UNIVERSIDAD DE MURCIA

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TESIS DOCTORAL

A mobile application for students with learning difficulties: design and evaluation

Una aplicación móvil para estudiantes con dificultades de aprendizaje: diseño y evaluación

Dña. Nikoleta P. Retzepi

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Una aplicación móvil para estudiantes con dificultades de aprendizaje: Diseño y evaluación

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"*It's only a drop in the ocean - but the ocean wouldn't be the same without that drop*".

Mother Teresa

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LIST OF ABBREVIATIONS

Abbreviation	Definition
ADDIE	Analysis, Design, Development, Implementation, Evaluation
BLTH	Bluetooth
D-Learning	Distance Learning
E-Learning	Electronic Learning
GPRS	General Packet Radio Service
M-Learning	Mobile Learning
MMS	Multimedia Messaging Service
MSN	Microsoft Network
PDA	Personal Digital Assistant
SEN	Special Educational Needs
SEND	Special Educational Needs and Dissabilities
SMS	Short Message Service

RESUMEN

Nuestra era es un período de transición de la sociedad de la información a la sociedad del conocimiento. Por lo tanto, hay una demanda creciente de formas innovadoras de educación, porque las personas deben adquirir nuevos conocimientos, aptitudes y competencias de manera rápida y eficaz. Así, la evolución de la tecnología informática y de redes es capaz de proporcionar muchos medios diferentes para apoyar el aprendizaje con su flexibilidad, portabilidad y de acuerdo con las necesidades de los individuos.

El derecho a la educación es innegable y común a todos. Los estudiantes que experimentan dificultades de aprendizaje no deben ser excluidos o impedidos de las actividades educativas. El uso de las nuevas tecnologías en la educación especial puede funcionar como ayudantes de muchos estudiantes con necesidades especiales, dándoles la oportunidad de descubrir y cultivar sus habilidades reales. Por lo tanto, es necesario que las estructuras políticas y educativas internacionales pertinentes desarrollen una nueva filosofía universal con respecto a la educación especial en relación con la utilización de las TIC, con el fin de lograr el desarrollo de los estudiantes independientemente de sus necesidades particulares (Makris & Markou, 2015).

Según la OECD (2000) entre el 2 % y el 18 % de la población escolar eran al menos estudiantes con necesidades educativas especiales. Sin embargo, la oferta de educación para los estudiantes con discapacidad difiere entre los países europeos. No obstante, todos los países europeos coinciden en que las nuevas tecnologías en la educación son un paso importante para hacer frente a los problemas educativos que afectan a los estudiantes que necesitan educación especial. Por esta razón, las tecnologías se incluyeron en los planes de estudios de los estados europeos (Toom, 2018).

En nuestros días, los rápidos cambios en la tecnología y en las necesidades de aprendizaje de los estudiantes han llevado a una nueva era de la educación, donde el

aprendizaje electrónico (E-Learning), aprendizaje a distancia (D-Learning), aprendizaje móvil (M-Learning) son cada vez más adoptados por las instituciones educativas, y los gobiernos como soluciones prometedoras para el aprendizaje exitoso. En la literatura se han propuesto múltiples y diversas definiciones de M-Learning. Muchas definiciones hacen hincapié en las características y capacidades que ofrece M-Learning a los alumnos para que se autoestudien siempre y en todas partes, exclusivamente a través de dispositivos móviles.

Por lo tanto, el M-Learning se considera una herramienta prometedora y eficaz para ayudar a los estudiantes con dificultades de aprendizaje, ya que les da la oportunidad de acceder a contenido de aprendizaje en cualquier momento y en cualquier lugar y ajustar el contenido a sus necesidades (Klimova, 2019). Los dispositivos móviles inteligentes se pueden utilizar como una herramienta educativa apoyando ciertos aspectos del proceso de enseñanza y aprendizaje de los niños, como la alfabetización y las matemáticas (Kyriakides et al., 2016; Neumann & Neumann, 2015).

