THE IMPACT OF THE IMPLEMENTATION OF MOBILE APPLICATION FOR CHILDREN WITH DYSGRAPHIA

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ABSTRACT

This study investigates the utilization of mobile applications to provide assistance to children with dysgraphia, a cognitive impairment that impacts their ability to write by hand. The objective of the study is to determine current patterns of research, benefits, and difficulties associated with the utilization of mobile applications for children diagnosed with dysgraphia. The research methodology employed a systematic examination of studies published from 2014 to 2024, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The study findings indicate that the majority of research was carried out in Asia, with a particular focus on the Middle East and South East Asia. The participants consisted of students, teachers, and professionals or experts. Mixed-methods was the predominant research approach. The study also found benefits and difficulties linked to the utilization of mobile applications for children with dysgraphia, such as the requirement for interfaces that are easy to use, customization options, and techniques to enhance engagement. The study highlights the significance of aligning technology initiatives with established instructional goals and safeguarding sensitive data collected by mobile applications.

Keywords: *Dysgraphia, Handwriting, Learning Disabilities, Mobile Application*

1.   INTRODUCTION

Learning includes not only reading and writing, but also other fundamental skills. Writing is introduced at an early point in the learning process along with reading (Sihwi et al., 2019). The development of reading skills relies on the early and effective acquisition of writing skills, including handwriting. This acquisition is fundamental for subsequent academic advancement (Barnett et al., 2020). According to Nurchaerani et al. (2022), writing skills are important for school because students need to be able to put their thoughts on paper to explain them or use new information to change or review old ideas. In addition, according to Polat et al. (2023), students who have difficulty with writing may also experience challenges in their academic performance. Some teachers mistakenly assume that their students are lazy when it comes to learning how to write, and as a result, they push the students in an incorrect way, even if the students may be impacted by learning disabilities (Sihwi et al., 2019).

Learning disabilities are a significant challenge for a significant number of students who are affected by them (Molina-Vargas et al., 2021). In addition to their academic difficulties, they also confront significant behavioral and social issues (Atanga et al., 2020). Some examples of learning disabilities are dysgraphia, autism, and dyslexia. According to Gouraguine et al. (2023), dysgraphia is one of learning disabilities that is commonly seen in the educational sector. It significantly affects the individual's academic performance, motor skills, and mental health. Moreover, individuals with dysgraphia struggle with all aspects of writing, including legibility, speed, spelling, syntax, composition, and more (Chung & Patel, 2015). According to Chung et al. (2020) dysgraphia is a disorder characterized by particular characters. These include

difficulties with letter formation or legibility, letter spacing, orthography, fine motor coordination, writing speed, grammar, and composition, as well as an overall lack of proficiency in written communication abilities. Additionally. Dysgraphia has the potential to impact not only academic learning but also various aspects of daily life. Children with this condition may experience adverse emotional and behavioral outcomes, including heightened anxiety, diminished self-esteem, and an early likelihood of dropping out of school (Chung et al., 2020; Feder & Majnemer, 2007). There are three distinct forms of dysgraphia: Dyslexia Dysgraphia, Motor Dysgraphia, and Spatial Dysgraphia (Gkeka & Drigas, 2022). Dysgraphia is usually diagnosed in students after the second year of elementary school, when they should have mastered the basics of handwriting. Unfortunately, dysgraphia is currently nearly impossible to diagnose in children younger than that age, which has devastating effects on the lives of the poorest children (Lomurno et al., 2023). Thus, it is critical to choose appropriate intervention and preventing adverse repercussions in academic, occupational, and daily spheres.

Conventional approaches to the treatment of language-based learning disabilities are time-consuming and frequently expensive. Many children go untreated because medical care is unavailable in their rural or suburban communities (Bhatt, 2020). Assistance, training, and facilitation of learning can all be achieved through the use of digital technologies. Students with impairments may find it easier to integrate into and succeed in regular classrooms with the use of purpose-built apps that pique their interest (Williams et al., 2006). Furthermore, children with dysgraphia may find relief through the use of educational technologies. For children with dysgraphia, there is a multitude of opportunities to learn through their unique qualities, especially with mobile applications (Hopcan & Tokel, 2022). Mobile applications can provide assistance to those with dysgraphia, a learning condition that impacts their writing skills. These applications can offer assistance and intervention for children who have dysgraphia, dyscalculia, semantic dyslexia, and surface dyslexia. Moreover, Mobile technologies in education include the use of mobile devices, such as smartphones, tablets, and laptop computers, to improve and facilitate the learning process. These technologies have altered the educational environment by giving students access to a diverse variety of instructional resources, allowing them to study in a more dynamic and customized way (Criollo-C et al., 2021; Zablotska et al., 2021). Nowadays, there are mobile education applications are designed to improve the learning experience by giving students access to educational resources, interactive tools, and personalized learning opportunities. These programs can be used on a variety of mobile devices to help students learn and engage more (Criollo-C et al., 2021).

