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Are Existing Mobile Writing Applications for Writing Difficulties Sufficient?

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Students who struggle with writing may also struggle academically. Mobile applications play a vital and supportive role in addressing this issue. The purpose of this research is to examine mobile writing applications and to gather the opinions of teachers and experts on these applications in order to support the writing skills of 1st and 2nd-grade primary school students. In this way, the strengths and weaknesses of the existing applications will be evaluated, and a projection will be kept on the mobile writing application that should be. The researchers applied qualitative and quantitative methods. In order to reveal the needs in question, a number of applications from the Android and IOS stores were reviewed using a rubric devised by the researchers. Semi-structured interviews were conducted to gather opinions from primary school and special education teachers and subject matter experts in primary and

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special education. The study revealed the insufficiency of targeted applications to support writing skills, particularly regarding accessibility, audio, and visual elements. This finding emphasizes the need for new mobile applications to eliminate the limitations. This study provided vital insights into building a mobile application for addressing writing difficulties that might satisfy the needs. The results of this study include suggestions that will shed light on future research on mobile writing applications.

Introduction

Mobile technologies create inspiring learning environments for people by delivering engaging and dynamic content (Cavus & Ibrahim, 2009). Tablets and smartphones offer far more options for exploration than conventional environments owing to their touch screens, which enable children to practice vibrant visualizations, animations, audio, and, more crucially, intriguing features for experimental purposes (Siew et al., 2019). In this regard, using mobile applications for children's learning has become a prominent issue for researchers in recent years.

Mobile applications enable a multisensory approach that is made richer by multimedia features. These applications provide different access options to a single instructional material or exercise, creating opportunities for teaching and learning (Ahmetovic et al., 2021). In this sense, mobile technologies may support students in overcoming problems in learning (Avila-Pesantez et al., 2018). Writing is one of the areas of learning which children frequently struggle. In this regard, many mobile applications have been developed to overcome this difficulty. Despite the significance of the issue, however, the number of studies on mobile writing applications is very few. This study analyzed and evaluated existing mobile applications and provided vital insights for developing a mobile writing application that addresses the needs.

Background

Writing difficulties

Skills, such as writing one's own name and writing letters, which are frequently encountered in pre-school children before the transition to formal writing education, are an important indicator of developmental maturity for children (Haney, 2002). With the transition to formal writing education, which starts in the 1st grade of primary school, writing skills become more important for students and form a basis for their academic success. Given that most activities at school, even on a typical day, are centered on writing, teaching how to write is essential in education. Writing is a complex task and activity that consisted of kinesthetic, perceptual motor and cognitive components, has a process (Engel-Yeger et al., 2009; Reisman, 1993). Therefore, accomplishing all of these together can be challenging for children. Providing many other resources to children struggling with their writing abilities is needed. Writing difficulty, one of the special learning disabilities, is characterized as a disorder in written expression and is marked by lower writing abilities than expected, given the student's intelligence, age, and educational background (Parastar Feizabadi et al., 2013). Writing difficulties can arise in children with motor and coordination challenges and children with special needs (Connelly et al., 2012). Children with writing difficulties have trouble writing properly (Graham et al., 2017; Park et al., 2017). Such students typically have illegible handwriting, and writing is usually slow and a challenging task for them. They struggle with issues including syllable errors, poor composition, and slow, extremely poor, and illegible

writing (Chung & Patel, 2015). In summary, students who struggle with writing are highly improbable to become competent writers unless they receive specialized training in this direction.

Educational technologies have a significant potential one of the most noticeable educational interventions for students who have writing difficulties and require an effective and rigorous writing intervention. Meta-analysis studies have shown that, regardless of the student's individual performance, technology can be helpful for any student when completing writing assignments (Morphy & Graham, 2012). Despite that, it is worthy of note that technology needs to be sufficiently incorporated into writing instruction and that there needs to be more data on how well technology-based interventions can support writing difficulties (Evmenova & Regan, 2019).

Educational mobile applications

Educational mobile applications offer a mobile learning environment that allows students to interact, lets them quickly access a variety of web data, and accommodates details about each person's learning abilities (Drigas & Angelidakis, 2017). These tools can adapt to each student's individual pace (Akbayrak et al., 2021; Kagohara et al., 2013) and various environments, and offer the student the opportunity to practice more than once. Research has shown that educational mobile applications at many educational levels — from preschool to undergraduate — and in various course subjects contribute favorably to students' academic achievement (Ansari & Tripathi, 2017), promote collaborative work, provide project-based learning (Leinonen et al., 2016). In addition, educational mobile applications can also incorporate a gaming context. Many educational mobile applications are created for students at various grade and school levels within the context of mobile educational games (Polat & Hopcan, 2019). According to the literature, mobile educational games positively contribute to academic achievement and can be employed as supplementary instructional instruments in lessons (Martin & Ertzberger, 2013; Song et al., 2014; Torun & Dargut, 2015). Educational mobile applications are also utilized in the field of special education for children with various needs (Cumming & Draper Rodríguez, 2017). Additionally, by offering low-cost, feasible, and practical solutions, technology-supported education is a promising opportunity (Tanimoto et al., 2015).

