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Educator Insights: A Need Analysis on Developing Mobile Applications as Learning Interventions for Dyscalculia

Noor Hasanah Hashim

Faculty of Educational Studies, Universiti Putra Malaysia

43400 Serdang Selangor, Malaysia

Jazihan Mahat (corresponding author)

Faculty of Educational Studies, Universiti Putra Malaysia

43400 Serdang Selangor, Malaysia

Ahmad Fauzi Mohd Ayub

Faculty of Educational Studies, Universiti Putra Malaysia

43400 Serdang Selangor, Malaysia

Sharifah Intan Sharina Syed-Abdullah

Faculty of Educational Studies, Universiti Putra Malaysia

43400 Serdang Selangor, Malaysia

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Abstract

Dyscalculia, a specific learning disability affecting mathematical abilities, presents challenges in educational settings. This study investigates the academic needs of students with learning disabilities, specifically Dyscalculia, and explores effective interventions to enhance their learning experiences. Semi-structured interviews with experienced educators were conducted using a qualitative approach to gather insights into teaching these students. The findings

emphasize the importance of mastering foundational mathematical concepts, such as numbers 1 to 10, for further understanding. Key themes include the need for tailored learning approaches and technology integration in teaching practices. The research highlights the potential of mobile applications as tools to boost engagement and comprehension. While this study offers valuable insights, it acknowledges limitations such as the small sample size and calls for broader research across diverse educational settings. This article aims to guide educators and policymakers toward inclusive, effective mobile learning interventions for those who are either at risk of or have already been diagnosed with learning disabilities, specifically Dyscalculia.

Keywords: Dyscalculia, needs analysis, mobile application

1. Introduction

According to the Individuals with Disabilities Education Act (IDEA), a specific learning disability refers to a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which may manifest in difficulties with reading, writing, spelling, or mathematical calculations (Mohd Zuri, 2014). Furthermore, according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), individuals with Dyscalculia may struggle with basic arithmetic operations, mathematical reasoning, and number sense. Students with specific learning disabilities may exhibit challenges in acquiring, organizing, retaining, or retrieving information, impacting their academic performance and daily functioning. Dyscalculia is often overshadowed by other learning disabilities like dyslexia, resulting in limited research and fewer specialized interventions.

Early intervention using technology that is widely used, such as mobile applications, helps students in their education, especially students with learning disabilities, master three primary skills: reading, writing, and counting. With the increasing use of digital learning tools worldwide, mobile applications offer a practical, cost-effective, and flexible approach to addressing learning disabilities. Research suggests that mobile-based interventions provide personalized learning experiences and adaptive learning systems (Er-Radi et al., 2023). This intervention can cater to individual needs by offering multimodal content that aligns with learners' strengths with Dyscalculia.

Globally, countries like the United Kingdom and Finland have made strides in integrating technology into learning for students with disabilities, including Dyscalculia. However, in Malaysia, such interventions are still in the early stages, with limited access to specialized tools or teacher training programs focused on dyscalculia-specific strategies. Addressing this gap is crucial for Malaysia to keep pace with global educational trends. Without proper support, students with Dyscalculia face long-term academic underachievement, reduced confidence, and challenges in daily life tasks involving numbers, such as budgeting or time management.

In pursuing quality education and Sustainable Development Goal 4 (SDG 4) of ensuring inclusive and equitable education, it is imperative to have intervention strategies for

Dyscalculia in the Malaysian context. The paradigm shifts in Malaysia curriculum 2027 align with current and future global changes and aim to address challenges with balanced and thoughtful solutions by ensuring student well-being in all circumstances that emphasize technology and inclusivity across all demographics (Kementerian Pendidikan Malaysia, 2023). Specifically, Dyscalculia is a learning disability impacting mathematical abilities poses a significant challenge in Malaysia. Studies have indicated a prevalence rate of Dyscalculia ranging from 4% to 5.5% among school children (Wong et al., 2016). In light of these statistics, Dyscalculia is often overlooked as a significant learning disability issue.

This study explores the potential of mobile technology to bridge the gap in effective dyscalculia interventions in Malaysia. Educators on the front lines of student engagement are uniquely positioned to provide valuable insights into the challenges and needs of students with Dyscalculia. Their insights and experiences in teaching these students provide informative feedback on the design and implementation of the intervention strategies, making their input essential for developing practical, classroom-friendly mobile solutions. Using technology as a learning aid to support the student understanding of a lesson, teachers need to use it wisely in their teaching and learning (Norok & Kamaruddin, 2022). The Malaysian Ministry of Education also emphasizes teacher empowerment programs to produce quality, competitive, skilled teachers who master the latest technology and professional, creative, and critical thinking (Kementerian Pendidikan Malaysia, 2012).

1.1 Learning Intervention for Students With Learning Disabilities or Dyscalculia

Dyscalculia is an alternative term for difficulties characterized by problems processing numerical information, learning arithmetic facts, and performing accurate or fluent calculations. It is a learning-specific disorder, where it is expected to know about Dyslexia rather than Dyscalculia. This issue is not well emphasized because the term was never written once in the Malaysia Education Blueprint of PPPM 2013-2025 (Yoong & Ahmad, 2020). Statistic-wise, about 4% to 6% of the student population is Dyscalculic (Bird, 2017). The condition is often undiagnosed, given its significant impact on individuals and society. The poor mathematical ability associated with Dyscalculia can lead to significant psychosocial and economic risks, including early school dropout, unemployment, and an increased likelihood of developing depressive symptoms (Haberstroh & Schulte-Korne, 2019).

