

# Serious Game Model for Dyslexic Children

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## Abstract

Dyslexia is a hidden neurological disorder, in which children suffering from weak phonological awareness, and that affects his/her poor academic records. A dyslexic child is quit intellectual and interestingly good in different fields of life but weak in language-based learning. They feel difficult to identify similar face letters, which led them to misspell and wrong pronunciation. Serious gaming and cognitive learning through assistive applications emerged in the 21st century. Numerous serious gaming applications are developed to combat the issue of effective cognitive learning for dyslexic children. The degree of success is varying due to the lack of standard postulates to design and develop a novel system for dyslexic children. It's quite difficult to claim that a serious game meets the standard learning pedagogy for a special group of users. This research paper proposed a serious gaming model for dyslexic children to pursue the issue of standard rules for serious gaming applications for developers to achieve effective learning outcomes.

**Keywords:** *dyslexia, cognitive, Serious Game, Gamification, Special need children.*

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## 1 Introduction

Term Dyslexia is also known as a language-based learning disorder[1]. Dyslexia is a hidden neurological disorder in which children feel it difficult to fluently identify letters and their sound due to the defect in their phonological component[1]–[4]. There is no cure for dyslexia but timely diagnosis and repetitive instruction from a trainer and family members can help a child to combat this hidden language-based learning difficulty[1]–[7]. Internationally Assistive multimedia applications are a great source of learning for children having cognitive defects [1], [5], [8]–[10]. Gaming industry entices millions of people spending hours and hours in playing games, in the early 2000s, serious gaming was introduced to develop full-fledged games to educate and train parallel with pleasure, fun, and motivation towards such systems[11], playing games is an interesting experience to

motivate and engage its audience. The latest trends for serious gaming applications to reduce the complexity and well-designed games with the simplest components can't be failed to engage its player's attention[11], [12]. Serious gaming used to cater to both technical toolset and implementation of game-based experience in educational context[11], [13], [14]. Gamification for a special group of children according to their mental model and educational context according to the latest trends of serious games equipped with pure entertainment value in terms of educating them is challenging.

In this proposed serious gaming model we tried to address an issue of serious gaming model for dyslexic children in which focus can't be just the contextual cognitive activities of learning through the game can be solved, as few frameworks and developed application is previously done in this area of research. Cognitive activities in a serious gaming

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context are a significant part but some other unclear standards based on user interface design components for dyslexic children should resolve parallel in such frameworks. Proposed model for a serious game based on the learning theories of manual teaching system for dyslexic children with contextual activities and combination of required modalities for user's interaction with a serious game in an interactive and easy to use the environment to feel free to learn while playing.

## 2 Literature Review

Research reveals that dyslexia is heritable and 15% to 20% population is affected[5]. Assistive multimedia applications, games, learning tutors playing a vital role in learning in an interactive environment in a fun way[5], [6], [8], [15]–[18]. The gaming industry and game development are emerging and people spend hours and hours playing games on smart phones[19]. Playing games increase children to accept challenges and increase their critical learning[11]. Research reveals that the pedagogy of learning through serious games is quite effective for dyslexic children[1], [4]. Studies showed that there are various frameworks were proposed for both serious and non-serious games for the users of different disabilities and for normal users without any disability[20] we discovered numerous serious gaming applications and a framework for serious game with different parameters need to design gaming applications for dyslexic children are listed in Table 1 with their studies and findings.

TABLE I. LITERATURE REVIEW FOR DIFFERENT STUDIES AND THEIR FINDINGS IN SERIOUS GAME MODELS.

Studies	Findings
A mobile-based application named EasyLexia[9] is structured based on different cognitive activities based on “words finder”,	A progressive outcome in the user’s performance is catered while evaluation. Study shows that tablet

“mathematical activities” and “sound finder”	applications are more effective and more engaging than mobile devices.
A mobile-based serous game named Dyslexia Baca [2] developed in Malaya language they used a multi-sensory approach for suitable learning echo systems for dyslexic children.	The expert’s opinion for the Design of application is effective, easy to use, user-friendly and supportive for dyslexic child.
A mobile comic application for dyslexic children [6]	Children feel motivated and the composition of techniques is effective for a dyslexic child to interact with a multimedia application.
A theoretical framework based on dyslexia with dual coding theory and scaffolding instructional technique based on a multimedia application named as MyLexic[21]	This courseware is a great tool for learning for dyslexic children in the Malaya language. Cognitive activities of learning in remedial classes with this courseware of MyLexic environment tailored according to the children’s mental model.

