Designing Gamified Learning Interfaces for Dyslexic Students in Malaysian Primary Schools: A Conceptual Framework

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ABSTRACT

This study proposes a comprehensive conceptual framework to guide the design of gamified learning interfaces that support the unique cognitive and contextual needs of dyslexic students in Malaysian primary schools. Grounded in study across inclusive education, assistive technology, and culturally responsive pedagogy, the framework emphasizes cognitive accessibility, learner motivation, and socio-cultural relevance. It considers Malaysia's socio-economic stratification, encompassing the B40, M40, T20, and T5 categories, along with the enduring digital gap between urban and rural populations. These factors are considered to ensure that design strategies remain equitable, inclusive, and suitable for large-scale implementation. Informed by an exploratory literatures and synthesis of recent studies, including advancements in mobile literacy tools and intelligent reading systems, the framework addresses current gaps in educational technology for dyslexic students. A set of six interrelated pillars of practical design is also presented to guide future prototyping, collaborative design efforts, and usability testing in real classroom settings.

Keywords: gamified learning interfaces, culturally responsive design, inclusive education, digital education, dyslexic students

INTRODUCTION

Dyslexia is a prevalent learning disability that affects the acquisition of reading and writing skills [1], with significant implications for primary school students. In Malaysia, this condition is gaining increasing attention in educational discourse and policy, yet digital learning interventions remain inadequately adapted to the cognitive and contextual needs of dyslexic students. The existing gamified learning solutions are often designed for generalized populations, neglecting the specific issues encountered by dyslexic students especially those from the B40 income category and living in rural regions. Restricted device accessibility, inadequate parental digital proficiency, and under-resourced schools further marginalize these students.

While key governmental initiatives such as the Malaysian Education Blueprint 2013-2025 and the Zero Reject Policy demonstrate increased institutional commitment to inclusive education, implementation remains varied. This variation depends on the school type and geographical area. The disparity between legislative purpose and classroom practice emphasizes the need for scalable, cost-effective digital interventions that accommodate to students with diverse cognitive and socio-economic backgrounds.

In Malaysia, socio-economic segmentation is officially divided into four primary income groups: the Bottom 40 percent (B40), the Middle 40 percent (M40), the Top 20 percent (T20), and the Emerging Top 5 percent (T5) within the T20 category. These classifications are based on household income and are used to guide educational, health, and social development programs. Students from B40 households frequently experience budgetary constraints, restricted access to digital devices, and low levels of parental digital competence. In contrast, students in the T20 and T5 groups frequently benefit from enhanced learning spaces, private tutoring, and access to cutting-edge technology.

As a result, this paper aims to introduce a conceptual framework that recognizes these disparities and integrates

pedagogical theory, as well as gamification principles to guide the design of gamified learning interfaces for dyslexic students. This is in line with the current digital learning approach where gamification serves as a strategic method to transforming rigid teaching structures into adaptive, user-centered experiences that appeal to dyslexic students. Furthermore, the conceptual framework also aims to bridge current gaps by advocating for culturally localized, and digitally inclusive solutions aligned with national and global educational equity goals.

LITERATURE REVIEW

An increasing amount of evidence supports the use of gamified learning approaches to improve literacy outcomes in dyslexic students. Gamification, when combined with pedagogical intent, has been found to improve student motivation, reinforce literacy skills, and create engagement. Several projects, such as LexiPal [2] and LexiLearn [3], demonstrated the effective use of gaming mechanics to improve phonemic awareness and word recognition through structured activities and interactive storytelling. These studies highlighted the use of adaptive challenges, progress-based rewards, and individualized pacing to satisfy individual learner needs.

Reference [4] highlighted the value of participatory design, a method in which students who have dyslexia are directly involved in the process of defining the characteristics of educational games. This promotes cognitive alignment and usability. Reference [5], on the other hand, provided evidence that reading fluency can be greatly improved by the use of mobile game-based sight-word training that incorporates vocabulary repetition and multimodal feedback. In a similar vein, the iRead Project [6] pushed for the utilization of intelligent linguistic modelling and the adaption of information to several languages in order to customize interventions for students from a variety of backgrounds.