Mobile applications for writing difficulties

Some studies introduce mobile applications that support the writing skills of students with writing difficulties. These applications support literacy skills such as recall and vocabulary, letter-sound harmony, letter recognition, word, and sentence formation skills (Kazakou et al., 2011), and early writing skills of students with writing difficulties. Additionally, the literature includes mobile applications that employ educational gamification design for students who struggle with writing. These applications, in the same vein, offer a variety of opportunities, including teaching letter writing skills to students who have writing difficulties (Admodisastro et al., 2021; Rahman, 2021), helping students improve their spelling, copying (Admodisastro et al., 2021), and orthographic coding skills (Skiada et al., 2014), and correcting their spelling errors (Rello et al., 2014). Some of these applications specifically focus on improving the handwriting skills of students with writing difficulties. For instance, students with writing difficulties can be given tablets to improve their pencil grip skills and handwriting and increase their spelling accuracy through prewriting activities and writing exercises (Berninger et al., 2015; Corkett & Benevides, 2016; Diah et al., 2012). The studies pointed out that students found writing more enjoyable and easier after using these applications. Such

favorable interventions also include studies that are based on theories. Diah et al. (2012) based their tablet application on improving students' handwriting skills with writing difficulties on Hannafin and Peck's instructional model. On the other hand, Berninger et al. (2015) created a tablet application as an interactive e-learning environment to support holistic language by providing students with feedback. With some mobile applications, digital pen technology has been used to help students with writing difficulties improve their handwriting. It has been found to improve the quality of written works' quality and boost such students' motivation for writing (Belson et al., 2013; Czyzewski et al., 2009). Also, teachers who use writing applications think they are simple to use and describe them as helpful in improving students' writing skills, teaching correct writing, and maintaining students' attention more effectively than traditional writing practices (Hopcan & Tokel, 2022).

Aside from the above-mentioned studies, studies have been done evaluating the effectiveness of applications that support students with writing difficulties to improve their handwriting skills. One such study is about an independent, web-based educational software platform based on a gesture recognition algorithm usable on tablets and smartphones (Giordano & Maiorana, 2014). Another study with a similar context is on a mobile learning application for android-supported devices (Hopcan & Tokel, 2021; Tariq & Latif, 2016). Through the availability of various exercise types, these applications seek to support the development of basic handwriting skills and letter knowledge (Thapliyal et al., 2022). They have been found to improve the performance of students with writing difficulties in writing and letter recognition, increase their writing speed, and promote their motivation for writing (Berninger et al., 2015; Hopcan & Tokel, 2021; Martens et al., 2018; Rahim & Jamaludin, 2019; Tariq & Latif, 2016;). In addition, applications that use gamification, like "Bugs and Buttons 2," and those that aim to improve letter writing, like "Dexteria Jr," "iTrace," and "iWriteWords," as well as cursive handwriting skills, like "Writing Wizard," supported children's handwriting development for those with writing difficulties and other fine motor challenges (Educational Apps for Kids, 2022). As can be seen, there are applications in the literature students with writing difficulties to recognize spelling, letter and writing, copying, to increase their writing speed, and writing appropriately and orthographic coding skills and help them to compose their writing appropriately (Admodisastro et al., 2021; Berninger et al., 2015; Corkett & Benevides, 2016; Diah et al., 2012; Hopcan & Tokel, 2021; Martens et al., 2018; Rahim & Jamaludin, 2019; Skiada et al., 2014; Tariq & Latif, 2016). In this study, for specific to students with special needs the existing applications were examined in this context by considering the factors such as usability, suitability for age, suitability for inclusive pedagogy, visual and animation richness and instructional objectives. The current situation is presented in depth with interviews with teachers who work with students with special needs in the field.

Research Problem

Writing is a crucial tool that students can use to express and keep track of the things they have learned. Typically, students begin writing in primary school's first and second grades. Therefore, writing difficulties are most common during this period. As indicated by the literature, various applications for children with writing difficulties have been developed and examined. However, the literature reveals that, there is still a need to evaluate available mobile writing applications.

The purpose of this research is to examine mobile writing applications and to gather the opinions of teachers and experts on these applications in order to support the writing skills of 1st and 2nd-grade primary school students. In this way, the strengths and weaknesses of the

existing applications will be evaluated, and a projection will be kept on the mobile writing application that should be. To that end, the following questions were addressed:

(1) To what extent are the applications adequate according to the rubric?
(2) What is the relationship between the rubric scores and the store ratings?
(3) How are the opinions of experts and teachers about mobile writing applications?

METHOD

Model of the study

The purpose of this research is to examine mobile writing applications and to gather the opinions of teachers and experts on these applications in order to support the writing skills of 1st and 2nd-grade primary school students. In this way, the strengths and weaknesses of the existing applications will be evaluated and a projection will be kept on the mobile writing application that should be. In this context, qualitative and quantitative methods were used together in this study. First of all, it is aimed to examine the existing mobile applications. Creswell and Plano Clark (2007) emphasized that mixed methods are helpful in leveraging the strengths of both qualitative and quantitative methods and complementing their non-overlapping weaknesses. For this purpose, available applications in Android and IOS stores were obtained. Then, they were evaluated with a rubric developed by researchers in order to illustrate needs. Semi-structured interviews with primary education teachers, special education teachers, and primary and special education experts were conducted to reveal their opinions.

Data Collection Tools

Mobile Writing Application Evaluation Rubric: It was developed by researchers by taking the rubric developed by Ok et al. (2016) as an example. Opinions were received from two educational technology experts and one special education expert for the rubric. Necessary revisions were made. There are 14 items in the rubric, and each item is evaluated with 1-3 points. The items are classified according to the themes of form, content, and usage, and evaluations are made for the total score obtained with the rubric. Rubric description is given under the title of data collection. Sample items for the evaluation rubric of mobile writing applications are presented in Figure 1.