There are several previous studies related to mobile application that support children with learning disabilities. The first study is conducted by Bhatt (2020). It focuses on the creation of a mobile application utilizing Apache Cordova and Android Studio. The purpose of this application is to provide support to children who have dysgraphia, dyscalculia, semantic dyslexia, and surface dyslexia. The program is created using a combination of several senses and seeks to create a learning environment that is suitable and appropriate for youngsters. The second, Hopcan & Tokel (2021) investigate the efficacy of a mobile writing application in facilitating the development of handwriting skills in students with dysgraphia. Another study is from Drigas & Angelidakis (2017), they conducted a study that presents a literature evaluation of mobile applications designed for dyslexia screening and intervention. These applications target various parts of dyslexia symptoms, such as difficulties in writing. In a recent study conducted by Muthumal et al. (2022), a novel mobile application named 'Helply' was introduced. This program utilizes a robotic-based simulation to facilitate learning and enhance reading abilities, color recognition skills, and short-term memory skills in children diagnosed with dyslexia. In addition, Madeiraa et al. (2015) examine the utilization of assistive mobile applications for dyslexia, presenting a prototype that specifically targets the Portuguese language and underwent testing with Portuguese students.

In Indonesia, there are several mobile applications that are design and develop for supporting handwriting skill of students. Those application can be downloaded on App Store and Play Store freely. However, Mobile applications provided by the app store and play store are still very limited, especially mobile applications that use Indonesian as a language of introduction. Besides, the applications available in Indonesia are not intended for children with dysgraphia.

Particularly, in Indonesia, there is a scarcity of comprehensive research on mobile application used for enhancing writing of children who have learning disabilities, especially dysgraphia. As a result, there is a scarcity of review research into mobile application for dysgraphia children, and the current study is significant in the field because it provides a systematic review of the findings generated by previous studies in the literature, which can pave the way for future research and give researchers insight. Nevertheless, the purpose of this study is this study aims to examine the studies' research trends, advantages, and challenges concerning the use of mobile application for children with dysgraphia. Responses to the following research questions are solicited for the purposes of the review: (1) what are the research trends of mobile application for children with dysgraphia? (2) What advantages and challenges are presented in implementing mobile application for children with dysgraphia? (3) What are the recommendations for future research and development on mobile application for dysgraphia children?

2.   RESEARCH METODOLOGY

Articles published between 2014 and 2024 will assess the influence of mobile applications on the handwriting abilities of children with dysgraphia. Systematic observation techniques were employed to gather pertinent data from several articles. The article selection was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards established (Page et al., 2021). The PRISMA principle is employed in the process of reviewing articles to establish the framework and aid in the visualization of searching and selecting results. The PRISMA model was utilized to establish research eligibility criteria, devise data collection processes, specify data particulars, identify information sources, and present the findings.

