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WordWall Applications in Teaching Mathematics Subjects for Students with Dyscalculia

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ABSTRACT

Students with dyscalculia often have difficulty with tasks involving arithmetic, measurement, and recognizing patterns in numbers. However, with the rise of technology, we can now create innovative tools to help them learn. This paper explores the effectiveness of the Wordwall app in improving the math learning experience of children with learning disabilities. The focus of this study is to identify the suitability of WordWall app in teaching the topic value of money and investigate how the WordWall app help to improve dyscalculia students' understanding of this topic. This study uses a qualitative approach by involving two special education teachers who are teaching in Malaysia government secondary school. Interviews are the methods used as research instruments for of data collection. Based on the outcome, it's shows that the WordWall app able to help and improve the learning of the students with dyscalculia and it has the potential to be use in the classrooms. Nevertheless, there are some limitations that came up in the process of using the WordWall application. Teachers also provide suggestions for WordWall application in mathematics subjects on the topic of money value. In conclusion, this study provides an important view on the appropriateness of using the WordWall application for the topic of the value of money in mathematics subjects for students with dyscalculia.

Keywords: Perspectives; dyscalculia; basic mathematical; Wordwall; special education teacher; application; mathematics

1. Introduction

Mathematics plays a vital role in the personal development in terms of thinking, skills, and knowledge. Mathematics education can equip students to think logically, analytically, systematically, and critically [1,2]. The topic of money value in mathematics is very important for students because it helps them understand basic financial concepts that will be useful in their daily lives. It raises students' awareness about finance, where it teaches them the importance of managing finances from a young age and provides skills in managing money as students learn how to budget, save, and make wise financial decisions. However, not all the students can learn these skills easily.

Dyscalculia, a learning difficulty that affects a person's ability to understand and work with numbers, can make math a real struggle. People with dyscalculia may find it tough to grasp basic concepts, perform calculations, or even remember simple math facts and making financial concepts particularly challenging [2]. Dyscalculia involves the inability to understand mathematical facts, perform mathematical operations [3], solve mathematical problems [4,9], and remember mathematical facts. People with dyscalculia have trouble with math at many levels. Mukherjee *et al.*,

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[4] emphasised that dyscalculia is a disability that results in difficulty learning or understanding arithmetic, such as difficulty in understanding numbers, learning how to manipulate numbers, performing calculations, etc. However, dyscalculia can be detected as early as preschool years, and it becomes very visible when children grow older. While research has extensively focused on the cognitive challenges associated with dyscalculia, limited studies explore how digital learning tools can address the specific needs of dyscalculic students. This gap is particularly significant as technology evolves, requiring innovative approaches to integrate digital tools into effective learning strategies for these learners. In guiding their learning, teachers need to apply 21st-century skills such as critical thinking, communication and collaboration, creativity and innovation, information literacy, media literacy, digital citizenship, problem-solving, and decision-making. As technology evolves rapidly, these skills become even more important for students to learn.

1.1 Objective

This study seeks to explore the use of the WordWall application to teach money concepts to students with dyscalculia. The specific objective is to identifying the suitability of the WordWall application for teaching money value and how the WordWall application helps improve the understanding of dyscalculic students for the money value topic in mathematics subjects.

1.2 Literature Review

1.2.1 Social constructivist theory

Social constructivist theory by Lev Vygotsky emphasizes the significant role of social interaction and cultural contexts in cognitive development. According to Navarro *et al.*, [5] a student's knowledge grows through interaction with others and due to environmental influences. The fundamental notions which make up this theory are the Zone of Proximal Development, the concept that describes the gap between what a student is able to accomplish on their own and what they can achieve with help; scaffolding, or the process in which the support given by the teacher is gradually taken away as the student's abilities improve; and the use of language as a tool in cognitive children's development [6]. Through social engagement with more knowledgeable individuals, students internalize new skills and knowledge, making learning deeply rooted in their cultural and social context. Vygotsky's sociocultural theory of development has equally been observed to give an edge on the interaction between the learner and other people in learning and development.