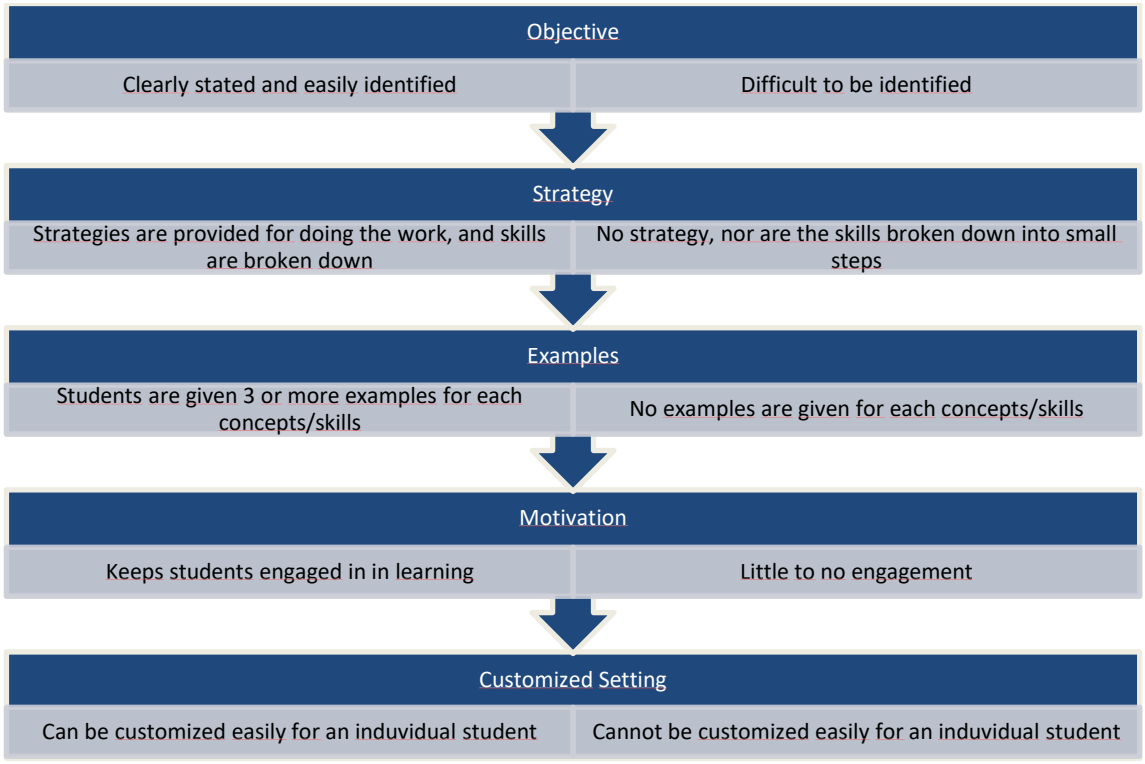

Figure 1. Sample items for mobile writing application evaluation rubric

The evaluation tool for mobile writing applications, which includes sample items presented in Figure 1, was thoroughly examined by researchers and subject matter experts. The rubric allowed for a comprehensive evaluation by focusing on thematic areas. Ratings ranging from 3 to 1 were assigned to each of the 14 items within these thematic areas, and scores were determined for each mobile writing application.

Semi-structured interview forms: In order to determine the need for mobile writing applications and to determine the features of mobile writing applications, a form consisting of 5 main questions was prepared to conduct semi-structured interviews with primary education teachers, special education teachers, and experts in classroom education and special education. Examples of questions are the following: If a mobile writing application is to be developed for students, what should be the content (learning objectives)? What should be included? What features should be considered when developing such a mobile application?

Participants

Participants of the study included three primary education teachers, four special education teachers, and two subject matter experts (one specialized in primary education and the other in special education). Information about participant is presented in Table 1.

Table 1. Information about participant

Participant	Gender	Years of Experience	Education Level
Primary education teacher (PT 1)	Female	10+ Years	PhD candidate
Primary education teacher (PT 2)	Male	10+ Years	Bachelor's Degree
Primary education teacher (PT 3)	Male	Bachelor's Degree	PhD candidate
Special education teacher (SET 1)	Female	1–5 Years	Master's Degree
Special education teacher (SET 2)	Female	1–5 Years	Bachelor's Degree
Special education teacher (SET 3)	Female	1–5 Years	Bachelor's Degree
Special education teacher (SET 4)	Male	10+ Years	Bachelor's Degree
Primary education expert (Expert 1)	Male	15+ Years	Doctoral Degree
Special education expert (Expert 2)	Male	10+ Years	Doctoral Degree

Data Collection

The authors listed applications that could be used directly or indirectly for developing writing skills in the Android and IOS stores. A total of 37 mobile applications were identified. The applications' store download rates and user ratings were recorded. Each mobile application was then downloaded, tested, and scored following several items on a rubric by considering a variety of parameters, including its scope, content, graphics, background voice-overs, visuals' colors, and dimensions, as well as its suitability for different age and incompetence groups. Five different researchers carried out evaluations, and the results were discussed by considering the averages of the scores obtained from each. Themes of form, content, and usage were used to evaluate the applications in general.

The *scope* parameter was used to evaluate which activities the application included and which learning objectives could be met due to these activities. The application was evaluated in the context of *content* to determine if it included the skills addressed in the acquisition of writing skills for 1st and 2nd-grade primary school students. Additionally, the diversity of its visuals and sounds was evaluated. In the context of *graphics*, the suitability of the colors and sizes of the visuals and other in-application graphics for age and the area of incompetence was assessed. It was also considered whether they would provide distracting stimuli while the user practiced the target skill. When it came to *voice-overs*, it was assessed whether there were voice-overs that were coded for the correct and incorrect attempts, whether distracting voice-overs were playing in the background while the target skill was being performed, and whether these sounds could be turned on and off. To summarize, the parameters were evaluated for the contributions they could make to the level of readiness of individuals with special needs in achieving the target skill and the disadvantages they created for the individuals. Five researchers carried out the evaluations, and the results were discussed considering the mean scores of the researchers' ratings. Three themes — form, content, and usage — were used to evaluate the applications in general.