Malaysia's education system has been trying to enhance accessibility and support for students with learning needs. Locally, there are several Special Education Schools nationwide. Apart from that, there is an expansion of the Integration Special Education Programme (PPKI) in primary schools. Furthermore, the Ministry of Education Malaysia implemented a special program known as inclusive education, and the Special Education Division (BPK) was introduced (Ali & Mohamad Nasri, 2021). However, students who are not diagnosed with mild specific learning disorders and are not categorized as students with special educational needs (MBPK) cannot register for the program. Hence, they will be in the mainstream classrooms. If identified as having learning difficulties, they will be in remedial education classes, as stated by the Department of Special Education (2012). Teachers in mainstream courses must support them in their learning so they do not fall far behind their peers (Hasan

& Ahmad, 2018).

Early intervention is needed to help these students support their Mathematical learning, eventually preventing them from encountering math anxiety in the future. As confirmed by research conducted by Vintere (2021), both dyscalculia and maths anxiety can overlap for an individual, although Dyscalculia is a cognitive disorder and maths anxiety involves emotions. Hence, modern technology, such as mobile applications for learning mathematics, will support these children in improving their learning tailored to their needs. Research by Young and MacCormack (2014) emphasized that mobile learning is an effective intervention in learning for children with learning disability as it can stimulate their memory to memorize mathematical facts besides implementing creative ways that attract young students.

In addition, the mobile application's ease of use at any time and from any location will empower educators and parents to assist children with Dyscalculia in their mathematics learning. As a result, exploring the current practices within the Malaysian context makes the development of a mobile application intervention crucial to meet the needs of dyscalculic students while also supporting teachers and parents in Malaysia. This study aims to identify the need for developing a mathematics education intervention using a mobile application for students with learning disabilities, specifically Dyscalculia, in Malaysia. To achieve the need analysis phase, the research questions are as follows:

1) What are the evaluations or assessments used for students with learning disability, such as dyscalculia students in Malaysia, that cover the topic of numbers?

2) What are the learning interventions practiced by the teachers for students with learning disability such as Dyscalculia?

3) What are the requirements for developing a mobile application that covers the topic of numbers for students with learning disabilities, such as dyscalculia, in Malaysia?

1.2 Literature Review

1.2.1 Dyscalculia

Specific learning difficulties or disabilities in mathematics, also known as Dyscalculia, involve challenges in processing and understanding numerical information (Deruaz et al., 2020). The challenges experienced by individuals with Dyscalculia should be significantly below what is expected for their chronological age and should not be attributed to insufficient education, daily activities, or intellectual disabilities (American Psychiatric Association, 2013). According to the International Classification of Diseases (ICD-10), the World Health Organization (WHO) defines Dyscalculia as a specific impairment in arithmetic skills that cannot be fully explained by general intellectual disability or inadequate schooling (ICD-10, Version: 2019, Article: F81.2). This impairment primarily affects basic computational abilities, such as addition, subtraction, multiplication, and division, rather than more advanced mathematical concepts like algebra, trigonometry, geometry, or calculus (World Health Organization, 2010).

Students with Dyscalculia, often referred to as dyscalculic pupils, typically lack number sense,

struggle with subitizing, and have difficulty recognizing and remembering mathematical symbols, thus confused in mathematical computation (Wang et al., 2016; Sharma., 2015). They struggle with recalling basic arithmetic facts, performing mental calculations, and understanding mathematical symbols, leading to anxiety and avoidance of mathematical tasks. These pupils have fundamental deficits in representing and processing numerosities, which refer to the size of a set (Butterworth, 2019; Kadosh & Dowker, 2015). They often exhibit persistent difficulties in basic numerical understanding, affecting their ability to grasp concepts like magnitude, quantity, and number sense. Westwood (2015) further highlighted that a significant issue for young Dyscalculics is their inability to establish a one-to-one correspondence between spoken numbers and the objects they point to in a sequence. Additionally, dyscalculic students may face challenges in sequencing, spatial awareness, and pattern recognition, which are crucial for developing higher-order mathematical skills. They also tend to have slower processing speeds regarding mathematical operations and may struggle with working memory, further hindering their problem-solving abilities (Winkel & Zipperle, 2023).

Research estimates that Dyscalculia affects 3-6% of the population (Bird, 2017), yet many teachers, who are crucial for early detection, lack sufficient knowledge about the condition. It is essential to highlight interesting findings by Fu and Chin (2017): 58% of primary school teachers in Malaysia were unaware of Dyscalculia, indicating a substantial knowledge gap. Building on this perspective, it is vital to indicate another recent study that showed that the readiness for teaching and learning with dysgraphia and dyscalculia students is low involving teachers in mainstream primary schools. Additionally, it is crucial to acknowledge that, if given a choice, these educators agreed that these students need to be with special education teachers trained to teach them (Ahmad et al., 2024). Another critical aspect to consider is though many teachers are familiar with the term dyscalculia, they frequently struggle to define and identify its symptoms accurately (Mutlu et al., 2022; Nurkan & Yazıcı, 2020). These findings highlight educators may not adequately prepare to recognize and support students with Dyscalculia, especially in mainstream education settings.

1.2.2 Educational Intervention Using Technology

Technology integration in educational interventions for students with Dyscalculia has shown promising results. Primary school teachers, including those in special education, inclusive education, remedial, and mainstream settings, play a critical role in the early intervention of students with Dyscalculia. Effective teaching strategies for these students involve a combination of the concrete-semi-concrete-abstract sequential approach, direct teaching methods, technology-assisted instruction, and game-based learning (Benavides-Varel et al., 2021; Milton et al., 2019; Miundy et al., 2019; Mohd Ariffin et al., 2019; Mohd Syah et al., 2015). A previous study emphasizes the potential of mobile applications as practical tools for enhancing mathematical learning among students with Dyscalculia (Young & MacCormack, 2014). Butterworth (2019) highlighted the importance of mathematics educators creating targeted, theory-driven interventions and assessments tailored to each learner's needs.