Es inevitable que los estudiantes con dificultades de aprendizaje se enfrenten a enormes problemas para participar en el sistema educativo. Especialmente para los estudiantes que según el estudio de derecho griego en los Departamentos de Integración de las escuelas típicas, no se ha proporcionado mucha intervención para ayudarlos a ser incluidos sin problemas en la clase general. Según la Ley de educación griega, esos estudiantes asisten a los mismos cursos y participan exactamente en los mismos temas de examen que los demás estudiantes sin dificultades de aprendizaje. No se proporcionan temas de examen diferenciados según su tipo de dificultad. Por lo tanto, el sistema educativo los trata injustamente. Por lo tanto, se decidió brindar alguna ayuda a esos estudiantes y hacer de esta manera que su inclusión a la clase regular fuera más suave.

La investigación internacional, por otra parte, ha puesto de manifiesto que tanto los estudiantes como los profesores son muy partidarios de utilizar sus teléfonos móviles en clase durante el proceso educativo. Según los hallazgos anteriores, nuestra aplicación fue diseñada para dispositivos Android con la opción

de que estudiantes y profesores la usen en cualquier momento y en cualquier lugar según el modelo de M-Learning. Esta aplicación fue pensada para ser utilizada y probada en clases de integración departamental de dos escuelas secundarias y finalmente, la experiencia del uso de la aplicación a ser evaluada.

El objetivo principal de este estudio es evaluar la eficacia de una nueva aplicación móvil diseñada en el contexto de la investigación. Para lograr este objetivo se utilizaron herramientas cuantitativas y cualitativas. Este enfoque ofrece las mejores oportunidades para responder a las importantes preguntas de investigación de este estudio, ya que dos de los métodos de recolección de datos más comúnmente empleados son los cuestionarios y las entrevistas que proporcionan una herramienta alternativa para la recolección de datos empíricos.

El problema de investigación que se espera analizar es el siguiente: ¿Podemos mejorar el aprendizaje en matemáticas de los estudiantes con dificultades de aprendizaje mediante el uso de una aplicación móvil? En relación con este problema, se formularon las siguientes preguntas de investigación:

1. ¿Están familiarizados los maestros de educación especial con el uso de las TIC?
2. ¿Cuáles son sus actitudes y percepciones sobre las aplicaciones existentes y sobre una nueva aplicación de Android para dispositivos móviles?
3. ¿Incluye la aplicación el contenido educativo apropiado para ayudar a los estudiantes en el aprendizaje?
4. ¿Está bien diseñada la aplicación, caracterizada por su funcionalidad y usabilidad?

Para los fines del estudio, se estimó necesario asegurar la disposición y las actitudes de los docentes de educación especial en el área de nuestra investigación. Para ello se llevó a cabo el diseño y la evaluación de una app. Por lo tanto, el principal objetivo de la investigación ha sido evaluar la funcionalidad de una nueva aplicación educativa para Android que podría ayudar a los estudiantes con dificultades de aprendizaje que estudian en los departamentos de Integración de dos escuelas griegas en el campo de las matemáticas. La aplicación, como hemos

indicado, también se ha diseñado en el contexto de esta investigación. Los objetivos especfícos de la investigación son:

- Analizar la disposición, actitudes y percepciones de los docentes en relación con el uso de tecnologías digitales.
- Evaluar la eficacia didáctica para el aprendizaje de las matemáticas de esta aplicación después de haber sido implementada con estudiantes con necesidades educativas.

Para el cumplimiento de los objetivos del estudio se siguieron los siguientes pasos. En primer lugar, se han examinado las actitudes y percepciones de los profesores griegos de educación especial sobre el uso de las tecnologías digitales en clase mediante un cuestionario. Respondieron al cuestionario 48 profesores griegos de educación especial de enseñanza primaria y secundaria. De sus respuestas se desprende que el conocimiento de la mayoría de los docentes sobre las TIC es suficiente, requisito necesario para aceptar el M-learning en la educación. Todos los profesores están familiarizados con el uso de las TIC y reconocen la importancia de las TIC en el proceso de aprendizaje y en la educación de los alumnos con necesidades educativas especiales. Los profesores declaran que podrían aceptar y usar fácilmente una nueva aplicación educativa móvil en el proceso de aprendizaje.