Data Analysis

The research findings were constructed using quantitative and qualitative analysis methods. The ratings assigned by the users during store purchases and the ratings obtained from the rubric were standardized and converted to a scale ranging from 0 to 100. The differences between the scores obtained throughout the study were analyzed and evaluated using the SPSS 24 package program. An independent samples t-test was carried out to determine whether there was a statistically significant difference between the user ratings of the applications discussed in the study and the researcher ratings, which were standardized ratings created using the rubric (Table 1). Before conducting independent samples t-test, normality analyses were performed on the data. According to these analyses, it was found that the Kolmogorov-Smirnov value was

not significant (p=.200) and the skewness and kurtosis values were within the range of -1 to +1. Additionally, the histogram, line graph, and Q-Q plot indicated a normal distribution. Evaluating the obtained findings in line with the literature, it can be concluded that the assumptions for conducting the t-test were met (Pallant, 2017). The qualitative research findings were constructed through content analysis (Creswell et al., 2007). To test the coherence of the themes developed in the qualitative portion of the study, the codes collected from 50% of all participants were analyzed and divided into themes independently by two researchers. Afterward, Miles and Huberman's (1994) interrater reliability formula [reliability = (consensus/consensus + disagreement) × 100] was used, and the reliability was calculated to be 95%. Miles and Huberman (1994) state that this rate must be equal to or greater than 80% for a study to be considered reliable. The triangulation method was used during the analysis of quantitative and qualitative data. In the literature, it has been stated that there are four different types of triangulation methods (Denzin, 2007). In this research, methodological triangulation was used as multiple data collection methods were employed (Houser, 2015). As a result, the obtained data were evaluated together and discussed in line with the existing literature.

Results

Evaluations of mobile writing applications reveal that most applications need to be developed. For instance, only 4 of the 37 applications fulfilled the criterion for the availability of various user interaction options (single click, double click, press and hold, and so forth). In addition, only four applications meet the requirement for adaptive/adjustable visuals, and 12 meet adaptive/adjustable audio. The insufficiency of the content- and format-related adaptation options in these applications emerges as a significant limitation given that adaptation and individualization are crucial factors in the educational life of children with special needs.

Figure 2 includes images obtained from applications that available in application stores to support writing skills. It has been stated, using of tablet and computer-based applications by teachers studying with individuals with SEN (Special Education Need) is common and that teachers stated that these applications are effective for supporting these students (Haksız, 2014). However, when Figure 2 is examined, it is noticed that the images used in the applications in the stores are not sufficiently structured to study with individuals with SEN. Students with SEN may experience deficiencies in areas such as attention orientation and attention span (Wong and Kasari, 2012). For this reason, the visuals to be used in applications should not only be interesting, but also should not show distracting stimuli. The color used in the applications, the presentation of content for more than one skill on the same screen, and the fact that these features may cause the attention of students with special needs to be distracted and may prevent the maximum benefit from the applications.

Figure 2. Problematic design issues from the applications

The user and researcher ratings for the mobile writing applications in Android and IOS stores were analyzed using the rubric. The mean scores were compared using a t-test. The findings are presented in Table 2.

Table 2. Comparison of mean scores from the rubric scores and store ratings

Variable	**Group**	***N***	**$\bar{X}$**	***SD***	***p***
Mobile Applications	Rubric Scores	37	51.1	18.1	.000
	User Ratings	37	85.5	13.5	

Table 2 displays the mean ratings for mobile writing applications given by users on the stores, the mean scores provided by the researchers using the rubric, and the p-value indicating whether the difference between these means is significant (t=9.27, p<.01). The mean ratings given by users on the stores and the mean scores as determined by the researchers using the rubric were 85.5 and 51.1. As a result, it is reasonable to conclude that evaluating mobile applications based on user ratings can be different. Figure 3 depicts the ratings and scores graphs for each application.