Reference [7] underlined the necessity of user interfaces that lower cognitive load for dyslexic students through the use of dyslexia-friendly fonts, straightforward navigation, and minimalist design. Larco et al. (2021) introduced the Helpdys app [8], which is designed for rural distribution by providing offline access and compatibility with low-end Android devices. Meanwhile, local studies from Malaysia [9]-[10] emphasized how inclusive students in B40 households encountered significant barriers in digital literacy, including limited device access, low teacher preparedness, and socio-economic constraints.

Reference [11] conducted a meta-analysis of gamification in educational contexts, highlighting autonomy, competence, and feedback loops as essential motivational factors for maintaining student engagement. Additionally, sustainability and cultural localization have emerged as essential design imperatives. Reference [12] performed a systematic review demonstrating that mobile learning interventions can be tailored for inclusive education by integrating local cultural references, accommodating user diversity, and employing context-sensitive pedagogical strategies. The study highlighted the necessity of making mobile applications both technologically accessible, as well as socially and culturally pertinent for students with functional impairments. These studies collectively contribute to the development of a framework that is both pedagogically sound and contextually attuned to the socio-economic and cultural realities of Malaysian primary school students.

METHODOLOGY

This study employed an exploratory, literature-informed approach to develop a comprehensive conceptual framework for gamified learning interfaces designed for dyslexic students in Malaysian primary schools. The methodology emphasized the synthesis of current academic findings from interdisciplinary sources to guide framework creation. This methodology was considered suitable due to the study's aim of integrating design principles and pedagogical issues for dyslexic students into a cohesive framework to inform future educational interventions and system development.

In order to accumulate pertinent information, we utilized credible online databases such as Scopus, SpringerLink, and ScienceDirect to access peer-reviewed academic literature. The search queries included terms such as "inclusive education", "dyslexia", "gamified interface design", and "educational interface

design". Twelve studies published between 2019 and 2024 were purposefully chosen for their empirical foundation, relevance to primary education, and alignment with the learning requirements of students with literacy difficulties. Critical elements, including pedagogical scaffolding, visual design considerations, cognitive accessibility features, and user engagement strategies, were meticulously examined in these studies. The extracted insights were subsequently thematically organized and condensed into the primary components of the framework.

The resulting conceptual framework incorporates these findings while remaining thoroughly contextualized to the Malaysian primary education setting. The framework specifically addresses the needs of both digitally privileged (T20 and urban) and underserved (B40 and rural) student populations. Cultural appropriateness, digital accessibility, and learning diversity were prioritized to enable broad applicability. Though the study does not include empirical validation or prototype testing, it provides a research-informed foundation for future development of gamified educational tools aimed at supporting dyslexic students in Malaysian classroom settings.

FINDINGS

The suggested conceptual framework comprises six interrelated pillars, each symbolizing a fundamental aspect of inclusive and context-sensitive gamified learning for dyslexic students in Malaysian primary schools. These principles together inform the design of learning interfaces that address students' cognitive, motivational, visual, and socio-economic requirements. Fig. 1 visually depicts the linkages among the pillars, demonstrating how each component contributes to a cohesive, learner-centered design strategy.

Learner Profile

The first pillar provides a foundational understanding of the target users, who are primary school students with dyslexia. It takes into account a variety of cognitive traits, including issues with phonological processing, limitations in working memory, and slower reading or decoding speeds. In addition to these neurocognitive traits, it takes into account socio-environmental factors such as access to digital devices, exposure to assistive technology, primary language spoken at home (either Bahasa Malaysia, English, or other vernacular languages), and the overall digital literacy of the student's household. By profiling students across these dimensions, designers can develop instructional pathways that are both inclusive and responsive to varied learning capabilities and environmental constraints. The constraints may include dependency on shared mobile devices, intermittent power supply, or insufficient parental support for digital learning.