However, there remains a shortage of learning aids specifically designed for early

intervention in dyscalculic students in Malaysia (Aquil & Mohd Ariffin, 2020). Nevertheless, these studies indicate both teachers and parents recognize the benefits of using technology to support students with Dyscalculia, suggesting a shift towards more innovative and inclusive teaching practices. As such, the development and implementation of mobile applications tailored to the needs of dyscalculic students should be prioritized to support their learning and improve their outcomes in mathematics.

2. Method

This study is grounded in the McKillip Discrepancy Model, a widely recognized framework for analyzing needs and requirements across various fields, including education. It is commonly employed in research involving Design and Development Research (DDR). This model identifies gaps (discrepancies) between the current state and the desired state of performance or conditions, guiding researchers in prioritizing and addressing those gaps through tailored interventions. In the context of Design and Development Research (DDR), especially during the needs analysis phase, the McKillip Discrepancy Model provides a structured and systematic framework for identifying the educational or instructional needs of the development of mobile applications as learning interventions for learning disabilities, specifically dyscalculia students.

The methodology used in this study is qualitative with semi-structured interviews, allowing for an in-depth exploration of participants' experiences and perspectives regarding learning disability, specifically dyscalculia. The interview is conducted with prior consent obtained from participants to ensure ethical compliance. This includes permission from the participants to be recorded for study purposes. The interview protocol consists of four parts: rapport, warming up questions, probing issues, and closure. This protocol ensures that the same general areas of information are collected from each participant, helps the researcher to be more focused, and still allows a degree of freedom and adaptability during the interview. A topic guide helps the researcher stay on track with the broad areas to be covered without feeling constrained (Knott et al., 2022). The credibility of the qualitative research was further enhanced by consulting academic supervisors through peer debriefing during the development of the interview protocol (Spillett, 2003).

The participant selection process utilized purposive sampling, targeting teachers with more than ten years of experience in special remedial classes or unique education settings. This deliberate selection ensured that the participants had substantial expertise working with students with learning disabilities. Two educators consented to participate in this research. The first participant, Mrs. Wawa (a pseudonym, P01), is an experienced special education teacher, while the second participant, Mrs. Sue (a pseudonym, P02), specializes in remedial education for students with learning challenges. Both participants met the established selection criteria, aligning with Melnick and Meister’s (2008) definition of experienced teachers. Their long-standing professional backgrounds provided rich perspectives on the challenges and opportunities in educating students with learning disabilities.

Ensuring the accuracy and validity of the extensive data collected during the interviews involves having participants review and sign the finalized transcripts. This crucial step is

aligned with the recommendations of Bogdan and Biklen (2007), who emphasize that participant feedback is essential to maintaining the integrity of qualitative research. Allowing participants to review the transcripts enables the researcher to confirm that their responses have been captured accurately, reflecting their true thoughts, feelings, and experiences. This process enhances the credibility of the findings and empowers participants, giving them an active role in the research process. Additionally, incorporating participant verification helps identify any misinterpretations or inaccuracies that may have occurred during the initial data collection, further solidifying the reliability of the results. Engaging participants fosters a sense of collaboration between the researcher and the participants, which can lead to richer insights and a deeper understanding of the themes explored in the study. Ultimately, this commitment to accuracy and validity strengthens the overall quality of the research, ensuring that the conclusions drawn are well-founded and representative of the participants' perspectives.

The primary aim of face-to-face interviews is to gather rich and nuanced insights into participants' experiences teaching students with learning disabilities, particularly those with Dyscalculia. Engaging with participants in person enables the interviewer to establish a rapport crucial for eliciting authentic responses and minimizing potential misunderstandings or biases that may arise in less personal interactions. This physical presence fosters a more open and transparent dialogue, encouraging participants to share their thoughts and feelings more freely (Bavelas, 2022). The interviews also investigate the participants' awareness of the complexities and challenges associated with Dyscalculia and the various assessment methods and interventions they implement to support students facing these learning difficulties. Grounded in the philosophical frameworks of constructivism and interpretivism and drawing on over 15 years of experience in teaching mathematics within mainstream education, the researcher seeks to understand how these educators interpret their experiences and the meanings they ascribe to their teaching practices. The researcher aims to produce findings that reflect the realities of classroom practices and offer valuable insights into effective strategies for addressing the needs of students with Dyscalculia. While interviews are recognized as a powerful tool for data collection, they also present various challenges that must be navigated carefully. Ethical considerations, such as ensuring participant confidentiality and obtaining informed consent, are paramount in maintaining the integrity of the research process.

Additionally, the complexity of data analysis requires meticulous attention to detail to accurately interpret the rich qualitative data gathered. The researcher has approached these challenges with diligence and ethical rigor, ensuring the findings are credible and trustworthy (Roulston, 2023). Consequently, this research aims to provide clear, actionable recommendations that will support the development of mobile applications as effective learning interventions for students with disabilities, specifically those with Dyscalculia, in Malaysia. By synthesizing the insights gained from experienced educators, the study aspires to contribute to the ongoing discourse on inclusive education and the utilization of technology in fostering academic success for all students.

3. Results

Thematic analysis was utilized to examine the findings from the interviews. This approach entails coding the data to uncover recurring themes and patterns associated with the participants' insights on their experiences in teaching and learning with students with learning disabilities. Thematic analysis provides flexibility in identifying themes and their prevalence, along with the capability to analyze large datasets (Kiger & Varpio, 2020; Braun & Clarke, 2006).