Según las respuestas de los profesores, se creó una nueva aplicación tecnológica para dispositivos Android con el objetivo de ayudar a los estudiantes con dificultades de aprendizaje en matemáticas. La aplicación se llamó “Love2LearnMath”. El Sistema de Gestión del Aprendizaje (aplicación móvil) que se implementó se basó en la teoría del conductismo, mientras que para la planificación del proyecto docente se utilizó el modelo ADDIE como guía de desarrollo. Según sus siglas (ADDIE) consta de 5 fases, que se siguieron en cada paso del estudio. Esas fases son: análisis, diseño, desarrollo, implementación y evaluación.

La herramienta de desarrollo de aplicaciones que se utilizó es Android Studio, el IDE oficial (Entorno de Desarrollo Integrado) para la plataforma Android. El

lenguaje de programación que se utilizó es Java, mientras que el conocimiento de XML es necesario para personalizar el formato y la apariencia de la aplicación.

Antes de su implementación, la aplicación fue evaluada por 7 profesores de matemáticas e informática a través de un cuestionario con preguntas cerradas, recolectando datos cuantitativos. A partir de sus respuestas podemos afirmar que los matemáticos y profesores de informática mostraron una actitud positiva hacia la aplicación Love2LearnMaths.

La aplicación se utiliza luego en los departamentos de integración de dos escuelas secundarias griegas en un período de dos meses. 16 estudiantes con dificultades de aprendizaje que asistieron a los departamentos de integración o recibieron apoyo paralelo durante el año escolar 2021-2022 probaron la aplicación bajo la supervisión de 3 profesores de matemáticas de educación especial. Los estudiantes de los departamentos de integración que responden un cuestionario con preguntas cerradas y abiertas, parecen estar positivamente entusiasmados con el uso de la aplicación Love2LearnMath. Además, factores como el género y el tipo de dificultad no parecen diferenciar las percepciones absolutamente positivas de los niños hacia la aplicación.

Los mismos puntos de vista positivos hacia la aplicación Love2LearnMath, sin ninguna diferenciación por género, nivel de estudios y edad, se observaron en las respuestas de los entrevistados, que fueron 3 profesores de matemáticas de educación especial, quienes respondieron a una entrevista estructurada con preguntas cerradas y abiertas.

Así, en conjunto los participantes de este estudio fueron:

- 48 profesores griegos de educación especial de enseñanza primaria y secundaria que respondieron a un cuestionario estructurado de cinco escalas Likert sobre la disposición de los profesores a adoptar y utilizar las TIC en clase, antes del diseño de la aplicación,

- 7 matemáticos y profesores de informática que respondieron un cuestionario de escala Likert de cinco preguntas cerradas, recogiendo datos cuantitativos, antes de la implementación de la aplicación en clase,
- 16 estudiantes de los departamentos de integración respondiendo a un cuestionario de cinco escalas Likert con preguntas cerradas y abiertas,
- 3 profesores de matemáticas de educación especial que fueron entrevistados y respondieron a preguntas de la entrevista, incluyendo preguntas cerradas y abiertas.

Para el análisis de los datos se utilizó el Paquete Estadístico para las Ciencias Sociales (SPSS) para Windows. La confiabilidad de los cuestionarios se evaluó mediante el índice Alpha de Cronbach. Para el análisis de los resultados se utilizó estadística descriptiva y estadística inferencial (prueba U de Mann-Witney y prueba ANOVA de una vía de Kruskal-Wallis).

La estadística descriptiva se refiere a la presentación resumida y eficaz de los datos de una encuesta estadística. Los datos se eligieron inicialmente para ser analizados con estadística descriptiva con el fin de extraer para cada pregunta el número y porcentaje de personas que eligieron cada una de las respuestas sugeridas. Las sugerencias reciben respuestas en una escala Likert de 1=No hay nada a 5=Mucho.