Data Collection Technique

A comprehensive search was performed in the Open Knowledge Maps databases to uncover articles that may be relevant. This study utilized a database as an electronic repository to search for and select articles that were pertinent to the subject of this systematic observation. Within this database, researchers inputted three distinct categories of keywords into the search engine. The specified keywords were "mobile application", "dysgraphia", and "handwriting". A total of 125 items successfully completed the screening step via Open Knowledge Maps. Next, the articles were filtered out based on certain inclusion and exclusion criteria. This stage was conducted to get publications that were more precise or pertinent to the subject of this systematic observation
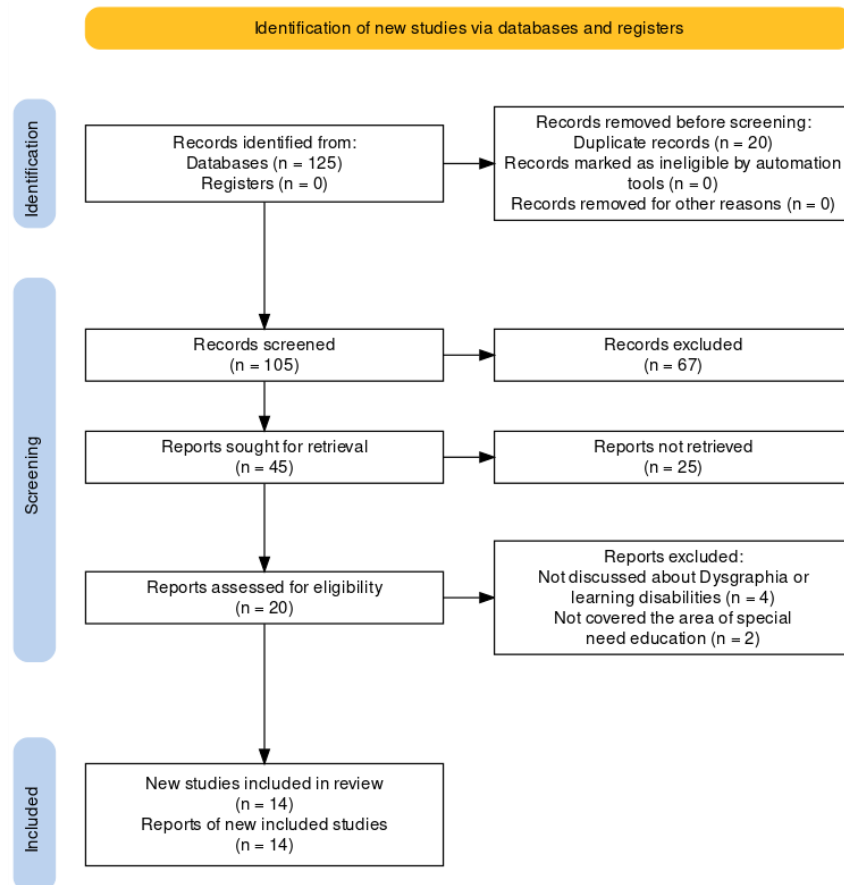
Figure 1. Visual representation of the search and selection process

Data Analysis

A comprehensive investigation was conducted in the study, utilizing Open Knowledge Maps as an online database. This database is enhanced by an artificial intelligence system that facilitates the process of finding and filtering pertinent studies for researchers. This non-profit organization operates the world's largest visual search engine for research, as stated by Kraker et al. (2017). Open Knowledge Maps facilitate the discovery of readily accessible materials by emphasizing open access content, hence eliminating the requirement for a barrier. By consolidating relevant documents, they also facilitate the recognition of pertinent and interconnected information (Vignoli et al., 2022). The organization comprises advisers, partner organizations, team members, support members, and an international community. Open Knowledge Maps offers a range of services that are both free and governed by open licenses. The infrastructure is openly constructed based on the principles of open science (Kraker et al., 2017)s.

Prior to entering keywords, the search engine can be configured as the initial step. The objective is to categorize the data based on certain requirements. For instance, the researcher has the ability to determine the year of publication based on their preferences. For this study, the researcher selected a specific time period spanning from 2014 to 2024. There were two options available: "most relevant" and "most recent". In this instance, the researcher selected the most pertinent articles in order to locate those that were most applicable to the research topic. In addition, there are several document selections available, including journals, newspapers, theses, novels, and others. In this instance, the researcher selected a scholarly journal

article. Subsequently, the high Meta data option was selected due to its ability to offer a selection of summaries of at least 300 words. After completing all the previous steps, the user can proceed to enter the keywords. The initial term entered was "dysgraphia". Subsequently, a total of 100 articles were displayed on the screen. Subsequently, it was reset to display items that were available for open access. A total of 85 articles were published with open access. The second keyword entered was "mobile application". This keyword was set in a manner that is comparable to the first keyword setting. A total of 20 articles were available for retrieval. These papers were freely accessible and may be downloaded.

Once the articles are retrieved from the web database, they are further filtered based on specific inclusion and exclusion criteria. Table 1 provides an overview of the criteria used to pick the articles. The exclusion criteria were employed to eliminate publications that did not align with the research scope, while the inclusion criteria were utilized to choose papers that were relevant to the research focus. Following the completion of the selection procedure, which was based on specific inclusion and exclusion criteria, a total of 14 papers were chosen to be utilized in this study. Out of all the publications reviewed, only fourteen satisfied the specific criteria. These articles primarily focused on the utilization of mobile applications to assist children with dysgraphia. They encompass a wide range of mobile applications that facilitate the enhancement of children's handwriting.

Table 1. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Discuss about Dysgraphia or learning disabilities	Not discussed about Dysgraphia or learning disabilities
Covered the area of special need education	Not covered the area of special need education
Published in the year of 2014-2024	Not published in the year of 2014-2024
Article must be in English	Not in English
Emphasized on the implementation of mobile application for children with Dysgraphia	It is specific described the use of mobile application for children with Dysgraphia

3.   RELATED RESEARCH

Researchers from around the world have made substantial contributions to research on using mobile applications to support children with dysgraphia. In Pakistan, Khan et al. (2017) did a study that specifically examined the use of augmented reality to assist students with dysgraphia. Ariffin et al. (2018) conducted a study in Malaysia on the "Dysgraphi Coach" mobile application, which was specifically developed to aid children with dysgraphia. In their study, Sihwi et al. (2019) employed support vector machine approaches to identify dysgraphia by analyzing handwriting patterns.