Braun and Clarke (2006) state thematic analysis has six phases. As noted in the previous section, these participants have distinct profiles in their teaching careers. P01 is in special education, while P02 is a special remedial teacher in mainstream education. The researcher must immerse in the data by reading and re-reading the interview transcripts. This process helps a deeper understanding of the content and context, allowing the researcher to identify initial ideas and patterns. After becoming familiar with the data, the researcher begins to generate initial codes. This involves identifying specific data features that are relevant to the research questions. Codes are labels that categorize data segments, capturing essential aspects that may contribute to themes. Next, the third phase involves the researcher examining the codes generated in the previous step to identify broader patterns or themes. The researcher then grouped related codes to category, then form potential themes, considering how these themes relate to this study's overall research questions and objectives. Once potential themes were identified, the researcher reviewed and refined them. This involves checking if the themes accurately represent the coded data and categories, and if they work in relation to the entire dataset. In this phase, the researcher may merge, split, or discard themes based on this review to ensure clarity and coherence. The next phase is where the researcher defines and names each theme. This is executed only when themes are refined. This fifth phase involves articulating what each theme represents and how it contributes to understanding the research topic. It is essential to ensure that the themes are distinct and meaningful. Finally, the researcher compiled the findings into a coherent report or documentation. This includes presenting the themes, supporting them with data excerpts, and discussing their implications for the research questions. This provides a straightforward narrative that conveys the findings' significance and relevance to the field of study.

In short, the analysis was carried out in multiple stages, which included becoming familiar with the data, generating initial codes, searching for themes, reviewing those themes, and finally defining and naming them. In this article, the researcher discussed five themes from the interview analysis. Table 1 describes the refined key themes from the thematic analysis.

Table 1. Key themes for Thematic Analysis

Theme Number	Key Theme
1	Priority mathematical topics for students with learning disabilities of Dyscalculia
2	Evaluation or assessment methods for students with learning disabilities
3	The importance of technology for Mathematics Learning Interventions
4	Tailored learning approaches
5	Multisensory and engaging learning aids

3.1 Priority Mathematical Topics for Students with Learning Disabilities or Dyscalculia

P01 highlights difficulties identifying place values within the Mathematic syllabus, specifically ones and tens. This indicates that students struggle to grasp the fundamental concepts of number value, which is crucial for their overall numerical comprehension. P02 emphasizes the importance of recognizing basic numbers, stating that understanding the position of a number is essential for learning more significant numbers. This underscores the necessity of mastering foundational numerical concepts before advancing to more complex mathematical tasks. Overall, both participants agree on the critical need for students to build a strong foundation in number recognition and place value to support their mathematical learning and progression. The key codes, the underlined words, encapsulate the themes identified by each participant regarding the challenges faced by students with Dyscalculia. The code "number" reflects the fundamental aspect of mathematics that students struggle with, emphasizing their difficulty in comprehending the concept of whole numbers. It suggests focusing on foundational numerical skills before advancing to more complex mathematical operations. "Place Value" points to the challenge of understanding the positional value of digits within a number, particularly in the context of ones and tens. It highlights a critical area where students with Dyscalculia may require targeted intervention to develop their numerical understanding. The code "number symbol" signifies the recognition of numerical symbols as a foundational skill necessary for mathematical learning. It implies that students may struggle to associate the abstract representation of numbers with their corresponding values.

Additionally, "recognize the number" emphasizes the importance of basic number recognition as a prerequisite for further mathematical learning. It suggests that students must first be able to identify and understand numbers before they can progress to more complex concepts. Finally, the "basic number" code refers to the fundamental numerical concepts one must grasp to build mathematical skills. It indicates that a strong understanding of basic numbers is crucial for students to successfully learn about more significant numbers and engage in more advanced mathematical operations. Overall, these codes illustrate the essential themes related to the foundational challenges faced by students with Dyscalculia, emphasizing the need for tailored evaluations or assessments that address these specific areas of difficulty. Table 2 summarizes the theme 1.

Table 2. Codes and Theme 1 for each participant

Participant	Codes
P01	*Based on mathematics syllabus, whole number, the values of the number is difficult in terms of identifying the place value of ones and tens. As these children are yet to identify the number symbol*
P02	*Recognize the number first. The basic number is essential. Basic number is very important so that students know the position of the number. If they do not know this, then how can they proceed to learn the bigger numbers?*

3.2 Evaluation or Assessment Methods for Students with Learning Disabilities

P01 underscores the significance of having an Individual Education Plan (IEP) for students in

special education. An IEP is a tailored educational program designed to meet the unique needs of each student with disabilities. This code indicates that the students receive specialized support and accommodations to facilitate their learning. The presence of an IEP reflects the recognition of the diverse educational needs of students with learning disabilities and emphasizes the importance of personalized approaches in academic settings.

P02 highlights the assessment methods employed to evaluate students' progress. The mention of a "writing test" signifies that written assessments are a key component of the evaluation process for students with Dyscalculia. This indicates a focus on the student's mathematical skills and ability to express their understanding in written form. Additionally, P02 mentioned specific assessment tools used in the educational context, such as the LINUS program, which stands for "Literacy and Numeracy Intervention." This indicates that the 2018 instruments were utilized to gauge students' abilities and provide targeted support. The reference to the assessments reflects the structured approach to assessing literacy and numeracy skills within the framework of a particular remedial class. Oral and Written Tests were also emphasized, indicating the use of oral and written assessments in evaluating students' understanding. Including oral tests suggest recognizing the need for diverse assessment methods that accommodate different learning styles and capabilities.

In summary, the themes represented in Table 3 demonstrated the critical importance of individualized assessment and tailored educational plans for students with Dyscalculia. Both participants highlight the necessity of employing various assessment strategies, such as IEPs and oral and writing instruments, to ensure that educational practices are aligned with the specific needs of each student, ultimately aiming to enhance their learning outcomes.

