Abstract

Dyslexia is one of the most common learning disabilities experienced by children and adults. A large amount of research is currently being conducted in exploring the benefits of using Information & Communication Technologies as a learning platform for individuals and especially children with such learning difficulties. Given the potential benefits, we focused on developing a mobile application which could foster learning and help children improve some of their fundamental skills, such as reading comprehension, orthographic coding, short-term memory and mathematical problem solving. We attempted to design a stimulating and interactive experience for children, which could encourage the learning process. Our main focus was to assess the usability of the technology, evaluate how it affects the learning experience, its consequences and the benefits it offers to each user. In this paper we present the methodology, environment setup, design choices, implementation and the results of our preliminary evaluation and assessment of “EasyLexia”, a mobile application for children with learning difficulties. Preliminary results show the promising prospects mobile learning holds in such contexts.

Keywords: Dyslexia, Reading comprehension, Mobile Learning, Software for education
Introduction

1.1. Problem Description & Related Work

Recent research estimates that a staggering 15% of the world’s population may have dyslexia[1]. Dyslexia is the most common learning disability that affects one’s ability to read and write. Individuals with dyslexia typically read at levels significantly lower than expected, despite having normal or average intelligence scores. Although the disorder varies from person to person, some common characteristics among people with dyslexia are, difficulties with phonological processing (the manipulation of sounds), spelling, and/or rapid visual-verbal responding[2]. Dyslexia is a life-long condition and its symptoms might vary at different stages in a person’s life, but timely and appropriate intervention can deliver significant results. Many intervention methods are currently in use, and more studies need to be done to determine which interventions work best. Research is now focusing among others and on the potential benefits of employing Information and Communication Technology (ICT) to develop interactive experiences and optimistic learning surroundings, that can motivate and help children, thus helping them address their disability early on and possibly mitigate its various negative effects.

Digital technologies can be used in order to train, assist and even enable the learning process. Specifically designed applications can stimulate students interest, but may also help students with disabilities fit into and progress within mainstream school environments[3]. Thomas regarded ICT as an enabler, as it can facilitate access to students by learning, increasing their motivation, fostering self-competition, enhancing their confidence and self-esteem [4]. Various implementations of ICT in education and learning, have been researched, such as the use of websites as educational motivators for adults with learning disabilities [5], virtual environments[6], [7] and computer games [8][9], implementations of portable writing aids and configurable word processing environments to support people with writing difficulties [10], [11]. One of the main groups of people with special educational needs, such as dyslexia, could potentially gain many benefits from ICT [3], [12]. Keates[13] explained the need of dyslexic pupils to access ICT for learning and being introduced to the appropriate ICT, including hardware and software (such as different word processors) for these pupils. The use of multimedia is also believed to assist dyslexic learners[14]. Multimedia applications do not only allow, but also reinforce the bimodal presentation of information via visual and auditory channels; thus, information processing is accelerated and mnemonic recall is facilitated [8].

However, much less research has been conducted in the emerging field of mobile learning (m-learning). The adoption of mobile phones in the last decade has been explosive, but the potential of using these devices to transform teaching and learning has not yet been fully explored. M-learning is considered to be intersecting with mobile computing and e-learning technologies; it combines individualized learning with anytime and anywhere learning [15], [16]. Mobile learning provides an educational experience which is altering the nature of knowledge (formal and informal) and is focusing on the user’s experience of learning through mobile devices. It provides a wide range of educational and learning material in a uniquely engaging manner (touch-screens), whilst giving them the option to choose from information which will enrich their knowledge and improve their skills. Educational applications for mobile devices motivate the children and engage their attention while focusing on solving problems, improving their memory, their reading and writing skills. In addition to the traditional classroom contexts, the use of advanced technology in the learning process and its assessment through the m-learning tests enables the learner to develop the time of use according to his/her needs, by personalizing their experience. M-learning seems to be favored by students, as it can potentially accommodate a wide range of features and sections which offer a highly interactive learning experience. It provides a stress free environment that is enhanced by specially designed user friendly interface. The design and text layout can eliminate the frustration and confusion, while making the information a much easier source to take in.

Peter Mulligan a Disability Advisor at Sunderland College, advises learners with dyslexia to use their mobile phones to make learning an easier and more pleasant process[17]. In fact, mobile applications encourage children with dyslexia to carry out a larger number of exercises, and as for the children’s interaction and learning through
technology, it can progressively improve their mind mapping abilities. Saleh & Alias developed a mobile learning comic application for dyslexic children, which provided evidence for the potential of m-learning in such an environment [18]. Rello, Bayari & Gorriz developed “Dyseggia”, a game application with word exercises for children with dyslexia which received positive feedback [19].