Bhatt (2020) conducted a study in India to investigate the effectiveness of a customized mobile application in addressing different learning challenges, specifically dysgraphia. John & Renumol (2022) created an Android software with the purpose of enhancing fine motor skills in youngsters who have difficulty with handwriting. In Lebanon, Nabhan & Kamel (2021) did a study on the use of technologically enhanced art therapy to improve morphological awareness in pupils diagnosed with dysgraphia.

In their study, Hopcan & Tokel (2022) examined the viewpoints of special education teachers in Turkey regarding the use of a mobile writing application for children diagnosed with dysgraphia. Gkeka & Drigas (2022) examined the association between information and communication technologies (ICTs) and dysgraphia in

Greece. In their study, Gouraguine et al. (2023) employed convolutional neural networks and child-robot interaction to identify dysgraphia.

Ikermane & El Mouatasim (2023) utilized artificial neural networks to identify dysgraphia through the examination of digital handwriting characteristics. In Italy, Lomurno et al. (2023) did a study that utilized deep learning and Procrustes analysis to identify initial indications of dysgraphia through the utilization of a tablet application. Polat et al. (2023) evaluated the suitability of existing mobile writing applications for children who have dysgraphia.

The researchers' collaborative efforts emphasize the worldwide cooperation and utilization of mobile technologies to aid children with dysgraphia. Their common objective is to improve the educational experiences and general well-being of these children.

4.   RESULTS AND DISCUSSION
Result

The Research Trends of Mobile Application for Children with Dysgraphia

The researchers examined the geographical distribution of the nations where the studies were conducted, the composition of the participants, and the research methodology utilized. The subsequent section provides a comprehensive description of each category.

Distribution of Countries

The majority of studies were conducted in Asia, specifically in the Middle East and South East Asia, whereas a limited number of studies were conducted in Europe, including in Italy and Greece. Studies on the use of mobile applications for children with dysgraphia were conducted in 10 countries.
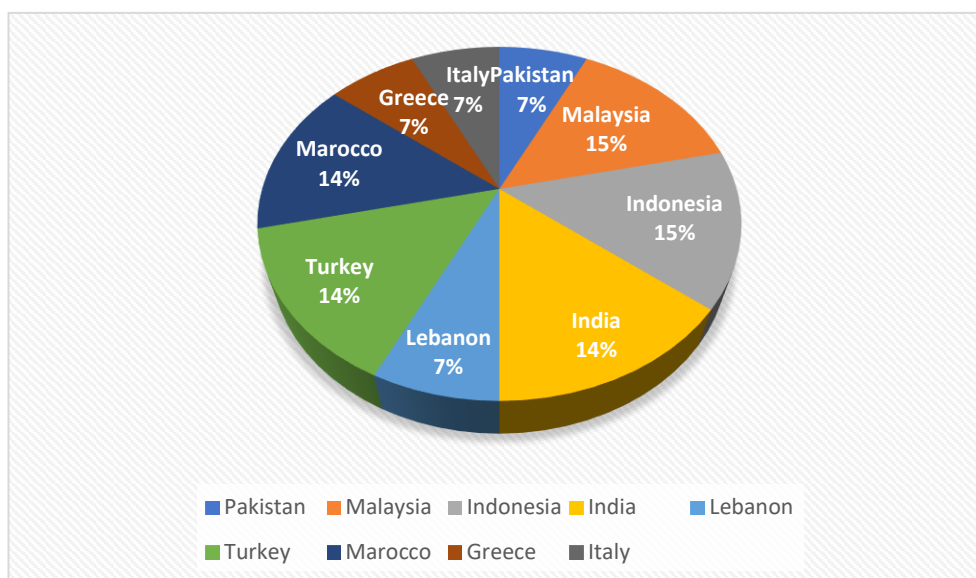