Table 3. Codes and Theme 2 for each participant

Participant	Codes
P01	*These students have individual Education Plan for special education*
P02	*Writing test. We used questions in LINUS, instrument 2018 if I am not mistaken. Both oral and written test is still in used until last year*

3.3 The Importance of Technology for Mathematics Learning Interventions

Table 4 emphasizes the importance of integrating technology into the educational experience for students with Dyscalculia, as reflected in the coded responses of the participants. P01 highlights the utility of modern technology, specifically mentioning smart TVs and YouTube platforms as valuable resources for enhancing students' understanding of fundamental concepts such as numbers, alphabets, and pronunciation. Furthermore, the use of handphones for matching games is discussed, illustrating the appeal of auditory feedback during gameplay. This suggests that engaging multimedia resources can captivate students' attention and make learning more enjoyable.

P02 underscores the necessity of combining technology and traditional teaching methods in remedial education. She expressed the importance of teachers adapting to students' preferences, referencing a parent's feedback about their child's affinity for using handphones, laptops, and computers. This highlights the need for educators to incorporate these tools into

their instructional strategies to resonate with students' learning styles and preferences. Additionally, P02 implies a commitment to utilizing available resources effectively, reinforcing that teachers must be flexible and innovative in their teaching practices to ensure effective learning.

The overarching theme from the participants' codes reflects a recognition of technology's significant role in the learning process for students with Dyscalculia. The insights suggest that integrating digital tools can enhance engagement and cater to diverse learning needs, ultimately fostering a more effective educational environment. Educators are encouraged to leverage these technologies alongside conventional methods to provide a well-rounded and inclusive approach to teaching mathematics to students facing learning difficulties.

Table 4. Codes and Theme 3 for each participant

Participant	Codes
P01	*Nowadays, we have smart tv, so can use suitable content in YouTube about numbers, alphabets or pronounciation.*
	Those that used handphone likes to have the matching game. The students like the sounds when they were playing that game.
P02	*Must use technology. Remedial education teacher must be mix, with conventional too.*
	I asked the father, and he said that his child likes the technology such as handphone, laptop and computer. So by hook or by crook, as teacher we must also use these devices during our teaching and learning in school.

3.4 Tailored Learning Approaches

Table 5 summarizes both participants' responses, coded to reflect a theme related to tailored learning approaches for student improvement. P01 mentions a one-on-one teaching approach involving using concrete objects as instructional tools. For instance, she used tangible items such as a ball to illustrate concepts ("This is a ball. One ball"). This suggests the participant values physical or real-life examples to support the student's understanding of abstract concepts. Additionally, there is a focus on guided writing practice, starting with dot-dotted lines to help the student begin the writing process. This approach emphasizes step-by-step teaching with clear, structured guidance for the student.

Conversely, P02 highlights using picture cards that display quantities, which likely assists in making abstract ideas more understandable. Similarly, with P01, there is an emphasis on one-to-one teaching, noting that special attention and personalized treatment are necessary for students to improve. This reflects the need for tailored, individualized support, ensuring students receive focused guidance based on their needs.

This theme revolves around personalized and structured teaching methods, using tangible or visual aids like concrete objects and picture cards. Both participants underscore the importance of individual attention (one-to-one teaching) to facilitate student progress, particularly in early learning tasks like writing or understanding quantity. The coding-tailored learning approaches reflect how these educators employ specific tools to cater to student's unique needs and promote better learning outcomes.

Table 5. Codes and Theme 4 for each Participant

Participant	Codes
P01	*Usually we teach one to one with the student. Use concrete objects. For example the ball. This is a ball. One ball. Then teach the student to write by using dot dot lines first.*
P02	*Using picture cards that shows the quantity.* *In order for them to improve, need guidance on one to one, special treatment.*

3.5 Multisensory and Engaging Learning Aids

The codes of the underlined words in Table 6 highlight specific tools and methods that align with the theme of multisensory and engaging learning aids. To engage students, P01 utilizes flash cards, puzzles, and beads resembling tiny marbles. These items likely stimulate multiple senses, such as sight and touch, making learning more interactive. The participant also adapts to the student's preferences, using alternative materials when necessary. For example, when students resist using traditional paper, they introduce tactile substances like flour or sand in trays. This approach suggests a commitment to creating a dynamic, hands-on learning environment that engages students' senses in varied ways.

Another approach from P02 focuses on using colorful pictures, particularly bright colors, to capture the students' attention and enhance their visual engagement. She incorporates children's video songs during set induction, which provides a visually appealing and moving experience. These videos combine auditory and visual stimuli, making them an effective multisensory tool that promotes engagement. Additionally, the students are encouraged to count and follow actions, reinforcing learning through visual and auditory cues and physical movement.

In summary, the theme of Multisensory and Engaging Learning Aids is evident in the strategies employed by both participants, which integrate various sensory stimuli (visual, tactile, auditory) to enhance student engagement. P01 utilizes physical, tactile materials like flashcards, puzzles, and sensory substitutes (sand, flour), while P02 leverages bright visuals and multimedia elements (videos with music) to create an engaging and multisensory learning experience. These codes reflect a commitment to adapting learning methods to stimulate students' senses and foster active participation in the learning process.