<p>A mobile application to improve the learning performance of dyslexic children with writing difficulties[3]</p>	<p>Writing mobile application promising effectiveness in advancing the writing skills.</p>
<p>A hybrid model is proposed with a combination of cognitive and software development approach[22]</p>	<p>Contextualize cognitive approach towards user interface design is more domain-specific.  Adding skilled based competence will lead the model for more user-centered.</p>

### 3 The System Architecture of proposed model

The aim of this research is to develop a model based on serious gaming principles, as literature has revealed that previously available serious gaming models are quite effective for pedagogy of learning with serious gaming applications, however, very little focus has been done on the standard application design according to fundamentals of Human-Computer Interaction, centric towards special needs children. Therefore, our proposed model is based on a combination of serious game modalities, in terms of application design with game attributes for serious games and pedagogy of learning through cognitive activities. The System architecture of the model is based on six phases, as shown in figure 1. This model is based on the scope of the disorder severity, to game design with detailed proposed parameters for application design rules for serious games. All modalities for serious gaming are integrated with game attributes, allowing cognitive activities

according to the mental model for the user. This integration can increase its effectiveness of learning for children while playing games.

#### 3.1 User Judgment

The user's Judgment phase defines the user's decision towards the system according to the modalities through which he/she has to respond[20]. Every user has a specific interest in the system and how he/she is going to perceive its judgment, is based according to its mental model. User judgment shows a relationship between players towards the game.

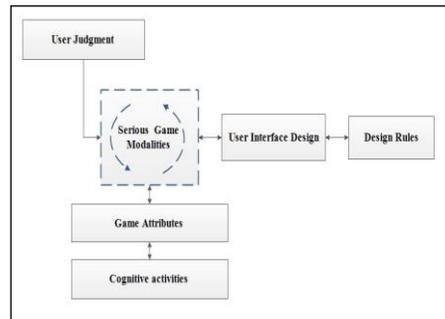


Fig. 1. Figure 1 System Architecture of serious game model Serious game Modalities

#### 3.2 Serious game Modalities

Game Modality is defined as how any acquired information, the idea is expressed in the form of different activities. Games that use one modal are known as Unimodal, whereas games that use two modalities are known as bimodal and similar games that integrate more than two modalities are known as multimodal. Joining two or more modalities for input is known as Multimodal Fusion and separating information and ideas into two or more communication modalities is called Multimodal Fission. Speech, gestures, gait, facial expression are examples of input modalities and text, graphics, animation, video model and feedback are examples of output modalities[18][23].

In serious gaming modalities, speech can be used as input modality but gestures, gait, facial expression were not used in serious

gaming modalities because such type of modalities is hidden actions that can increase the complexity of serious gaming. Output modalities were used in serious gaming applications according to application design and serious game attributes with cognitive activities that acquired output modalities according to the mental modal of its users.

### 3.3 User Interface Design

User Interface design defines the main conceptual phase of serious game development. It is a tangible structure for a game that can be sketched according to User interface design rules, to ensure that serious gaming is ease to use [2], [3], [21] and user interactivity is quite effective and enjoyable while playing and learning at the same time.

### 3.4 Design Rules

Design Rules defines serious game aesthetics in terms of mobile anatomy, placing & laying-out elements, widgets, graphics, and menu to manage the enthusiastic view of a game that is designed for special needs children with cognitive learning according to HCI (Human-Computer Interaction) rules. Following are the key Design rules proposed and adopted in this research:

- Reducing Cognitive fatigue by dividing large and complex sections into small chunks or tasks.
- Avoid cluttering, means removing overloaded user interface design with crowded action bars.
- Offload tasks can be managed by removing the hidden menu, options, navigations, and input gestures that make serious game application UI a burden.
- Don't use jargon in layout design need to remove technical terms, acronyms, phrases that make it difficult to read and understand for children in serious game design.
- Text legibility is managed by using a dark color and moderated text size that can be properly visible in game design.

- Consistency in layout can be managed by a functionally and visually consistent layout in overall serious game design.
- Avoid instant alert messages because such interrupted notification can distract the child while interacting with serious game.
- Removing background stimuli is necessary for serious games because it creates crowded graphics and texture can distract a child from cognitive activities.

### 3.5 Game Attributes

Serious gaming application design for a special group of users like dyslexia required specific well-defined methodology of gaming that incorporates manual teaching features for special needs children. All these features, attributes reflect the pedagogy of learning in an interactive environment of learning to engage and motivate a child. The literature highlighted various theories, cognitivism about serious gaming attributes.