Figure 2. Distribution of countries

Composition of Participants

Figure 3 illustrates that the majority of papers (n = 9) selected students as their participants, followed by students, teachers, and professional/experts (n = 3), and finally, students and instructors (n = 2).
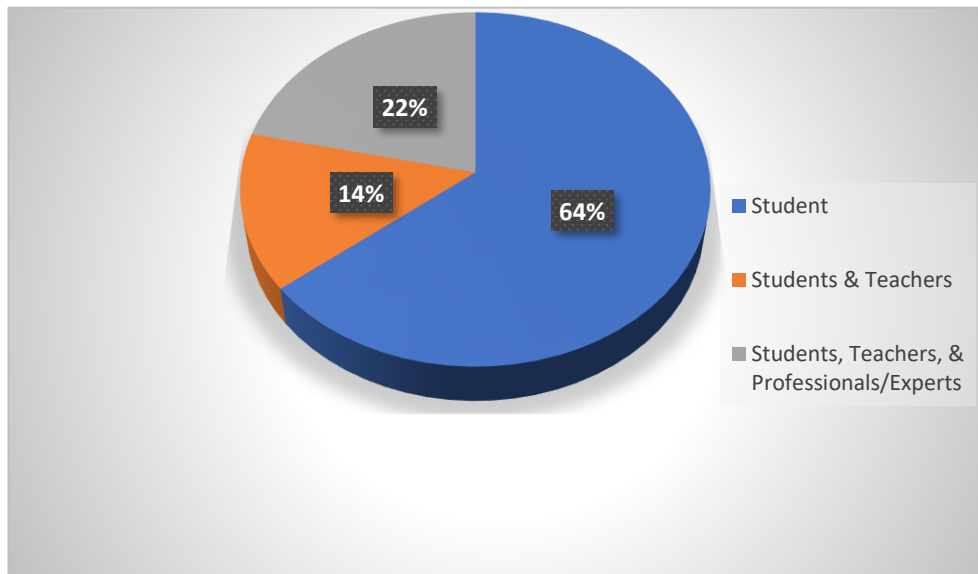

Figure 3. Composition of participants

Research Methods

The research method that was most commonly utilized was mixed-methods, with a sample size of 9, as depicted in Figure 4. The qualitative approach was used by only three participants, while the quantitative approach was used by only two participants. These methods were the least typically utilized.
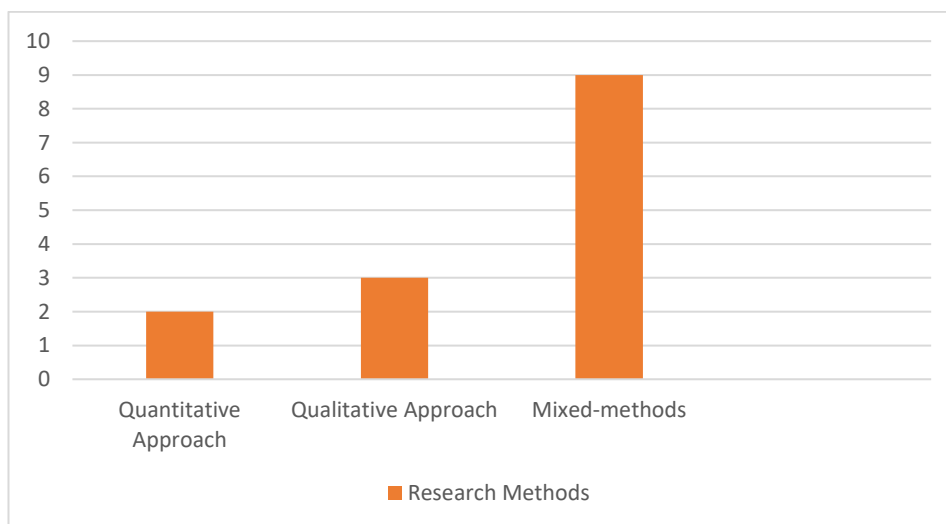

Figure 4. Research methods used in the reviewed articles.

Advantages and Challenges in Implementing Mobile Application for Children with Dysgraphia

The researchers identified and examined the subcategories of benefits and difficulties associated with utilizing the mobile application for children diagnosed with dysgraphia. The subsequent section provides a more detailed examination of the subcategories.

Advantages of Mobile Application for Children with Dysgraphia

Table 2 presents the benefits of mobile applications for children who have dysgraphia. The most often cited reasons are enhancing engagement and motivation (n = 4). The writers noted several advantages, including the enhancement of writing abilities, improvement of the learning experience, individualized learning, and increased accessibility and inclusivity. These advantages were mentioned by three authors. Two authors (n = 2) have also mentioned additional benefits, including promoting the development of handwriting skills and improving academic achievement. The remaining advantages were only mentioned once in the publications (n = 1).