Table 6. Codes and Theme 5 for each Participant

Participant	Codes
P01	*Flash cards, and puzzles with beads that looks like tiny marbles. Sometimes, if the students do not want to use paper that I give, I will use flour or sands to put in a tray.*
P02	*The students like colorful pictures. Must be bright colors.* *The students love the children video songs for set induction. It is visual appealing and moving. The students can count and follow the actions.*

4. Discussion

4.1 Priority Mathematical Topics for Students with Learning Disabilities or Dyscalculia

Priority mathematical topics for students with learning disabilities, including Dyscalculia, require focused attention on foundational concepts for building mathematical understanding. Students with these challenges often struggle with interpreting symbols, understanding mathematical vocabulary, and following sequential steps, which are crucial in mathematical learning (Chinn, 2021). These difficulties can impede their ability to perform even simple mathematical tasks. For example, mathematical symbols like "+" and "-" can become confusing and present barriers to processing arithmetic operations. Similarly, mathematical terms such as "greater than" or "less than" can complicate understanding numerical relationships, further adding to their struggles.

Widodo et al. (2021) research highlights the importance of targeted interventions to improve number recognition. Their study, which involved a single subject, emphasized specific activities such as naming numbers, recognizing numbers visually, and writing numbers in numerals from 0 to 9. These strategies were effective in enhancing the subject's mathematical abilities. Such interventions reinforce familiarity with numbers and associated symbols, which are foundational to acquiring more complex mathematical skills. The findings of this study are consistent with a broader body of literature, indicating that repeated practice on these basic concepts is necessary to overcome initial barriers in mathematics learning.

These insights align with the broader understanding of the needs of students with learning disabilities in mathematics. Early and targeted intervention in areas like number sense, basic arithmetic, and symbol recognition is critical in addressing the specific challenges posed by Dyscalculia. Students may struggle progressing to higher-level mathematical concepts without focused instruction on these elementary topics. Therefore, instructional approaches should prioritize teaching strategies that strengthen number recognition, symbol comprehension, and sequential thinking skills. These areas tend to be most affected in students with mathematical learning disabilities, making early and focused intervention vital to their academic development.

The literature supports the challenges, particularly around symbols, vocabulary, and sequencing, and emphasizes the importance of tailored interventions. These studies illustrated the effectiveness of concentrating on foundational skills such as number recognition and basic arithmetic. By prioritizing these areas, educators can better support students with Dyscalculia and other learning disabilities, improving their overall outcomes in mathematics.

The third research question focuses on the concept of numbers, a critical component in the development of mathematical proficiency. The findings from the study, along with insights from the existing literature, highlight a significant gap in students' understanding of basic arithmetic and numerical concepts. Both sets of participants demonstrated varying levels of difficulty with number recognition, number sense, and fundamental arithmetic operations, suggesting that these areas require targeted intervention.

In response to these findings, the proposed mobile application content is designed to address

these gaps by incorporating foundational mathematical concepts. Specifically, the application will focus on strengthening number sense, improving number recognition, and reinforcing basic arithmetic skills. Evidence from the research points to the effectiveness of interactive and engaging digital tools in enhancing students' comprehension of these concepts, particularly in a self-paced learning environment.

Furthermore, the study reveals that students struggle not only with rote memorization but also with applying numerical concepts in practical contexts. This observation aligns with literature suggesting that a deep understanding of numbers is essential for the development of mathematical reasoning and problem-solving skills. Therefore, the proposed solution includes interactive features that encourage students to apply their knowledge of numbers in real-life scenarios, fostering both conceptual understanding and practical application.

By integrating these evidence-based insights into the design of the mobile application, the aim is to create a learning tool that not only improves students' foundational skills but also supports the development of a more comprehensive mathematical understanding. This connection between the research findings and the proposed solution underscores the importance of addressing both the theoretical and practical aspects of number learning.

4.2 Evaluation or Assessment Methods for Students with Learning Disabilities

Evaluating students with learning disabilities, specifically Dyscalculia, requires specialized assessment tools and approaches that consider their unique challenges. Nevertheless, P02 described a standardized evaluation using oral and written tests, mainly because the student was identified as a slow learner. A different approach by P01 used the Individual Education Plan (IEP), a written document designed specifically for a student diagnosed with special educational needs (Sitti Hasnah, 2012).

The IEP documents modify and apply learning programs and services to meet the individual's educational needs. This document assists in the planning, monitoring, and evaluation of the education of special education children. It plays a crucial role in addressing the unique challenges faced by these students by documenting the specific modifications, accommodations, and specialized services required to support their learning. This personalized plan ensures students receive appropriate instruction and resources aligned with their capabilities and learning goals. Additionally, not only does it guide the development and application of learning intervention, but it also serves as an essential tool for continuous evaluation and assessment. Designing and implementing an IEP involves collaborative input from various stakeholders, including teachers, special educators, parents, and sometimes students. This collaborative approach allows for a holistic understanding of students' needs and ensures that the plan aligns with their strengths and weaknesses.

Evaluation and assessment are fundamental components of the IEP process. The plan outlines the methods and criteria that will be used to measure the student’s progress toward their established educational goals. The assessment techniques specified within the IEP are designed to accommodate the student's learning disability, ensuring that evaluations are fair and reflect their progress. These assessments may differ significantly from traditional

methods, incorporating alternative formats such as observation-based assessments, portfolio reviews, performance tasks, and adaptive testing more suited to the student's learning profile.

The IEP also incorporates regular reviews and progress reports, essential for tracking the student's development over time. These reviews assess whether the interventions and modifications outlined in the IEP are effectively meeting the student's educational needs. If the student is not making expected progress, the IEP team may adjust the instructional methods, goals, or supports to better align with the student's current abilities and learning trajectory. This ongoing evaluation process allows for a dynamic and flexible approach to education, where the IEP evolves to ensure that it continues to meet the student's changing needs. The methods measure both academic progress and the effectiveness of behavioral, social, and emotional interventions. For students with learning disabilities, growth in areas like self-regulation and communication is as vital as academic success. The IEP tracks development in these areas, recognizing the broader scope of education.