Mudi & Samanta [7] and Salas & Lupita [8] have pinpointed that his ZPD indicates greater learning may be facilitated by collaboration and guided support. This becomes a perspective colliding with other theories that propose predetermined, biologically modular stages of development and instead points out that learning is dictated by cultural and historical context [9]. Some of the key messages in Vygotsky's ideas include the development of critical thinking, creativity, and human agency by interaction between human beings and mediation through tools and signs. Application of

Vygotsky's theory into practice could yield learning that is much more contextualized and meaningful, thereby giving rise to democratic and supportive societies. However, the rigid focus on standardized outcomes now may inhibit such ideas from being tried; a refocusing of education may be needed in order to form social contexts within which young people can learn best.

1.2.2 Wordwall application

The use of applications WordWall opens up opportunities for students to be more creative and innovative during learning. In addition, an engaging learning process will boost students' enthusiasm and motivation to learn. One effort to make learning enjoyable as mentioned above is by using the WordWall application as an educational game. According to Hidayaty *et al.*, [10], the application of online gamification with WordWall has quite effective results in enhancing the absorption of learning materials, and the WordWall application can also increase students' learning motivation. WordWall provides various templates for games and activities such as quizzes, matching, random wheels, word searches, and much more.

The WordWall application allows teachers to create content that suits various learning styles and learning objectives. According to Rosdiani *et al.*, [11], the advantage of the WordWall application is that it has various types of templates that can be created and used by teachers in a short time and this application does not take long to create. The use of the WordWall application can help teachers easily adjust learning content to meet their needs, including adding text, images, and audio. This shows that the WordWall application can make Teaching and Learning (PdP) sessions more engaging and relevant for students. According to Maryanti *et al.*, [12], the WordWall learning application is easy to use and has many alternative options for delivering materials and questions, and teachers can use it as another alternative option for variation in creating other materials.

1.2.3 Integration Wordwall into mathematics

Recent studies have concerned how a web-based learning environment such as Wordwall might facilitate math concepts and improve student learning. Studies involving the use of Wordwall in teaching fundamental integration demonstrated that the teaching method was effective for both face-to-face learning and online learning. According to Ramanda *et al.*, [13], its implementation has been able to enhance understanding in science concepts significantly among students, while Salsabila & Tsurayya [14] document how such approaches enhanced their representation capabilities in mathematics. Integrating Wordwall to the students with dyscalculia can help and promote interactive, progressively more complex, culturally relevant experiences that support their diversity of learning and motivate them to learn.

Wordwall is designed for interactive gamified learning. With Wordwall's differentiated activities-matching games, sorting activities, and quizzes-teachers can plan activities to match each student's zone of proximal development, enabling students to engage in the math-related task that is challenging but achievable with assistance. By gradually removing this assistance as students gain confidence, teachers can support independent problem-solving skills.

In dyscalculic students, integrated approaches that marry working memory training with visual approaches like sketchnotes have resulted in an enhanced word problem-solving ability as stated by Ziadat [15]. Similarly, Ramirez *et al.*, [16] found the D-Knights mobile game demonstrated promising results in enhancing the learning experience for students with dyscalculia and math learning disabilities. The combination of engaging gameplay, effective monitoring tools for teachers, and customizable content contributed to improved math skills and increased student motivation. Salsabila & Tsurayya [14] adopting a quantitative research approach with experimental methods to assess the impact of WordWall media on students' mathematical representation abilities and determine the extent of this influence. The findings reveal that incorporating WordWall edugames in classroom instruction can enhance students' mathematical representation capabilities, foster an interactive learning environment, and improve students' self-expression. Although WordWall can

enhance motivation, it does not specifically address the cognitive needs of a dyscalculic student. Those students benefit more when the interventions are adapted concerning working memory and schematic understanding [17]. Since WordWall relies so much on its visual and interactive elements, it may not be suitable for a significant number of dyscalculic students, and rather than clarity, students will become further confused. While it may be effective in facilitating learning for many, Wordwall is not that effective for students with dyscalculia-only if there are specific learning preferences or supplementing instructional strategies.