Table 2. Advantages of mobile application for children with dysgraphia

Advantages	Sample articles
Enhancing Writing Skills	Ariffin et al. (2018), Choi Lean (2019), Gouraguine et al. (2023)
Improving Learning Experience	Ariffin et al. (2018), Bhatt (2020), Lomurno et al. (2023)
Supporting Handwriting Development	Gouraguine et al. (2023), Sihwi et al. (2019)
Enhancing Academic Success	Bhatt (2020), Sihwi et al. (2019)
Providing Engaging and Accessible Tools	Sihwi et al. (2019)
Personalized Learning Experience	Ikermane & El Mouatasim (2023), John & Renumol (2022), Polat et al. (2023)
Increasing Engagement and Motivation	Choi Lean (2019), Gkeka & Drigas (2022), Gouraguine et al. (2023), Khan et al. (2017)
Immediate Feedback	Polat et al. (2023)
Accessibility and Inclusivity	Ariffin et al. (2018), Bhatt (2020), Ikermane & El Mouatasim (2023)
Progress Tracking	Polat et al. (2023)

Challenges in Implementing Mobile Application for Children with Dysgraphia

While there were multiple benefits to utilizing mobile applications for children with dysgraphia, the implementation process may not proceed as seamlessly as expected. The authors (n=4) have encountered several problems, as shown in Table 3. These challenges include customization and personalization, engagement and motivation, data protection and security, and interaction with educational curriculum. Furthermore, three articles (n = 3) have identified cost and accessibility as challenges. The authors encountered two problems in developing a mobile application for children with dysgraphia: accessibility and usability, sensory overload, and user interface complexity (n = 2). The other advantages, such as expert advice and generalization of abilities, were mentioned only once in the article (n = 1).

Table 3. Challenges in Implementing Mobile Application for Children with Dysgraphia

Challenges	Sample articles
Accessibility and Usability	Khan et al. (2017), Polat et al. (2023)
Customization and Personalization	Ariffin et al. (2018), Choi Lean (2019), Khan et al. (2017), Polat et al. (2023)
Engagement and Motivation	Ariffin et al. (2018), Choi Lean (2019), Khan et al. (2017), Polat et al. (2023)
Data Privacy and Security	Ariffin et al. (2018), Choi Lean (2019), Khan et al. (2017), Polat et al. (2023)
Technical Support	Ariffin et al. (2018), Khan et al. (2017), Polat et al. (2023)
Integration with Educational Curriculum	Ariffin et al. (2018), Choi Lean (2019), Khan et al. (2017), Polat et al. (2023)
Cost and Accessibility	Ariffin et al. (2018), Khan et al. (2017), Polat et al. (2023)
Sensory Overload	Ariffin et al. (2018), Polat et al. (2023)
User Interface Complexity	Choi Lean (2019), Sihwi et al. (2019)
Professional Guidance	Sihwi et al. (2019)
Generalization of Skills	Sihwi et al. (2019)

Discussion

The Research Trends of mobile application for children with dysgraphia

In this study, 14 articles retrieved from Open Knowledge Maps were analyzed in mobile application for children with dysgraphia research trends, advantages, and challenges. The worldwide distribution of research on mobile applications for children with dysgraphia provides useful insights into the global efforts to tackle the difficulties encountered by these youngsters. Research is conducted in multiple nations, demonstrating the worldwide dedication to creating new and creative solutions. Khan et al. (2017) conducted a study in Pakistan to investigate the application of augmented reality in aiding pupils with dysgraphia. Ariffin et al. (2018) conducted a study in Malaysia on a mobile application named "Dysgraphi Coach" designed to assist youngsters with dysgraphia. Researchers Sihwi et al. (2019) employed support vector machine techniques to detect dysgraphia based on handwriting, whereas Nurchaerani et al. (2022) investigated the trait of perseverance in students with dysgraphia. Bhatt (2020) conducted a study in India that specifically examined a mobile application designed to address different types of learning difficulties, such as dysgraphia. Furthermore, John & Renumol (2022) created an Android application with the aim of improving manual dexterity in children who struggle with their handwriting. Nabhan & Kamel (2021) did research in Lebanon on the use of technologically enhanced art therapy to develop morphological awareness in students with dysgraphia. In Turkey, Hopcan & Tokel (2022) conducted a study to explore the perspectives of special education teachers regarding a mobile writing application. Additionally, Polat et al. (2023) conducted research to assess the adequacy of current mobile writing applications. Gkeka & Drigas (2022) conducted a study on the correlation between information and communication technologies (ICTs) and dysgraphia in Greece. In their study, Gouraguine et al. (2023) from Morocco utilized convolutional neural networks and child-robot interaction to detect dysgraphia. On the other hand, Ikermane & El Mouatasim (2023) employed artificial neural networks to detect dysgraphia by analyzing digital handwriting features. Italy's Lomurno et al. (2023) conducted a study on the use of deep learning and Procrustes analysis to detect the risk of early dysgraphia using a tablet application. The wide array of research in this field highlights the global cooperation and focus on using mobile technology to assist children with dysgraphia, with the goal of improving their educational and daily lives.