1.2. Research questions

Given the potential benefits of a mobile application for children with special learning needs, we focused on designing a mobile application which is directed to and focused on improving children’s capabilities. Our goal was to design a mobile application, in collaboration with students, which could potentially decrease their learning difficulties. We attempted to design a stimulating and interactive experience for children, which could encourage the learning process. Our main focus was to assess the usability of the technology, how it affects the learning experience, its consequences and the abilities it offers to each user. Our essential research question (Q1) focuses on analyzing whether a mobile phone application, designed specifically for children, can foster learning and help children with their learning difficulties by improving some of their fundamental skills, such as language and mathematical skills. Additionally, we attempted to explore the mobile application’s ability to improve the learning process, all in an interactive, playful and game like manner so that it engages children’s attention (Q2). This would eventually mean that students would use the application as an extracurricular activity outside of the school premises, while maintaining a continuous interaction with the source of the educational process. Finally, from a software engineering and design point of view, we examined the features and design elements which are required and utilized, in the best possible way, for an application such as this, in order for it to be appropriate and appealing to children (Q3). All of the above factors are principally measured as the “usability of the application”. In the following sections we present the methodology, environment setup, design choices and the results of our preliminary evaluation and assessment research.

2. Methodology

2.1. Methodology, School and Pilot Setup

From start, it was obvious that for the design of such an application, we needed to gather the most possible input from students and experts in the field. We employed an agile methodology which encourages an iterative approach and offers rapid response to change. Differentiating from the traditional software development methodologies, a combination of Agile and Extreme software development methods stresses on the importance of iterative and incremental development, where requirements and solutions evolve though the software development cycle. Based on recurring analysis, design, and evaluation cycles, rather than a linear design processes, we gathered the results which occurred from the final evaluation [20] and we were able to improve various elements of the application during its stages of development.

The design and development occurred in collaboration with the students and the teaching staff from the “Speech Therapy Center”, located in Syros Greece. We conducted our design and evaluation process during two successive semesters visiting the Center. We employed a combination of laboratory (emulators) and field study experiments (actual devices) to best evaluate the application. We used a mixed method of quantitative and qualitative analyses in order to reveal statistically significant information related to learning outcomes, gains and insights into the procedure. Current research supports that through a mixed method approach, an evaluator can employ triangulation by collecting both quantitative and qualitative data at different stages of inquiry, which in return can yield more decisive findings [19], [21], [22], [23].

Five students with dyslexia participated in this evaluation study, in two successive evaluation rounds. This number of students, conforms with the number of test users required in an ordinary usability test (in an iterative development process the literature proposes 5 to 10 users per test round[24]). We categorized them based on their
level of dyslexia symptoms, gender, age and the treatment period which they have been visiting a therapist (Table 1). All of the children have been visiting a specialized speech therapist and underwent treatment over a period of 12-18 months. Also, the dyslexia categorization was based on an expert’s diagnosis of the students, based on a psycho-educational assessment. None of them faced vision or hearing problems and were not native English speakers, but could speak English fluently and spell decently given their young age. All of the students had learning disabilities and more specifically, phonological - acoustic and superficial – visual dyslexia. The criteria used for the evaluation of each individual, was based on the users age and level of learning disability. In the attempt to develop conceptualizations and evaluation methods for our mobile learning application, was considered a personal and contextual learning process. It is important for the application to be individualized for each student’s learning level, by recognizing their diversity and needs. It is also necessary to understand whether a minimum initial level of knowledge is required, in order for one to gain and learn from the application itself.