The IEP provides a structured approach to evaluation, addressing the student's strengths and challenges while ensuring ongoing adjustments based on progress. It is a key tool for assessing educational progress, focusing on individual needs and continuous improvement ensuring comprehensive development monitoring.

This theme provides critical insights into the evaluations and assessments utilized for students with learning disabilities, specifically Dyscalculia, in Malaysia. It directly addresses research question 1: "What evaluations or assessments are used for students with learning disabilities such as dyscalculia in Malaysia that cover the topic of numbers?". To meet the specific needs of these students, diverse assessment methods, such as oral and written tests, were implemented. Additionally, the evidence of a structured approach is designed to gauge students' literacy and numeracy skills, providing targeted support based on their performance. Such tools are essential for identifying specific areas of difficulty and tracking progress over time. These multifaceted approaches allow a more comprehensive evaluation of students' abilities, accommodating different learning styles and providing insights into their mathematical competencies. The focus on basic numerical skills is crucial for students with Dyscalculia. Educators noted that evaluating students' understanding of fundamental concepts, such as number recognition and basic arithmetic operations, is vital for developing effective intervention strategies. Therefore, in the proposed solution, a structured approach assessments for tracking progress in each learner is an important element to be included.

4.3 The Importance of Technology for Mathematics Learning Interventions

The use of technology, particularly in game-based interventions, has proven to be a significant asset in enhancing mathematics learning. Research by Aquil and Ariffin (2020) highlights the effectiveness of game-based learning tools in creating engaging and interactive student experiences. Similarly, Mahat et al. (2020) points out that multimedia learning aids in subjects like Geography substantially positively impact classroom teaching and learning, which also applies to mathematics. These engaging elements capture students' attention and improve their comprehension of complex mathematical concepts.

Isa and Ma'arof (2018) emphasize that teachers must adopt creative approaches when selecting learning aids to maintain student engagement. This creativity is crucial for students with learning disabilities, as it helps them remain focused and improves their understanding of the material. Incorporating technology and multimedia-based interventions in lessons can facilitate deeper learning as students interact with visual and dynamic representations of mathematical ideas.

A recent study by Kamarudin et al. (2022) further highlights the importance of aligning teaching strategies and learning aids with the specific abilities of students, particularly in special education settings. Appropriately using technological tools tailored to individual learning needs can significantly enhance the educational outcomes for students with disabilities. When teachers carefully design lessons that integrate the right technological aids, they create opportunities for students to engage more effectively, fostering improved learning and retention.

The findings provide valuable highlights from both participants, addressing the use of technology, specifically handphones. This addressed research question 2 on identifying the educators' learning practices. Additionally, this addressed the aims of this study and specifically answered research question 3, whereby one of the requirements of having a mobile application is to have a matching game.

4.4 Tailored Learning Approaches

Tailored learning approaches are vital for ensuring that educational interventions meet the individual needs of students, particularly those with learning difficulties or disabilities. A study by Chin and Fu (2021) exemplifies this using a one-to-one remedial teaching approach, which adapted instructional methods to fit a student's current level of understanding in mathematics. The teacher used mathematics domino cards, a concrete tool, to help the student visually grasp the quantity concept before gradually transitioning to more abstract tasks. This tailored approach allowed the teacher to scaffold the student's learning, starting from a concrete representation and progressing to more complex abstract concepts, which is critical in addressing specific learning needs.

This method aligns closely with the broader theme of tailored learning approaches, emphasizing the importance of adjusting teaching strategies to each student's unique learning pace, abilities, and challenges. Tailored approaches in education, particularly mathematics, allow for a more personalized learning experience, enhancing student engagement and comprehension. By starting with concrete representations—such as the domino cards in the study—the teacher provided a foundation that the student could easily understand, which built the student's confidence and readiness to tackle more difficult abstract mathematical problems.

In mathematics learning, this form of individualized support is especially important for students with learning disabilities, who may struggle to connect abstract concepts to practical applications. By progressively guiding the student from simple to more advanced tasks, the teacher addressed the student's immediate learning challenges and facilitated long-term

academic development. This gradual shift from concrete to abstract concepts is central to many successful interventions, particularly for students with difficulties in abstract reasoning, which is common in conditions like Dyscalculia.

Tailored learning also requires continuous assessment and adjustment of the teaching strategy to ensure that the student remains on track. In the example provided, the teacher's ability to modify her approach as the student's understanding evolved highlights the flexible nature of personalized instruction. This method promotes active learning, where students can build on their existing knowledge without feeling overwhelmed by material beyond their current capabilities.

Overall, the tailored learning approach utilized in the study by Chin and Fu (2021) demonstrates the effectiveness of adjusting teaching methods to individual student needs. By combining concrete tools like domino cards with careful progression toward abstract reasoning, educators can create a learning environment that supports the student's cognitive development in a more accessible and meaningful way. This approach is particularly crucial for students with learning disabilities, as it helps bridge the gap between concrete experiences and abstract concepts, making learning both attainable and engaging. Based on the interviews and previous studies, these findings provide evidence that designing the mobile application addresses research question 3.

4.5 Multisensory and Engaging Learning Aids

The theme of Multisensory and Engaging Learning Aids plays a crucial role in enhancing the educational experiences of students with learning disabilities, particularly in mathematics. Fatwana et al. (2023) emphasize the effectiveness of both manual tools and technological aids in serving as multisensory learning aids, which cater to various sensory modalities—such as visual, auditory, and tactile stimuli. These aids are particularly beneficial for students with Dyscalculia, as they offer multiple ways to interact with and comprehend abstract mathematical concepts, leading to improved learning outcomes.