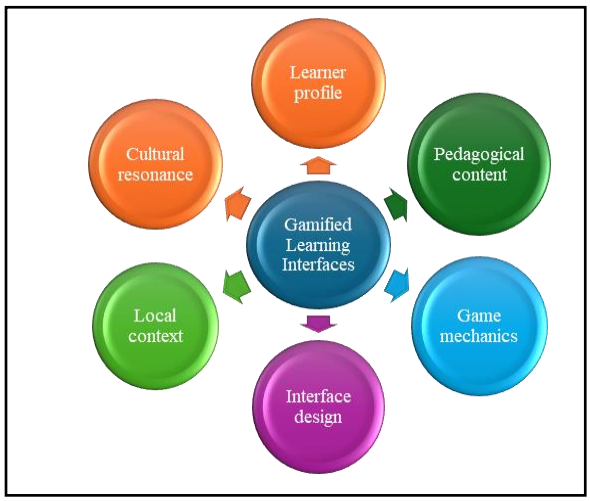

Fig.1. Six interrelated pillars of gamified learning interfaces for dyslexic students in Malaysian primary schools

Pedagogical Content

Successful gamified learning experiences must be grounded on robust literacy education approaches. This

component highlights the application of structured literacy principles tailored for dyslexic students. It encompasses focused interventions like phonemic awareness activities, grapheme-phoneme correspondence exercises, syllable blending tasks, and repeated exposure to high-frequency sight words. Reference [5] demonstrate that content promoting repetition through many sensory modalities, including concurrent text, images, and auditory cues, is beneficial. The content should align with national learning standards but remain modular in structure, allowing gradual progression and easy customization according to the learner's pace and performance.

Game Mechanics

The third pillar focuses on incorporating game-based aspects that promote student motivation and sustained participation. Mechanisms include accumulating points, collecting digital badges, unlocking new levels, creating individual goals, and delivering real-time performance feedback. These features are meant to provide students a greater sense of progress, ownership, and competence. Furthermore, through game mechanics, its emphasis is towards building intrinsic motivation by allowing students to feel autonomous, socially connected, and successful in their endeavors [11]. Importantly, each game component should complement an instructional objective, so that gameplay supports learning rather than serving as a distraction.

Interface Design

The user interface is crucial for accessibility, particularly for dyslexic students. This pillar advocates for visual simplicity, consistent layout, and intuitive interaction. Design components include the use of fonts that are easier for dyslexic readers to process such as OpenDyslexic, high-contrast colors, and a clear grouping of on-screen content. Textual content should be given in short, understandable chunks, with helpful indicators and visual cues. The navigation system should follow a sequential flow that is consistent with how students digest information step by step. Furthermore, the interface should remove unnecessary visual clutter and be suitable with various screen sizes and touchscreen sensitivity levels, especially for low-end Android smartphones [7].

Local Contextualization

This pillar ensures that the framework is pertinent to the diverse sociocultural, socio-economic, and infrastructural landscape of Malaysia. The design of characters and narratives that reflect the daily lives of Malaysian children, the incorporation of local dialects, and the creation of familiar environments such as rural educational institutions and national events are all part of this. This pillar is also fundamentally influenced by technological considerations. In order to facilitate learners in rural or underserved areas, the application must operate efficiently in low-bandwidth or offline environments. This component emphasizes affordability, cultural relevance, and inclusivity in order to overcome the obstacles to equitable digital learning.

Cultural Resonance Through Character Integration

This final pillar focuses on the purposeful usage of culturally known cartoon characters like *Upin & Ipin* and *Ejen Ali* to increase engagement, emotional connection, and motivational appeal in the learning interface. These characters are well-known and appreciated by Malaysian children from all socio-economic backgrounds. Their integration into the user interface can take several forms, such as animated guides, instructional avatars, or incentive figures that accompany students throughout the educational game. By incorporating familiar faces and narratives, the game design can boost student immersion and lessen the anxiety that is frequently linked with reading challenges. This method is consistent with the concepts of culturally responsive pedagogy and promotes equality by ensuring that learners from all socio-economic backgrounds see their cultural surroundings positively represented within the learning content.

Future Works

The next phase of this study will focus on translating the conceptual framework into tangible design artifacts. This includes making interactive wireframes and high-fidelity digital mock-ups that put into action each of the six interconnected pillars. These prototypes will be co-developed in collaboration with special education

teachers, Information Technology (IT) designers, and literacy specialists to ensure both pedagogical validity and technological feasibility.