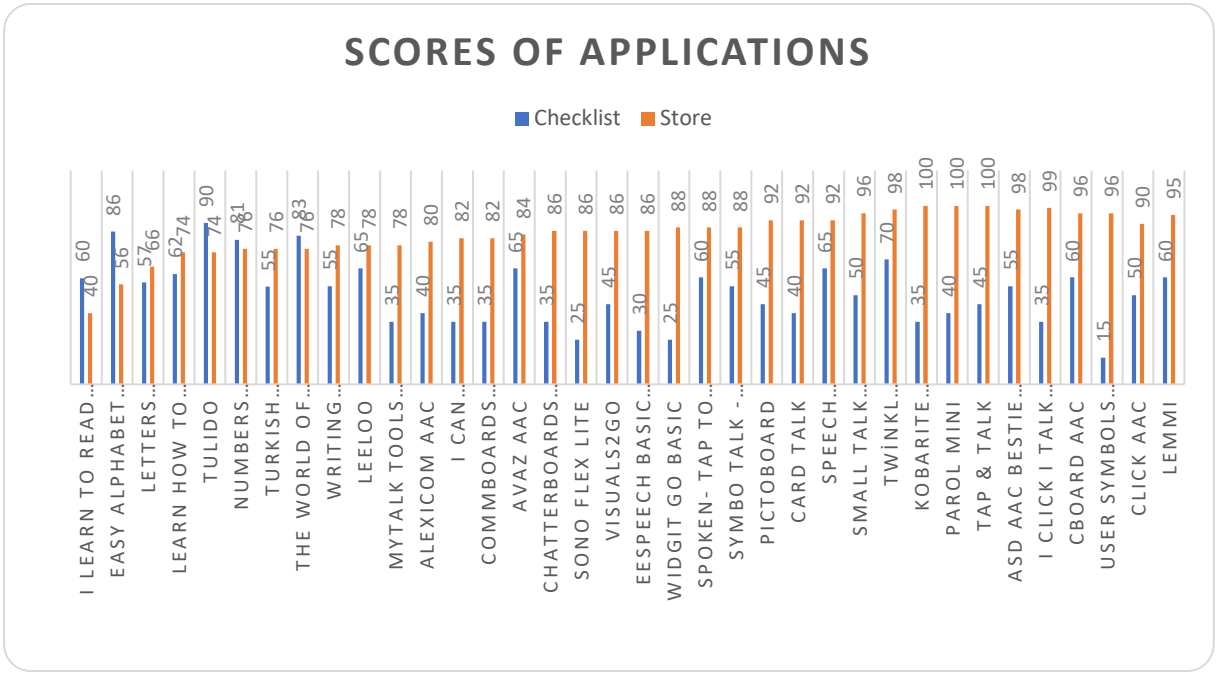

Figure 3. Application ratings

In order to determine the reason for the difference between the researcher and user ratings, the researchers carried out semi-structured interviews. Based on the teachers' opinions, it was hoped that these interviews would shed light on what caused the difference between the ratings. Additionally, an attempt was made to gather information in order to identify the features of mobile applications appropriate for the age and grade level.

Table 3. Correlation of rubric scores and store ratings

	Rubric Scores	Store Ratings
Rubric Scores	1	-412*
Store Ratings	-412*	1

*p<.05

Table 3 shows the correlation between the store ratings of the mobile applications covered in the research and the scores obtained from the evaluations of the researchers. The ratings given by the users and the scores given by the researchers show a moderate negative correlation.

Semi-structured interviews were conducted with teachers and experts working with different student profiles in order to take a holistic perspective on the suitability of the applications for children. This allowed the evaluation of the applications from different perspectives. Initially, interviews were conducted with primary education teachers. The semi-structured interviews with the teachers were examined. A primary school teacher, PT1, expressed the following regarding the mobile writing application to be developed, which aims to promote effective participation of students with special needs in instructional activities:

"*The key point here is the proficiency level of the kid …*" (PT1).

By doing so, he highlighted the significance of creating applications that are suitable for the students' grade level and age. Emphasis has been placed on students' attention spans." PT2 expressed to underline that the applications should be intriguing and enjoyable:

"*Students frequently become bored and unwilling to write. I believe technology can provide a solution in such cases — by delivering engaging and enjoyable applications for children ...*" (PT2).

Applications should be prepared taking into account individual differences, stressed PT3, noting that:

"*Students with specific learning disabilities are known to become bored and lose interest more quickly. Because of this, I believe that offering a mobile application as something customized to individual needs can improve writing skills by boosting motivation and attention span.*" (PT3).

PT2 emphasize how beneficial a well-designed mobile writing application would be for both children with special needs and their typically developing peers:

"B*ecause we observe that students who exhibit normal development in their classes also exhibit a wide range of writing abilities*" (PT2).

Secondly, interviews were conducted with special education teachers. It has been determined that during the interviews with special education teachers, there is a predominant emphasis on the inclusiveness of the mobile writing application to be developed. In the semi-structured interviews with the teachers on the features of mobile writing applications were examined, the SET1, a special education teacher, expressed that:

"*Writing is a challenge for all kids, not just those with special needs. The former ought to be taken into account, as well.*" (SET1).

SET2, a special education teacher, said that:

"*If a mobile application is inclusive, it will aid in the realization of activities involving it in later stages.*" (SET2).

Thus, these participants both emphasized the need for any mobile application to be created to be of a standard that will cover all kids, not just those with special needs. SET3, another special education teacher, underscored that the mobile application's visual elements should not have a hindrance or distraction by saying that:

"*The animations and visuals should be appropriate for the child's level, distracting visuals would not be appropriate ...*". (SET3).

SET4 highlighted the importance of mobile applications being appropriate for each user's goals and learning objectives as well as being highly effective in terms of usability. With the claim that:

"T*he functionality of the application to be created will increase if it can resolve a problem that is awaiting a fix in the field*." (SET4).

Finally, interviews were conducted with subject matter experts. The semi-structured interviews with the subject matter experts were also examined. It has been determined that the experts participating in the research, unlike teachers, highlighted diagnostic features in their opinions. For example, Expert 1 expressed about the features of mobile applications as follows:

"*The applications will be beneficial for those who have learning difficulties. However, given that there are numerous subcategories of learning disabilities, I believe that applications tailored to each subcategory should be created.*" (Expert 1).

Expert 2 said that:

"*I believe that mobile applications that offer opportunities for differentiation,*

enrichment, support, and modeling in special education will be useful." (Expert 2).

Expert 1 offered the following statement to share his viewpoint:

"*To enrich a mobile writing application, it is necessary to take into account writing abilities in two categories: Mechanical and content dimensions ...*" (Expert 1).

Expert 2's interpretation is as follows:

"*I believe that reactions — whether acoustic or visual — in milliseconds, i.e., instant feedback, are very effective in helping children learn a skill, so it would be suitable to design an application with these considerations in mind.*" (Expert 2).

With these viewpoints weighted together, the subject matter experts indicated that a mobile writing application should be prepared by paying attention to individual differences. Figure 4 depicts the concepts that were emphasized in the semi-structured interviews with the teachers and experts about the features of the mobile application for writing, as well as the themes that correspond to these concepts.