The diversity of participants in research studies on mobile applications for children with dysgraphia is seen in the composition of these research projects. The majority of research focused on students, who were the main recipients of the mobile applications being evaluated for their efficacy in resolving dysgraphia. Significant research conducted by Ariffin et al. (2018), Bhatt (2020), Gouraguine et al. (2023), Ikermane & El Mouatasim (2023), John & Renumol (2022), Khan et al. (2017), Lomurno et al. (2023), Sihwi et al. (2019) centered on actively involving students in their research endeavors. Furthermore, the research encompassed not just kids but also teachers, professionals, and experts to gain a more comprehensive comprehension of the impact of the applications on dysgraphia. Nabhan & Kamel (2021) and Polat et al. (2023) incorporated these groups into their research to obtain diverse viewpoints and insights. In addition, specific research focused on the interaction between students and teachers to assess the impact of mobile applications on dysgraphia. For instance, Hopcan & Tokel (2022) conducted a study to gather the perspectives of both students and teachers regarding mobile writing applications. The inclusion of a wide range of participants in these studies highlights the collaborative strategy adopted by researchers, which involves incorporating the perspectives and knowledge of children with dysgraphia, educators, and specialists. The multidimensional strategy is to create efficient mobile applications customized to the individual requirements of children with dysgraphia, therefore enhancing their educational achievements.

The study methodologies employed in studies on mobile applications for children with dysgraphia demonstrate the several approaches researchers have adopted to assess the efficacy of technology in aiding individuals with this illness. A prevalent methodology involved employing a mixed-methodologies approach, which entailed the integration of qualitative and quantitative methods to thoroughly evaluate the influence of mobile applications on dysgraphia. Researchers including Ariffin et al. (2018), Bhatt (2020), Gouraguine et al. (2023), John & Renumol (2022), Khan et al. (2017), Nabhan & Kamel (2021), Polat et al. (2023), Sihwi et al. (2019) utilized this strategy to gather both quantitative and qualitative data. Conversely, many research employed a solely qualitative methodology to investigate participants' experiences and perspectives on mobile applications for dysgraphia. The studies conducted by Choi Lean (2019), Hopcan & Tokel (2022), Nurchaerani et al. (2022) focused on exploring the qualitative aspects of how technology can assist children with dysgraphia. Several research utilized a quantitative methodology, which involves analyzing numerical data and performing statistical evaluations to measure the efficacy of mobile applications in addressing dysgraphia. Researchers can gain a comprehensive understanding of the benefits of mobile applications for children with dysgraphia by employing several study methods, such as mixed-methods, qualitative, and quantitative approaches. This comprehensive method enables a comprehensive assessment of the effectiveness of technology-based interventions, which can enhance writing abilities and cater to the educational requirements of individuals with dysgraphia.

Advantages and Challenges in Implementing Mobile Application for Children with Dysgraphia

The advantages of implementing mobile applications for children with dysgraphia, as specified in table 2 and substantiated by multiple authors, illustrate the positive influence of modern technology on improving writing abilities and overall educational experiences for children with dysgraphia. Ariffin et al. (2018), Choi Lean (2019), Gouraguine et al. (2023) have emphasized that mobile applications provide interactive workouts and activities specifically designed to enhance handwriting skills. These applications offer systematic and captivating methods for youngsters to improve their ability to write letters, maintain proper spacing, and develop good

penmanship, resulting in improved writing skills. Furthermore, the inclusion of features that enhance interactivity and enjoyment in educational activities can enhance the learning experience for children with dysgraphia while using mobile apps. Ariffin et al. (2018), Bhatt (2020), Lomurno et al. (2023) suggest that these applications employ gamification, multimedia material, and adaptive learning approaches to accommodate individual learning styles and preferences, hence enhancing the engagement and effectiveness of the learning process. Moreover, mobile applications facilitate the improvement of handwriting skills by providing a variety of tools and activities specifically tailored to target writing challenges. Gouraguine et al. (2023) and Sihwi et al. (2019) highlight the significance of applications that specifically target fine motor skills, letter recognition, and hand-eye coordination in order to improve handwriting proficiency. Mobile applications offer a customized learning experience, adjusting to the specific requirements and difficulties faced by children with dysgraphia. Ikermane & El Mouatasim (2023), John & Renumol (2022), and Polat et al. (2023) observe that these applications provide personalized settings and customized learning paths to guarantee individualized assistance for every child. Finally, mobile applications enhance engagement and motivation by incorporating features that create an enjoyable and gratifying learning experience for children with dysgraphia. According to the research conducted by Choi Lean (2019), Gkeka & Drigas (2022), Gouraguine et al. (2023), and Khan et al. (2017) applications use features such as progress tracking, rewards systems, and interactive challenges to promote active engagement and a feeling of achievement in writing activities. Overall, these advantages illustrate the positive impact of mobile applications on children with dysgraphia, as they improve their writing abilities, enhance their learning process, and increase their involvement in educational tasks.