- Motivate players after achieving a good score at the end of the activity to encourage them to play hard, congratulation text and audio played in serious games to strengthen their skill.
- Repetition of tasks can increase their practice and drill helps to improve their cognitive knowledge.

### 3.6 Cognitive Activities

Cognitive activities define the activities that have been designed for serious games based on appropriate learning tasks and enthusiastic challenges that they feel motivated and connected towards learning while playing the game. Game genre, game learning activities, and game mechanics are the part of cognitive activities that define that game genre an interaction between the game and a player which should be challenging interactive game to play rather than visual or narrative activities for example puzzles, finding missing letters, listen and find letters, etc. Game mechanics defined the set of behaviors, actions, and control given to the player within the cognitive activity so he/she

make the decision for levels of game and game mechanics support the overall dynamics of gameplay to improve their interactivity and engagement towards the system. Learning activities are designed to maintain parallel both game and scenario of learning. Choosing which types of activities are necessary for a dyslexic child to learn in serious games[1], [3].

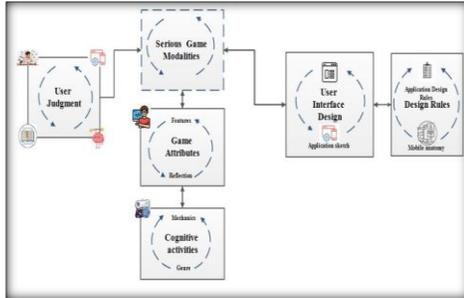


Fig. 2. Detailed view of serious game model

#### 4 Results and Discussion

The research revealed that numerous frameworks and models available for Gamification (Game Design) but few of them focused on Serious Game Design model specifically for hidden neurological disorders. We chose two frameworks for evaluation, discussed by Nizar, B. S., et al.[25]and Yusoff, A., et al. [26], with our proposed Serious Game Design Model because their research objectives, domain, and components that have been proposed by both researchers is similar. Components that have been used for evaluation are discussed in Table 2, based on the similar components from both framework and some additional components are from the proposed serious game design model for dyslexic children. An objective of serious game frameworks is aimed towards the developers to develop and design an effective serious game for children with neurological disorders like dyslexia and autism spectrum disorder etc. Components that are related in our proposed serious game model are grouped together as shown in Table 2. Parameters that have been selected for evaluation are based on interrelated components of both models and some components are added on behalf of a

proposed serious game model that was not defined by both researchers in [26] and [25]. Parameters that have been selected for evaluation between three models are user profile, serious game modalities, user interface design, user interface design rules, game attributes and cognitive activities. All these selected parameters are co-related with both serious game models [25],[26] as shown in Table 2. Table 2 clearly shows that A Conceptual framework for serious game[26] based on gaming attributes and they did properly managed what type of learning activities and game mechanics should be followed by serious gaming developers to develop an efficient application for users but the limitation of this research is that they wouldn't be focused onto user interface design and rules for UI design for serious game and there is no any clear modalities mentioned that were preferred for a serious games. As shown in Table 2 design components of serious gaming for Autism Spectrum Disorder ASD[25] they managed user profile, serious gaming modalities, game attributes with cognitive activities and their sub divided components like game mechanics, genre and learning activities and somehow they discussed user interface design but in this research limitation are there is no any user interface design rules for serious games and which type of modalities should be preferred for the developers when developing an application for special group of users having learning-based difficulties.

#### 5 Conclusions

In this research paper, we try to cover a diverse issue of serious gaming for dyslexic children. In this proposed model, each phase is discussed which plays a vital role in the development of serious gaming applications. Each phase from user judgment, where he/she has to decide the type of interaction required for the serious game based on the input/output modalities, suggested according to a mental model of serious game users.

TABLE II. DETAILED VIEW OF SERIOUS GAME MODEL

Parameters		Conceptual Framework for serious game[26]	Design components of serious gaming for Autism Spectrum Disorder [25]	Serious Game Model
User profile		No	Yes	Yes
Serious Game Modalities		No	Yes	Yes
User Interface Design		No	Yes	Yes
User Interface Design Rules		No	No	Yes
Game Attributes		Yes	Yes	Yes
Cognitive Activities	Mechanics	Yes	Yes	Yes
	Genre	No	Yes	Yes
	Learning activity	Yes	Yes	Yes

Serious game design sketch is based on application design rules in which manually teaching methodologies parameters were used to design a user interface and their interactive behaviors are controlled with game attributes that cater to the issue of gaming objectives. These objectives differ a serious game from any tutor application to do so cognitive activities made more appealing to motivate the users to accept challenges to perform different tasks in a game-like environment. We expect that the model is providing standard postulates for serious gaming application developers.

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