Multisensory learning tools engage more than one sense at a time, allowing students to build stronger cognitive connections. For instance, the use of colored bead Montessori media, as demonstrated in the study by Damri et al. (2023), illustrates how tactile and visual elements can be combined to enhance the numeracy skills of students with Dyscalculia. The beads allow students to manipulate physical objects, providing a hands-on experience reinforcing mathematical concepts such as counting, addition, and subtraction. This approach helps students understand numbers through physical interaction and engages their visual senses using colours, which can aid in memory retention and conceptual understanding.

The multisensory teaching approach further validates using these learning aids, as highlighted in the previous study by Emerson and Babtie (2014). Their research indicates that students with dyscalculia benefit from lessons integrating various sensory inputs, such as auditory cues paired with visual aids or physical objects. For instance, using manual tools like number lines, abacuses, or counters, alongside technological tools like interactive software, provides a more comprehensive learning experience. By stimulating multiple senses, these aids make

the learning process more dynamic and help students better grasp abstract ideas, which is often challenging for those with Dyscalculia.

From a broader perspective, engaging learning aids stimulate multiple senses and maintain students' interest and focus. Students with learning disabilities often struggle with attention, and engaging tools like colored beads, interactive apps, or dynamic visuals can hold their attention longer than traditional methods. These tools encourage active participation in learning, which is essential for improving engagement and retention of mathematical concepts. Combining sensory stimulation and active engagement is key to helping students with Dyscalculia overcome difficulties and gain confidence in their mathematical abilities.

Incorporating these engaging, multisensory aids into mathematics education aligns with the broader understanding that learning is more effective when students are actively involved. Educators can use tools that engage multiple senses to create an environment where students are more likely to absorb and retain information. For children with Dyscalculia, who often face significant challenges with traditional teaching methods, this approach offers a pathway to more accessible and enjoyable learning experiences.

The findings from this study, in conjunction with existing research, reveal the significant potential of multisensory and engaging learning aids in improving educational outcomes for students with Dyscalculia. As demonstrated by Fatwana et al. (2023) and Damri et al. (2023), these learning tools, which engage multiple sensory pathways, not only enhance the interactivity of the learning process but also make abstract mathematical concepts more accessible and tangible for students who face challenges with numeracy.

The participants in this study provided strong evidence of the positive impact of multisensory learning approaches. Students exhibited increased engagement and retention of numerical concepts when exposed to interactive tools that appealed to visual, auditory, and kinesthetic learning modalities. These findings align with the broader body of research, which consistently suggests that learners with Dyscalculia benefit from environments that offer diverse sensory stimuli, thus aiding in the development of number recognition, number sense, and basic arithmetic skills.

Building on these insights, the proposed mobile application aims to integrate multisensory learning aids as another core component. This solution directly addresses the third research question by responding to the identified gaps in traditional educational methods for students with Dyscalculia. The application will incorporate features such as visual number representations, auditory cues for correct answers, and interactive touch-based activities to reinforce basic arithmetic concepts. This combination of sensory inputs is expected to create a more inclusive and effective learning environment, enhancing students' ability to grasp numerical concepts and apply them confidently.

Further, the research highlights the importance of maintaining student engagement. The findings suggest that students with learning disabilities often experience frustration and disengagement with traditional methods. The multisensory approach not only addresses the learning challenges but also fosters greater motivation through dynamic and stimulating

content. These observations are consistent with the growing body of literature advocating for creative, technology-driven interventions that support students with specific learning needs, such as Dyscalculia.

In conclusion, the evidence gathered from both participants and previous studies strongly supports the integration of multisensory learning aids in the development of a mobile application for students with learning disabilities. By responding to the research findings, the proposed solution seeks to provide an accessible, interactive, and engaging learning tool that enhances numeracy skills and encourages long-term retention of mathematical concepts, addressing the specific needs of students with Dyscalculia.

5. Conclusion

This study highlights the critical need for effective educational interventions tailored for students with learning disabilities, particularly Dyscalculia. Through semi-structured interviews with experienced educators, it was found that both participants recognized the importance of mastering foundational mathematical concepts, specifically numbers 1 to 10, as essential for further mathematical learning. The findings underscore the effectiveness of technology and learning aids to enhance these students' engagement and understanding of mathematics. In designing the mobile application for the mathematics learning intervention, the researcher will emphasize the essential numerical skills with a multifaceted evaluation approach consisting of structured and diverse assessment methods to address these students' needs. The findings from these participants shed light on the importance of the tailored approach of one-on-one, emphasizing that personal guidance and the stimulated multisensory and engaging learning aids are essential in developing a practical mobile application for these students.

Additionally, the researcher used McKillip's Discrepancy model, which focuses on systematically identifying educational needs through various methods (McKillip, 1987). This model directed the researcher to compare the real circumstances that occurred and the conditions that were supposed to happen, hence identifying existing problems and proposing solutions and comparing the actual experiences of the teachers in teaching students with learning disabilities to the expected conditions, enabling the identification of existing challenges and the development of targeted solutions. In this context, mobile applications are being developed as a learning intervention to support learners with learning disabilities.

This study acknowledges certain limitations, including the small sample size. Additionally, the reliance on qualitative data may introduce subjective biases despite efforts to maintain rigor through peer debriefing and participant validation of transcripts.

Future research should aim to expand the sample size and include a more diverse range of participants across different educational settings. Longitudinal studies could provide deeper insights into the long-term effectiveness of mobile applications and other technological interventions. Furthermore, exploring the integration of various pedagogical approaches, such as multisensory teaching methods, could enhance the understanding of best practices for supporting students with Dyscalculia.

In conclusion, while this study contributes valuable insights into the learning intervention of students with Dyscalculia, ongoing research is essential to develop comprehensive strategies that ensure inclusive and effective learning environments for all students.

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