<table>
<thead>
<tr>
<th>Table 1. Students involved in the evaluation process</th>
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<tbody>
<tr>
<td><strong>Age (years old)</strong></td>
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<tr>
<td>----------------------</td>
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<tr>
<td>Girl</td>
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<tr>
<td>Boys</td>
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<tr>
<td><strong>Gender</strong></td>
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<td><strong>Dyslexia Categorization</strong></td>
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<td>(the level of severity of the user’s difficulties)</td>
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<td><strong>Period of specialized intervention and treatment</strong></td>
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<td><strong>Time to complete a level</strong></td>
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<tr>
<td><strong>Errors</strong></td>
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<tr>
<td>(made by game)</td>
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<tr>
<td><strong>Clarifications needed</strong></td>
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<tr>
<td><strong>Found the app intriguing</strong></td>
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We also set up a “control group” by recruiting 5 students of the same age group who have not reported or been assessed as having learning difficulties, so as to ground the results of the previous data, we uncovered potential issues. The comparative use of the application and the subsequent data analysis also allowed us to determine whether the outcomes of our evaluation were actually related to learning difficulties or other factors (design choices, technology, computer experience etc.). For instance, the English knowledge was isolated as an important precondition for the users of this application. We chose to develop the application in English due to a larger market size and response, even though we observed that some non-dyslexic children encountered difficulties completing certain levels due to their knowledge of the English language, rather than their inability to learn. Lastly, we surveyed the children’s parents in order to record their point of view and opinions, offering us helpful information which helped us achieve a better understanding of the environment in which children with dyslexia function in and the difficulties they encounter everyday (the presentation of these results were omitted due to space restrictions).

3 Design Choices

3.1 Analysis & requirements specification

During the “Design Phase” of our application, we developed a survey addressed to parents with children with dyslexia, aged from 7 to 12 years old. The process relies on carefully chosen questions; based on research and specialized methods, so that we could gather the response data and deliver reliable results. We developed questions that involved the following areas: demographic characteristics of their children (age, gender, etc.), type of dyslexia the child struggled with, when and where the symptoms were first noticed, which tasks children had difficulties with, which was their treatment and their familiarity with ICT and mobile phones.

The survey’s questions, assess the parents view point and opinions while offering us a better understanding of the problems and difficulties their children face. The survey was carried out with 5 parents and the results provided us with an insight of the main indicators of dyslexia and how parents come to observe and react to the first symptoms. Analyzing the answers, we noticed that most of the children did not have severe symptoms of dyslexia.
(the children were all diagnosed by specialists and speech therapists). The tasks which confused and troubled most of the children was reading, writing and memorizing. The minimum period of time which substantial improvement was noticed was after one month of treatment and the maximum was noticed after 6 months. All of the parents agreed that electronic versions of tests would encourage their child to use the application and that multi-sensory technology of modern devices engage their children and intrigue them in comparison to the traditional paper and pencil learning process. Lastly, all of the children were familiar to mobile devices and had the ability to operate them effortlessly.

3.2 Application design & features

The benefits of game playing as a learning process (in a pedagogical perspective) has been widely acknowledged [25], [26], [27], [28]. Current research shows that games designed for mobile devices have considerable potential to encourage learning. Hence, we designed an application as a level based score game that implements a number of puzzles and quizzes (tests). The particular tests included in the application were selected according to the principles of existing educational methods coupled with the needs of children with dyslexia. In order to assist the users, we implemented specific techniques based on research and advice from speech language therapists. Our goal with the use of these tests, is to develop a positive and optimistic surrounding, by combining the positive effects of the use of new technological tools with the specialized tests that have been suggested and also evaluated by therapists and scientists that have been working in the field of “Specific learning disabilities” or dyslexia.

The application is structured around four basic categories: (i) “Words” Category, the goal of which is to support children’s reading skills and also enrich their vocabulary, although vocabulary is not considered to be a writing convention; it is a significant contributor to correct writing, (ii) “Numbers” Category, which is aimed at developing and supporting mathematical logic, (iii) “Memory” (visual memory) Category, aim’s at improving children’s short-term memory and concentration, (iv) “Books” Category, a unique section aimed at strengthening children’s concentration through reading whilst increasing their interest in reading. Each category is comprised of three different games, each of which have four levels of increasing difficulty, offering each child the ability to “play” and proceed to the next level in accordance with his or her individual needs and learning capacities. The scoring system employs a calculating feature, which is very lenient, in order to enhance children’s confidence. Also, it potentially motivates them to increase their involvement with the application while simultaneously increasing the possibilities of achieving the said goals of the application. All of the games are carefully designed in order to offer the children a suitable and user friendly interface. Therefore, a significant characteristic of our application is that the application consists of a specialized dyslexia friendly font (Open Dyslexic) which makes the reading process and letter and word recognition a less confusing procedure. More specifically, each category’s content and purpose is presented below.