2. Methodology

2.1 Research Design

This study uses a qualitative study design that is partially structured to interview the special education teachers. The choice of qualitative methodology is rooted in the need to understand the experiences and perspectives of both educators and students regarding the effectiveness of WordWall in enhancing mathematical learning. Researcher revisiting the interviewing protocol study, whereby this interview protocol refers to the document containing the design, structure and guidelines to conduct the interview in the investigation.

2.2 Participants

The participants consist of two special education teachers who are teaching Integrated Special Education Program (PPKI) in Terengganu. The names of the participants in this study are not announced, instead of being nominated Teacher A and B to maintain ethical research subjects must be protected to avoid any interference, threats, and misinterpretations against them.

2.3 Data Collection

Data was collected through a face-to-face interview with Teacher A and Teacher B. This approach allowed for flexibility in exploring participants' insights while maintaining a focus on specific topics related to the use WordWall in teaching mathematics. Each interview took between 40 minutes to 60 minutes. In accordance with the interview protocol, participants were asked semi-structural questions. The interviews will be conducted in a comfortable setting depending on participants' availability and preferences. Data from the interview session were transcribed verbatim upon consent from the participant. Data analyses were made to find the suitability of the WordWall application in teaching money concepts and how the WordWall application helps improve the understanding of dyscalculic students.

3. Results and Discussion

The analysis is based on interviews with two special education teachers, Teacher A and Teacher B, who have utilized WordWall in their teaching practices. The results of the findings are summarized to the specific themes that are the suitability of the WordWall application for teaching money value and the effectiveness of using WordWall application in help the mastery of dyscalculia students for teaching the value of money topic in mathematics subjects. The following is the findings of the study theme.

3.1 Suitability of The Wordwall Application for Teaching Money Value for Dyscalculic Students

This part focuses on evaluating the suitability of the WordWall application as a teaching tool for the topic of money in mathematics, specifically for students with dyscalculia. The analysis in Table 1 is based on interviews conducted with two special education teachers, Teacher A and Teacher B, who have experience using WordWall in their teaching practices.

Table 1

Suitability of the WordWall application for teaching money value topic

Participants	Themes and Descriptions
	Initial Use and Experience
Teacher A	First utilized WordWall during the COVID-19 pandemic in 2021 but reported infrequent use post-pandemic due to a lack of projector facilities in the school, making it challenging for all students to view the content clearly.
Teacher B	Faces similar limitations regarding projector availability, continues to use WordWall regularly in mathematics lessons. He emphasizes that he invests extra time during lessons to ensure all students can see the application.
	Ease of Use
Teacher A	Appreciates its simplicity, especially for older educators, as it allows for easy incorporation of images and text to create engaging templates.
Teacher B	Finds it straightforward and notes that his students enjoy using WordWall, which contributes positively to their learning experience.
	Suitability for Teaching Money Concepts:
Teacher A	Teachers manage to incorporate images of currency effectively, helping students visualize and differentiate between various denominations.
Teacher B	The application's interactive nature aligns well with students' interests, particularly in a technology-driven era where gamified learning is appealing.
	Impact on Student Learning:
Teacher A	Observed notable improvements in students' ability to remember and distinguish between different types of currency after using WordWall. This indicates that the application enhances retention and understanding of money concepts.
Teacher B	Stated that his students require less time to grasp money-related topics after engaging with WordWall, suggesting a significant positive impact on their learning outcomes

Both Teacher A and B show a strong agreement from the findings of an interview about WordWall suitable to be used in teaching money concept for math subject to dyscalculic students. Even though they face issues of technology accessibility, each educator sees value in the application for increasing student engagement and comprehension. WordWall is a great tool to promote peer learning as students can use the slides themselves which works well in special education and complex topics such as financial literacy.

3.2 The Effectiveness of using Wordwall Application to Mastery the Value of Money Topic in Mathematics Subjects

For the effectiveness of using WordWall application to mastery the value of money topic, both Teacher A and Teacher B reported that after using WordWall, dyscalculic students were able to effectively differentiate between various denominations of money, including both coins and notes. The analysis is showed in Table 2.