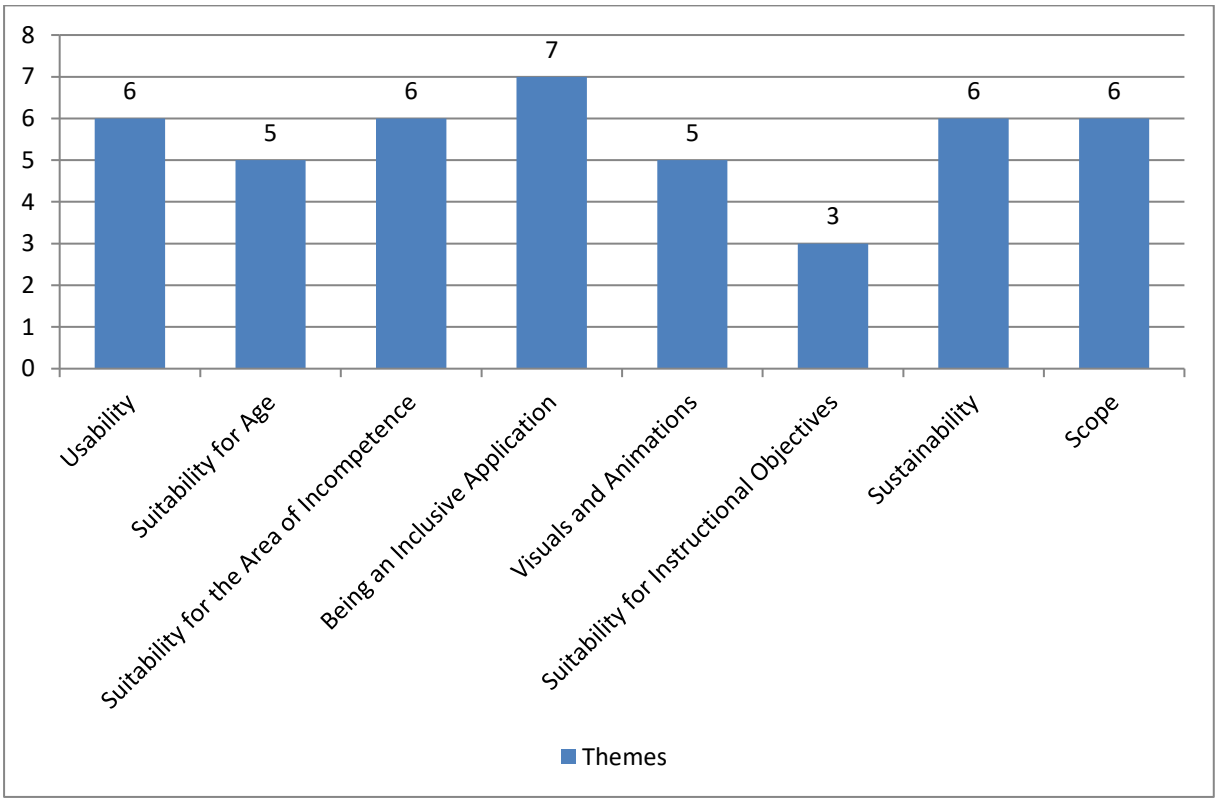

Figure 4. The features of the mobile writing applications from the teachers and experts

In Figure 5, the average scores obtained from the rubric of the applications evaluated within the scope of the research are shown. As can be seen in Figure 5, it is seen that none of the applications fully meet the items in the rubric. Although the applications meet the target in some items, generally all applications are insufficient.

APPs	ITEMS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I LEARN TO READ AND WRITE	2	2	2	3	1	1	1	2	2	2	2	2	1	2
EASY ALPHABET TRACING	2	2	1	2	1	2	3	1	2	1	2	2	2	3
LETTERS APPLICATION	1	2	2	2	2	1	3	2	2	2	2	2	2	2
LEARN HOW TO READ AND WRITE THROUGH GAMES	2	1	1	1	2	1	2	1	1	1	1	1	1	2
TULIDO	3	3	2	2	3	2	2	2	2	2	2	2	2	3
NUMBERS GAMES FOR CHILDREN	1	1	2	2	2	2	1	2	2	1	2	2	1	2
TURKISH ALPHABET: LEARN HOW TO WRITE LETTERS	2	1	2	2	2	2	1	2	1	2	2	1	2	2
THE WORLD OF LETTERS AND NUMBERS	3	2	3	2	2	2	3	2	2	2	1	2	1	3
WRITING APPLICATION	1	1	1	1	1	2	1	2	1	2	1	2	2	2
LEELOO	1	2	2	1	v	2	1	2	1	2	1	1	1	2
MYTALK TOOLS MOBILE LITE	2	2	2	3	1	1	1	2	2	2	2	2	1	2
ALEXICOM AAC	2	1	1	2	1	2	1	1	1	1	2	1	2	2
I CAN COMMUNICATE! AAC	1	2	2	2	2	1	3	2	2	2	2	2	2	2
COMMBOARDS AAC	2	1	1	1	2	1	2	1	1	1	1	1	1	2
AVAZ AAC	3	2	2	1	2	2	2	2	1	2	1	1	2	2
CHATTERBOARDS AAC	1	1	2	2	2	2	1	2	3	1	2	2	1	2
SONO FLEX LITE	2	1	1	2	3	2	1	2	1	2	1	1	2	1
VISUALS2GO	2	1	2	1	2	2	2	1	2	2	1	1	1	2
EESPEECH BASIC - AAC	1	1	1	1	1	2	1	2	1	2	1	1	2	2
WIDGIT GO BASIC	1	2	2	1	1	1	1	2	1	1	1	1	1	1
SPOKEN- TAP TO TALK AAC	2	2	1	3	2	1	2	2	2	2	2	2	1	2
SYMBO TALK - AAC TALKER	3	1	3	2	1	2	1	1	1	1	2	1	2	2
PICTOBOARD	1	2	2	2	2	1	3	2	2	2	2	2	2	2
CARD TALK	2	1	1	1	2	1	2	1	1	1	1	1	1	2
SPEECH ASSISTANT AAC	2	2	1	2	2	1	2	2	1	2	1	1	2	2
SMALL TALK STROKE ASSIST	1	1	2	2	2	2	1	2	2	1	2	2	1	2
Twinkl symbols TWINKL SYMBOLS	3	2	2	2	2	2	2	2	3	2	2	2	1	3
KOBARITE COMMUNICATION	2	1	2	1	2	2	2	1	2	1	1	1	1	2
PAROL MINI	2	1	1	3	1	2	1	2	1	3	1	2	2	2
TAP & TALK	1	2	2	1	1	2	1	2	1	2	1	1	1	2
ASD AAC BESTIE COMMUNICATOR	2	2	2	3	1	1	1	2	2	2	2	2	1	2
I CLICK I TALK SINGLE STUDENT	2	1	1	1	1	2	1	1	1	1	2	1	2	1
CBOARD AAC	2	2	2	2	2	1	3	2	2	2	2	2	2	2
USER SYMBOLS AAC LITE	1	1	1	1	1	2	1	1	1	1	1	1	1	1