The first category (WORDS) aims at exercising and improving the students reading and writing skills in an educational and entertaining process. The reading comprehension assessments, focus on children’s understanding of the given the text by using multiple-choice items.
In the first game “Word-finder” (Fig. 1), children must identify the correct letters which address the gaps and choose the best answer from among alternatives. A common dyslexia symptom is the confusion of some letters, such as b with d and p with q; therefore some words are pronounced and written backwards. For the aforementioned reasons, we chose five simple nouns for the first level of difficulty, while the purposely omitted letters are chosen based on the most commonly confused and frequently made errors. “Many researchers believe that developmental dyslexia is characterized by difficulties in phonological processing, specifically phonological awareness which is the ability to identify and manipulate the sound structure of words. Individuals with dyslexia, also have difficulty distinguishing rhyming sounds, counting the syllables of words, and sounding out novel words such as “stoat” or “train”.” [29]. Based on the researchers above, Phonological awareness and processing is believed to ameliorate with targeted practice. By processing and comprehending the students difficulties and decreased ability to recognize and identify certain words and sounds, the second game “Choose it” (Fig. 2), focuses on the child’s ability to first listen and thereafter recognize the word (which is spelled correctly) from the five given ones. It is a test which improves the student’s acoustic concentration whilst combining their recognizing and identifying ability. “In addition to a deficit in phonological processing, researchers have discovered that children with dyslexia also experience a deficit in auditory processing. The idea behind the rapid auditory processing hypothesis of developmental dyslexia is that the child is unable to distinguish certain phonemes and, as a result, develops an inadequate understanding of the phonology or sounds of his/her language[29].” Dyslexics do not acquire appropriate levels of phoneme awareness, regardless of their age or reading levels, although they eventually acquire appropriate levels of onset-rhyme awareness” [29]. Thus, we designed a third game, “Sound-finder”, which consists of sentences with missing words while combining phonological recordings of the missing word. Studies have shown that it is easier for kids to process and interpret words which rhyme and have similar sounds, therefore the meaning of each sentence is easier comprehended and the word choosing becomes a less confusing process. Across all games, illustrations are displayed, providing a user-friendly environment, helping students’ conjoin the given words to the referred pictures. In addition to the above alternations, we integrated phonetic pronunciations after the completion of each word or phrase. It is noticed that in order to “aid memorizing the teaching has to be multisensory, which means to involve as many senses as possible. Thus the pupil is encouraged to look carefully at what he has written and to listen carefully to the sound of the word”[30].

The application was developed based on the understanding of dyslexia’s nature and how it affects learning, not only in the writing and reading process, but also in mathematics and problem solving. Not all individuals with dyslexia face problems with mathematics but the majority shows signs of struggling. “Studies show that approximately 60% of dyslexics have a problem with mathematics.”[31]. The second category, “NUMBERS” (Fig. 3), aims at improving children’s mathematical skills through the identification of the basic mathematical equations and symbols. Children with Dyslexia often confuse mathematical symbols and find it difficult to identify. Hence, their difficulty in completing math problems often stems from their inability to recognize the wide range of symbolic representations of math concepts[31]. It is critical to make sure that the symbols are clarified and that the student understands the basic concepts that numbers and mathematical symbols represent. The two games which
exercise these mathematical skills are, the games “Equals” and “Symbols” respectively. Their main purpose is to help children distinguish, comprehend and become familiarized with the vocabulary and symbols which are most commonly used in the mathematical field but which will later on express mathematical ideas. We specifically selected numbers which research has proven to be most commonly confused with each other (such as 6 with 9). The third game “Clock” involves time telling, a process which numerous children struggle with. Children with dyslexia find it especially confusing to tell time with an analog clock. Therefore, we chose not to display time on a digital clock. We also observed that they may be able to tell whole hours and half hours (4:00, 2:30 etc.) but often details such as the exact seconds (6:08) are eluded. Furthermore, “they often find it difficult to distinguish between the minute and hour hand” and finally signal words, such as before (to) and after (past) can easily confuse them. The choices we gave the users are four (4), all of which aim at helping with the above complications, in order to assist them to easily tell time and lead them towards the correct answer.