Table 2

Effectiveness of using WordWall application to mastery the value of money topic

Teacher	Themes
	Ability to Differentiate Monetary Values
	Both of the participants reported that after using WordWall, dyscalculic students were able to effectively differentiate between various denominations of money, including both coins and notes.
Teacher A	Students did not take long to identify different values, indicating a significant improvement in them understanding.
Teacher B	Compare to previous teaching methods, where students struggled to distinguish between monetary values, WordWall facilitated better comprehension.
	Impact on Real-Life Situations
	When asked about the application's effectiveness in real-life scenarios, such as purchasing items at the school canteen, both teachers observed that students no longer required close supervision during transactions.
Teacher A	Teachers and Student Management Assistant (PPM) felt more at ease as students confidently handled their purchases
Teacher B	During her supervision at the canteen, students efficiently paid for their items without hesitation.
	Application in Daily Life
	The interviews also explored whether WordWall helped students apply their understanding of money in everyday situations.
Teacher A	A student assisted a peer who was unsure about making a payment, demonstrating the application's positive impact on social interactions and practical skills.
Teacher B	Feedback from parents indicating that their children could independently manage money outside school, further validating the effectiveness of WordWall.

4. Conclusions

The findings of the study revealed the suitability and effectiveness of the WordWall application in helping dyscalculic students to better understand concepts of money. Indeed, both Teacher A and Teacher B reported significantly improved skills. Both educators observed improvements in students' abilities to recognize and use different monetary values after engaging with the application. This is also supported by other studies, which have found that student engagement and learning are very much affected by interactive tools. For instance, a study by Aghel *et al.*, [18] revealed that students exhibited higher levels of participation and enthusiasm in learning activities when using WordWall, as evidenced by qualitative studies. The interactivity of these kinds of applications is bound not only to nurture but also to promote retention and comprehension of even abstruse concepts. Similarly, Siagian [19] reported that using WordWall media contributed positively to increasing students' learning outcomes. The application has been shown to facilitate better comprehension of complex concepts, leading to improved academic performance in mathematics. Moreover, both of the teachers mentioned that their students could apply their knowledge of money when buying things from the school canteen. Such application to real-life situations is very important for students with dyscalculia, as it fills in the gap of theoretical knowledge and usage in the real world. The observation by Teacher A further supported how WordWall built confidence and independence in dyscalculic learners by no longer having their students always supervised during transactions.

Consequently, this research has identified evidence to support the claim that the WordWall application serves as an effective tool in teaching monetary concepts to dyscalculic students in mathematics education. These findings are an indication of the fact that interactive learning tools can enhance, to a very great degree, the level of student engagement in learning and their comprehension, especially for those students with learning difficulties [20]. As educators continue to seek innovative solutions to support diverse learners, integrating applications like WordWall into teaching practices indeed presents an avenue of promise in attempts toward fostering academic

success for dyscalculic students. Long-term use of such applications and other features which can be integrated to make them more effective also needs to be studied in future research regarding their impacts on student learning outcomes.

While the benefits accruing from WordWall are apparent, full attention has to be paid to the fact that not all will respond similarly to interactive tools [21]. Some may continue being their slow selves with the conventional mode of learning, showing in this case a need for balance in implementation of different teaching skills for various learning needs. Implementing varied teaching methods has been shown to significantly boost up student motivation and engagement, creating a more conducive learning environment [22]. In general, the present study provides valuable insights pertaining to the role of technology in special education and raises a need for further innovation in teaching methodologies in order to more appropriately support all learners. Future studies should involve a larger, more diverse sample of teachers and students, employ mixed methods, and explore varied educational contexts to provide a comprehensive evaluation of the WordWall app's effectiveness for dyscalculic learners. In addition, future studies should address this by incorporating quantitative measures such as pre- and post-tests to assess students' mathematical skill improvements. Combining these with qualitative insights can provide a mixed- methods approach, offering a more robust and comprehensive evaluation. To address the issue of generalization, future studies should include a more diverse group of dyscalculic students with varying learning preferences, needs, and levels of severity.

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