*1: does not meet criteria, 2: partially meet criteria, 3: meet criteria

Figure 5. Analysis for the rubric items

Along with the themes that emerged from the interviews, generally, mobile writing applications need to be effective in supporting the students to reach the targeted skills. A detailed examination of these recommendations reveals several outstanding emergent themes: The application should be inclusive and usable for students with special needs and typically developing children, and its scope and content be appropriate, suitable for incompetence areas, and sustainable. Aside from these, the recommendation that the visual elements and animations

should not be distracting, and that the mobile application should be appropriate for the students' age and readiness level were other frequently emphasized themes based on participant opinions. In addition, a mobile writing application should comply with the standardized instructional objectives.

In addition to all these findings, the importance of gamification in the realization of the learning process of the achievements in the mobile application was mentioned in the interviews held with the experts and teachers. Experts and teachers stated that the mobile application can make learning more fun, and the importance of the gamification in learning was also emphasized. It has been stated that the most effective learning tools of all children are gamification and that play has an important place in children's developmental stories. However, they stated that the gamification should not override the purpose of the mobile application. It has been stated that the child's departure from the purpose of the target acquisition while playing may hinder the teaching process. It has been emphasized that if the gamification process is well planned, its positive effects will be quite high. Experts and teachers stated that gamification can positively affect peer interaction as well as teaching academic skills. Teachers stated that giving responsibility to students with special needs in the activities in their classes improves their communication with their peers. It has been stated that peer interaction is also supported in gamified skill teaching. It was underlined that after the experts performed the skill, the sense of achievement and motivation of the students could be provided by the gamification, and the continuity of the acquired skill and the motivation and desire to use the application could be increased with the gamification.

All in all, mobile writing applications in the Android and IOS stores were examined in terms of scope, content, and usage, and the findings indicate that the majority of the applications are inadequate. Accordingly, it is vital to create a mobile application in order to support children's writing abilities, both those with normal development and with disabilities.

Discussion

As indicated by the literature, various applications for children with writing difficulties have been developed and examined. However, the literature reveals that, there is still a need to evaluate available mobile writing applications. The purpose of this research is to examine mobile writing applications and to gather the opinions of teachers and experts on these applications in order to support the writing skills of 1st and 2nd-grade primary school students. In this way, the strengths and weaknesses of the existing applications will be evaluated, and a projection will be kept on the mobile writing application that should be. So, our study is valuable to the readers as it addresses this gap and is a first in its field of study. The researchers examined the adequacy of publicly accessible educational mobile writing applications developed for first and second grade primary school students experiencing writing difficulties, as well as for students with special needs. Criteria that are important in the education of students with special needs, such as usability, adaptability, and individual differences, were taken into account during the evaluations. Learning is possible when materials respond to the specific needs and requirements of students in terms of usability, adaptability, and individualization (Dedeoğlu & Yılmaz-Ataman, 2022). Previous studies have emphasized the importance of factors such as usability (Karanfiller et al., 2017), adaptability (Subakan & Koç, 2019), and supporting individualized learning (Doğan, 2018) in meeting the needs of students with special needs through mobile applications. In this context, mobile applications were examined from Android and IOS stores. However, the findings obtained from the 37 applications identified during the study indicated that the current applications were unsatisfactory in meeting student

needs. The main deficiencies identified in the evaluations were the lack of sufficient content and interactive adaptations in the applications.

User and researcher ratings were analyzed to evaluate the applications. The results suggest that there is a significant difference between the two ratings. Applications with high user ratings are insufficient, according to researcher ratings. In this regard, it can be argued that user ratings may not be reliable enough. According to Notari et al. (2016), the most popular mobile applications are inefficient for education. Aside from that, a number of studies in the literature have found no relationship between user ratings and other ratings using rubrics/rubrics (Delican, 2021; Papadakis et al., 2018). Vaala et al. (2015) also concluded that despite being among the highest-rated and best educational applications available in stores, the applications are inconsistent and need more content, and making decisions based on these evaluations may result in misleading outcomes. In order to more thoroughly explain the difference between the user and researcher ratings and to improve the validity of findings, expert opinions were gathered, and these three data were reviewed jointly.