Challenges in Implementing Mobile Application for Children with Dysgraphia

To ensure that technology adequately supports the learning and development of children with dysgraphia, it is necessary to overcome the many obstacles that arise when implementing mobile applications for this population. As pointed out by Khan et al. (2017) and Polat et al. (2023), designing user interfaces and input methods that accommodate various abilities and assistive technologies for a user-friendly experience is crucial, as is ensuring accessibility. According to Ariffin et al. (2018), Choi Lean (2019), Khan et al. (2017), and Polat et al. (2023), customization and personalization are crucial for making apps that cater to the unique needs and preferences of each child. Although it can be challenging to engage and motivate children, interactive and engaging activities, reward systems, and catering to unique learning preferences can keep their interest sustained (Ariffin et al., 2018; Choi Lean, 2019; Khan et al., 2017; Polat et al., 2023). Additional challenges to implementation include minimizing user interface complexity, protecting sensitive data, managing accessibility and costs, aligning apps with educational curricula, and avoiding sensory overload. If we want technology to help children with dysgraphia as much as possible, we must overcome these obstacles.

The Recommendations for Future Research and Development on Mobile Application for Dysgraphia Children

Improving the efficacy and usefulness of these technologies should be the focus of future research and development in mobile applications for children with dysgraphia. Meeting the specific requirements and challenges of each child requires customization and uniqueness. The personalized approach, which has been emphasized by scholars such as Ariffin et al. (2018) and Gouraguine et al. (2023),

can greatly improve the effectiveness of mobile apps for dysgraphia. The importance of user interface design in guaranteeing accessibility and usability cannot be overstated. According to Khan et al. (2017) and Polat et al. (2023), developers can make users happy and get them involved with technology by making interfaces that are easy to use for people of different abilities. A better user experience for children with dysgraphia can be achieved by adding features that make it more engaging and motivating, like the ability to track their progress, awards, and interactive challenges. In order to keep people interested in and actively involved in writing activities, researchers like Choi Lean (2019) and Khan et al. (2017) highlight the significance of engaging elements. Interventions designed specifically for children with dysgraphia can be more inclusive and successful if researchers from a variety of backgrounds work together. This includes students, instructors, and specialists. Some authors have shown how this kind of teamwork pays off; for example, Nabhan & Kamel (2021) and Sihwi et al. (2019). By incorporating mobile applications into educational curricula, classroom learning objectives can be supported and students with dysgraphia can have an enhanced educational experience. A number of researchers, like Ariffin et al. (2018) and Polat et al. (2023), stress the need to coordinate technological initiatives with established pedagogical objectives. Last but not least, protecting sensitive information gathered by mobile apps requires top priority when it comes to data privacy and security. In order to use technology in an ethical and responsible manner in educational contexts, researchers such as (Ariffin et al. (2018) and Khan et al. (2017) stress the importance of protecting user data. Researchers and developers may improve the support and resources for children with dysgraphia by following these recommendations. This will lead to mobile applications that are more effective, accessible, and user-friendly for this demographic.

5.   CONCLUSION

At some point the study stresses the importance of writing abilities in education, drawing attention to the crucial part that handwriting plays in academic success. It talks on how dysgraphia, autism, and dyslexia affect children's social and academic lives, as well as the difficulties these students encounter in the classroom. Teachers must ensure that children with learning difficulties receive the necessary support in order to help them acquire writing skills effectively and at an early age. More specifically, the research looks at how children with dysgraphia can benefit from using mobile apps to practice and improve their handwriting. It talks about how students with dysgraphia might benefit from using technology in the classroom to help them learn. Also emphasized are the need of data privacy, engagement features, and user interface design in mobile apps for kids who have dysgraphia. To sum up, the study sheds light on the difficulties encountered by students with learning disabilities, especially dysgraphia, and the ways in which technology, such mobile apps, might aid their educational path. Educators and researchers may empower kids with dysgraphia and other learning impairments to succeed academically and thrive by recognizing the significance of writing skills, employing effective solutions, and utilizing technological tools.

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