for dyslexic children. It integrates the insights and perspectives of both empirical research and expert opinion. By following these guidelines, game designers and educators can create engaging, effective, and inclusive games for dyslexic learners while also contributing to the advancement of game-based language learning research and practice. We also propose a framework Game Attribute Design Guideline for Game-Based Arabic Language Learning (GBALL) for Dyslexic Children.

Future research can build on the findings of this study to explore the impact of GBALL games on language learning outcomes and user experience, as well as the scalability and transferability of the guidelines across different contexts and populations. Overall, this study represents a valuable contribution to the field of educational game design and has the potential to significantly impact the language learning outcomes and well-being of dyslexic children.

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