According to the researchers' rating data, the diversity of user interaction in mobile applications for writing difficulties is small in general terms. However, the experts stress that there are different kinds of learning disabilities, each requiring different applications. This finding suggests that users' preferences for using mobile writing applications may vary depending on their unique characteristics, so it is critical to tailor the available interaction options accordingly. Some studies also stated that mobile writing applications must be compatible with individual differences, and content should be in line with individual differences (Akbayrak et al., 2021; Kagohara et al., 2013). Khan et al. (2017) and Avila-Pesantez et al. (2018) used augmented reality with hand-eye coordination in such settings as an option to help children to develop their motor skills. They found that this tool is effective for students with deficiencies in motor skills. According to research, children in a variety of circumstances, including those with general motor difficulties, special education needs, or those who experience difficulties like coordination disorders, may struggle with writing difficulties (Connelly et al., 2012). Research studies targeting specific disciplines indicate that more such applications are required. Similarly, the present study concluded that mobile applications should be appropriate for all students' incompetence areas. In their studies, Şenel et al. (2019) highlighted the need for inclusive mobile application design for people with special needs. In addition, the experts in this study recommend that applications be age-appropriate for children in general. For example, tablet applications used with pens/pencils positively affect kindergarten students' acquisition of handwriting skills (Bonneton-Botte et al., 2020). Sani-Bozkurt et al. (2021) emphasized the value of developing mobile applications according to children's age in terms of inclusivity and impact. Because people with writing difficulties have different motor and mental skills at different ages (Parastar Feizabadi et al., 2013), application directions should be presented in a way that learners can understand, depending on their characteristics. However, mobile applications are not classified based on criteria such as age, disability type, or adaptation (Yılmaz et al., 2022).

Another finding of the present study was that visual elements and sounds are insufficient in terms of target-oriented adaptability/adjustability. Martens et al. (2018) emphasized that three-dimensional visuals and animations used in mobile applications significantly impact motivation and comprehension in education. Nevertheless, avoiding using animations with too much motion is crucial because they may be distracting (Aşkın, 2016). In this study, experts advised that the visuals and animations should not divert the attention of user care. Instead, having more content that is directly goal-oriented and customized for each student provides feedback to

students about their learning and will be more effective.

Expert opinions have drawn attention to the fact that mobile writing applications must have a good level of usability. Usability refers to how well users can use a system (Zhang & Adipat, 2005). The comprehensibility of a system, the size of its text, the compatibility and understanding of its content, and the effectiveness of its interface design all contribute to the applications' usability (Çakıroğlu, 2020). Users can complete tasks and enjoy using a system with good usability (Wichansky, 2000). Usability assists students in improving their writing skills by allowing them to put what they have learned theory into practice (Abdüsselam, 2019). Learning develops through a flexible interface, suitable fonts, and a helpful guide (Minoofam et al., 2022). The experts also mentioned the importance of the sustainability of a developed mobile application — in other words, its continued use. Çakıroğlu (2020) attributed the success of an application's sustainability to its typography. The author articulated that an application can thrive if its interface and content are understandable in their entirety, in a holistic manner. Besides that, updating and improving an application progressively are other essential elements in ensuring its continued use.

The experts also believe that mobile applications can support students with writing difficulties with fun and motivation. For example, studies emphasized gamification to improve students' motivation and help them develop fine motor skills for struggling with writing (Dymora & Niemiec, 2019; Khaleghi et al., 2022). There are applications in the literature that use gamification techniques to improve the writing skills of students who experience difficulties in writing, such as Dysgraphicoach and Play-Draw-Write (Ariffin et al., 2018; Dui et al., 2021). Dysgraphicoach employs a variety of languages and fonts, whereas Play-Draw-Write is a tablet-based app for checking handwriting problems. Both students and teachers have positive things to say about gamification techniques, which make it possible to incorporate entertaining mobile applications into the education of students with special needs.

Lastly, the experts pointed out the significance of mobile applications' compatibility with standardized instructional objectives. Mobile writing applications should be aligned with the desired academic objectives for the child (Tariq & Latif, 2016). However, even though some mobile applications were created by considering instructional objectives (Çankaya & Girgin, 2018), many existing mobile applications with educational content lacked comprehensive instructional objectives (Battal & Kılıçkaya, 2017).

Implications and limitations

This study investigated Android- and IOS-based applications created for children who have writing difficulties. User and researcher ratings were found to be significantly different. This resulted in the understanding that user ratings were insufficient to gauge an application's effectiveness. The mobile applications available in the stores are unsatisfactory in several ways, according to the subject matter experts, researchers, and teachers, and any such mobile application should meet the following criteria:

- Has content — such as visual elements and audio — appropriate for and adaptable to its users,
- includes rich interactive elements tailored to user needs,
- has good usability,
- is appropriate for age and individual differences such as having different motor skills and needs,

- is appropriate for instructional objectives,
- is enjoyable, and
- is sustainable.

The criteria listed above, which are the study's outcomes, serve as crucial topics for future mobile writing application development. However, there are some limitations of the study. Creating a mobile writing application framework that considered all students' characteristics was challenging. Future research should specialize in providing recommendations for mobile writing evaluation rubrics based on evaluating existing applications for children with writing difficulties, focusing on specific areas of inadequacy. Additionally, although expert opinions were gathered to evaluate the current mobile applications, it is still necessary to obtain parents/students perspectives. How an application's design and content affect students can only be revealed after their use and experience (Chau, 2014). For this reason, the findings can only be generalized to the extent of subject matter experts' opinions and the researchers' rubric. Moreover, only the free applications in the Google Play Store and App Store were examined. The information gathered for this study is thought to be able to offer a general understanding.

Conclusion

Rapid technological advancement has paved the way for mobile learning via mobile applications and the ability to tailor learning opportunities to the individual needs of students with writing difficulties. This study uncovered the crucial prescriptive elements of mobile writing applications that will serve as significant inferences for the literature. The study has revealed that mobile applications should incorporate elements such as usability, adaptability, age appropriateness, sustainability, individualization, entertainment value, and visual appeal. The findings of this study will shed light on future research and application in the field of mobile writing applications. Considering the results presented in this study, mobile writing applications can be developed taking into account these findings, and their effectiveness in the field can be investigated. Studies focusing on specific areas related to writing difficulties can be conducted, and the opinions of students or parents who use the application can be collected. In conclusion, it is suggested that developed mobile writing applications should be tailored to the needs and characteristics of students. It is believed that this way, mobile writing applications can help alleviate the writing difficulties experienced by students.

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