Participatory design sessions will be conducted in selected primary schools representing both urban and rural settings. These sessions will involve dyslexic students, their parents or guardians, and classroom teachers to gather diverse feedback on usability, engagement, and cultural fit. The System Usability Scale (SUS) will be utilized to quantify user satisfaction, with qualitative data gathered through interviews and observations. The iterative testing cycle allows for continual refinement of the interface, instructional material, and motivational elements.

In parallel, the study intends to investigate integration with text-to-speech functionality to improve accessibility, particularly for students who have significant decoding difficulties. Additional work will concentrate on including gamified assessment tools that may deliver real-time feedback to both students and educators while measuring reading progress and engagement levels. Cross-platform accessibility will also be a design focus, assuring functionality across smartphones, tablets, and low-specification devices frequently used in B40 families.

Future phases will necessitate strategic partnerships with the Ministry of Education, local educational technology companies, and Non-Governmental Organizations (NGOs) that provide assistance to children with learning disabilities in order to expand the solution on a national scale. These collaborations will be crucial in aligning the final product with national curriculum standards and in facilitating pilot implementation across multiple school zones. Further study may also include longitudinal impact studies to evaluate learning outcomes over time and to assess how the gamified interface supports long-term literacy development and digital inclusion for dyslexic students in Malaysia.

Ethical Considerations

This study places a strong emphasis on safeguarding the rights and welfare of participating children, particularly dyslexic students in Malaysian primary schools. Considering the susceptibility of the target group, the research team upholds strict adherence to informed consent protocols. Prior to data collection, clear and age-appropriate information about the study's objectives, procedures, potential benefits, and any foreseeable risks will be communicated to all participants and their guardians. Informed consent will be obtained from parents or legal guardians, and assent will also be sought from the children themselves where appropriate. These measures are crucial to ensure that participation is voluntary and based on a full understanding of the research process. Special care will be taken to maintain confidentiality and anonymity, particularly when handling sensitive educational data or behavioral observations [13].

In addition, this study will comply with institutional and national ethical standards by obtaining formal ethics approval from the Malaysia Ministry of Education (MoE) and pertinent university ethics committees. Before interacting with any educational institution or student demographic, a comprehensive research protocol will be presented for evaluation, detailing the study's aims, methodology, data protection procedures, and risk management plans. In Malaysia, obtaining approval from the MoE is crucial for any educational research involving public schools [14]. Interactions with school officials and educators will adhere to formal protocols to guarantee transparency and cooperation during the research process.

Furthermore, this study is devoted to adhering to worldwide and national ethical frameworks such as the Declaration of Helsinki and the Malaysian Code of Responsible Conduct in Research. These frameworks highlight concepts such as respect for others, beneficence, and fairness, which are especially relevant in studies involving students with learning disabilities [15]. All researchers will be trained in child protection and ethical research techniques to ensure that interactions with students are polite and non-intrusive. All technical components, including the gamified learning interface, will be age-appropriate, culturally sensitive, and inclusive.

Finally, the study includes an ongoing process of ethical reflection and monitoring. This includes means for gathering input from participants, parents, and instructors, as well as adaptive procedures in the event that

unforeseen ethical problems arise during implementation. The research team will maintain strong ethical standards throughout the project, ensuring that the well-being and dignity of dyslexic students are safeguarded at all stages.

CONCLUSION

This study presents a comprehensive and contextually relevant conceptual framework for the design of gamified learning interfaces aimed at dyslexic students in Malaysian primary schools. The paradigm enhances equitable access to digital literacy tools by incorporating concepts from cognitive research, inclusive education, and technological adaptability. It also takes into account Malaysia's socio-economic stratification, which includes the Bottom 40 percent (B40), Middle 40 percent (M40), Top 20 percent (T20), and the highest-earning Top 5 percent (T5). These income groups affect discrepancies in device accessibility, digital exposure, and educational assistance at home. By considering these socio-economic aspects, the conceptual framework provides a means to mitigate the digital learning divide nationwide. Its link with Malaysia's national education framework renders it a pertinent and timely contribution to inclusive education reform.

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