The third category “MEMORY” contains visual and auditory/verbal features and has a beneficial effect on all types of memory problems. Furthermore, it is accommodating and accessible, because it helps users remember in an easier and faster way. The first game “Memo”, is an ordinary test working memory game, the purpose of which is to find the matching pairs of the given cards. In each pair of cards, the one spells out the word and its pair depicts it. This requires from the children to not only memorize the picture in their memory, but simultaneously analyze the meaning of each word. This game helps improve their visual memory. “Visual memory is also very important in the spelling process, because plethora of English words are irregular and their spelling does not follow the phonic rules. It has been observed that the only way to learn how to spell irregular words is by using visual memory”[32] In the second game “Shapes”, the children must recognize, memorize and identify visual shapes in order for them to redraw or choose them. The third game “In-order” is a sequential memory building game. Random numbers from 1 to 9, move across the mobile’s screen in a random sequence and children must rewrite the numbers in the correct order.

The final category, “BOOKS”, is a narrative storytelling feature, differentiated from the other three, in order to help the reluctant or struggling readers to get acquainted to dyslexia friendly books, whilst enhancing their literacy skills. The purpose of this feature is to broaden their knowledge, increase their interest in books, improve their vocabulary, spelling and enhance their imagination. The selection of the books was made based on the guidelines of the Dyslexia Action researches [33]. First of all, the books we chose consist of stories which are age appropriate for our target-group (7-12 years old). The explanatory pictures help users follow the stories easily and enjoy the reading process, while the sentences and paragraphs of each book are short and easy to read, in order to engage the children and encourage them to carry on reading. The layout of the selected books is specifically designed for children with reading difficulties; therefore it has wide margins and large blank areas in order to encourage a good reading flow and pace. Finally, these books are well-structured, offering simplicity in information and the syntax of words. It is very important that parents participate in this process and “encourage their children to join in by discussing the book’s content with them, including the pictures and what may be happening” [33]. They can also help their children by bonding with them in the reading experience and word finding process, or even asking them to explain the story they read by describing it in their own words. Also, the child is given the option to press a “like” button, which automatically sends a notifying email to his/her parent; noting that their child favored the book. The parent can find additional information by pressing the link of an online book store. Parent involvement helps children boost their self-confidence while it is shown that close parent relationships and constant encouragement helps them earn higher grades, test scores and improve their social skills. Therefore, our application introduces a special feature, an email operation, which enables the parents to receive date to date information involving their children’s progress and score achievements.

We developed the application on windows phone 7 & 8 platforms in accordance with the industry standards and guidelines. We made full use of available animations and story boards while trying not to introduce any additional user interface complexity. Although the students weren’t native English speakers, we decided to implement “EasyLexia” in English, while the percentage of native English speakers outnumber any other proposed language. Due to the aforementioned, we considered our selection of language to have a greater impact and therefore, a larger
number of individuals could benefit from our application, by purchasing it (for free) through the mobile application store.

4. Evaluation

The main objectives for evaluating our application were to:

- Observe students interacting with our application in a classroom and under the supervision of their teacher while obtaining qualitative and quantitative feedback. Also, identify design issues and possible breakthroughs (indicating productive new forms of learning or important conceptual change) or breakdowns (where a learner is confused with the technology, is asking for help, or appears to be struggling under a clear misunderstanding)[34].
- To allow students to use the application without supervision when evaluators purposefully leave the room, in order to evaluate if students find the application engaging or fun and if they would continue to use it outside of the “classroom premises”.

We evaluated the usability of the application within the learning environment by employing the well-researched generic usability attributes [35], [36], [37], [38], [39]: learnability, efficiency, memorability, user satisfaction, effectiveness, simplicity, performance and comprehensibility. During the evaluation we measured how easily students finished the specific tasks, how fast their performance was and how many errors they made during the process. The readability, their understanding of the content and their ability to remember info and features of the application (the ability of something to be easily remembered by someone) are some of the significant evaluation outcomes which helped modify our application. All of the above data was collected by interviews and on location usage of the application.

4.1 First Iteration

After the primary circle of the designing process, we visited the Speech Therapy Center, and in collaboration with the teaching staff, we arranged interviews with the students to evaluate the first prototype. As a part of the evaluation process, students were given a mobile phone with the application and under the supervision of their teacher; they were encouraged to try using the application. At this first evaluation of the application we revealed some interesting facts:

- Choice of Font: The specialized font was chosen after the first iteration; we noticed that some users had trouble recognizing certain letter. Thus, we conducted further research and found a widely used Dyslexia friendly font, which is created to increase readability for users with dyslexia.

- Text Layout: The layout of the text can affect children’s reading speed and confusion, making us modify some features. Children found it difficult to press the correct buttons which were displayed on the mobile’s keyboard, due to its inadequate size.

- The large number of alternative answers, made the process confusing and less useful. Hence, instead of requesting from the child to type in the correct letters, we gave them specifically chosen ones (even reversed) which the child confuses and finds difficult to recognize. Similar layouts and techniques are applied on all the word oriented games. In addition to the above, the indication of the form field where the user could enter their username, changed and was modified into a clearly discernible button.
4.2 Second Iteration

During the second phase of the evaluation the basic problems which occurred were mainly the difficulty in typing the chosen letters on the keyboard and in some cases, the use of the English vocabulary. They are both very important factors for our application, since English is its official language and the typing process is inevitable. We noticed that the game consists of many procedural steps until the user begins to actually play the chosen game. Therefore, the usage time is lengthened and an increased sense of insecurity and confusion is noticed. It is also important to be noted that the users made less clarification questions than the first time, since we wrote clearly before each game, its title and general purpose. Procedural reminders were integrated, such as the indications of a wrong choice and the score. Those were two very important factors, so that users can operate the application without any problems and confusion. Last but not least, we recorded a larger number of phonetic vocalizations of words and sounds which the children can hear during the games. That way, the user can listen to the phonemes and graphemes, whilst enriching his/her listening concentration.

5. Results

By evaluating the application with a group of students, our first significant observation was that all of the students showed their preference in practicing and completing the tests on a mobile device rather than on paper. The application helps children with dyslexia concentrate and keep them focused, avoiding distractions, by targeting their attention on the device’s touch screen. A result which indicates the significance of technology in today’s learning methods.

The students with different levels of dyslexia indicated differences in the duration of each test, while the students with mild symptoms of dyslexia completed the tests much faster than the others. Also, the students with mild dyslexia demonstrated higher reading recognition and comprehension compared to the students who showed severe dyslexia symptoms. Those groups of students didn’t differ significantly in spelling or listening. Regarding research “Question 1”, whether a mobile phone application, designed specifically for children, can foster learning and help children with learning difficulties improve some fundamental skills in language and mathematics, although the data is preliminary, we could identify a potential increase in overall scores over a short period of time. This observation agrees with documented research on the issue[8][40][41]. After the experimental evaluation had been conducted; we gathered the results and analyzed the student’s progress. Most of the students indicated a higher performance (based on their score achievements) compared to the previous evaluation. They no longer needed constant reading or writing assistance and word recognition became an easier process for most of the participants. The results showed progress, not only in the recognition of words and reading but also in phonological decoding. The students also gained experience and got familiar with the text layout of the application and were able to easily recognize and utilize all of the features without any assistance. During our evaluation process, evaluators left the classroom leaving students with the mobile phone, while using the application and operating it independently. Most of the students (3/5) continued to use the application even in the absence of the evaluator. Students were possibly able to enjoy using the application in a game like fashion. We also noticed that the Phonological recordings offered to the educational aspects of the content, helping users recognize, identify and memorize certain words.

Last, the clarifications and instructions which were needed, gave the children the opportunity to collaborate and ask each other what their next action should be. We encourage reading and writing collaboration, since ideas can be contributed while stimulating their imagination, therefore it made important gains in their ability to interact, promoting idea-sharing and cooperating with others.
6. Conclusion

Given the potential benefits of a mobile application for children with special learning needs, we focused on designing an application which is directed at improving children’s fundamental learning skills through the use of advanced technology (m-learning). The application was designed and implemented in a two-phase iterative research and development methodology with the collaboration of students and teaching staff at the “Speech Therapy Center” in Greece. We focused on developing a mobile application which could potentially foster learning and help children with their learning difficulties by improving some of their elementary skills, such as language and mathematical abilities. Although at this stage our present work cannot be conclusive, the preliminary results show the promising prospects mobile learning holds in such contexts as students showed progress in their overall game performance over a short period of time usage. It is our intention to further continue our research in the field, by testing the application’s effectiveness over an extended period of time to better assess the m-learning methods and their outcomes reflected in the user’s skill improvements. The application after the initial evaluations and assessments, could at this point be disseminated through the on-line application sales-point “Marketplace” and be procured either for individual use, which is by parents who wish to acquire it for their children, or for collective use, purchased by agents such as private or public dyslexia institutes, schools, health and communication centers etc. Lastly, we plan on expanding the list of compatible devices and consider integrating the application into a tablet, after having evaluated the specific device, outweighing its pros and cons.

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