Para probar la relación entre algunas características de los profesores se utilizó la prueba U de Mann-Witney y la prueba ANOVA unidireccional de Kruskal-Wallis para detectar diferencias estadísticamente significativas en las respuestas de la muestra global, dependiendo de algunas de sus características. Además se utilizó el coeficiente de correlación de Spearman rs para detectar correlaciones entre variables cuantitativas. Para determinar diferencias y correlaciones estadísticamente significativas se seleccionó el nivel a = 0,05.

Los principales resultados de este estudio resaltaron las opiniones positivas de la gran mayoría de los docentes hacia el M-Learning para ayudar a los estudiantes con dificultades de aprendizaje a lograr un mejor desempeño educativo. También se afirma que los estudiantes con dificultades de aprendizaje y los profesores podrían

aceptar y utilizar muy fácilmente una nueva aplicación educativa móvil en el proceso de aprendizaje.

Con respecto a la evaluación de la aplicación se afirma que los matemáticos y profesores de informática tienen una actitud positiva hacia la aplicación. El mismo punto de vista positivo hacia la aplicación puede observarse en las respuestas de los entrevistados, que son los matemáticos de educación especial. Los estudiantes de los departamentos de integración, por otro lado, parecen positivamente entusiastas sobre el uso de la aplicación Love2LearnMath. El hallazgo más importante es que el conocimiento de los niños en matemáticas parecía haber mejorado. Por lo tanto, el objetivo de este estudio se ha logrado.

Como en todas las investigaciones, se han observado algunas limitaciones en su desarrollo. Un serio obstáculo se enfrentó debido a la pandemia de Covid-19 y los muchos problemas que causó al funcionamiento de las escuelas en ese periodo complejo de afrontar. Debido a las restricciones de la Covid-19, el período de prueba de la aplicación se redujo notablemente a dos meses en lugar de seis como estaba previsto inicialmente. Otra dificultad que tuvimos que afrontar debido a la Covid-19 es que el acceso a la escuela era muy limitado.

Unido a los efectos de la Covid-19, otra dificultad es la estricta ley griega sobre los datos personales sensibles de los estudiantes con dificultades de aprendizaje, por lo que el acceso de la investigadora a los estudiantes presentó muchas dificultades y limitaciones. Así, en lugar de entrevistarlos según lo planeado en el diseño inicial, se les distribuyeron cuestionarios que fueron respondidos bajo la supervisión de sus profesores. Además, debido a la pequeña muestra de la población de profesores y estudiantes, los resultados de la investigación, por alentadores que sean, no pueden en lo más mínimo generalizarse. Esta podría ser una importante razón que justifique la necesidad de futuras investigaciones.

Para el futuro cercano, por un lado, se ha planeado intentar la reevaluación de la aplicación por parte de más estudiantes y profesores. Mediante un análisis estadístico más amplio de una muestra más amplia de la población educativa se podrían obtener mejores resultados de evaluación representando las opiniones de

una parte más amplia de la población. Por otro lado, ya se ha planificado actualizar algunas de las funciones de las aplicaciones en función de los comentarios que hemos recibido de profesores y estudiantes. Otra posibilidad futura es la de especializar el contenido de la aplicación, de modo que cada categoría corresponda a un cierto tipo de dificultad de los estudiantes, éste es el objetivo final que esperamos lograr para incrementar el potencial beneficio de la aplicación para la comunidad de estudiantes con necesidades educativas especiales más amplia y diversa.

ABSTRACT

In recent years the use of portable technologies and devices has become widespread in many fields, such as in the economy, tourism, entertainment, but also in education. There are many surveys that prove the huge spread of use and popularity of mobile devices (mobile phones, tablets and laptops) among young people. On the other hand, mobile phones are mostly preferred compared to other mobile devices by secondary school students.

Mobile technology offers the ability to support learning and also offers to both students and teachers personalized learning opportunities. The main factors for the adoption and implementation of M-Learning in schools are the willingness and readiness of teachers.

There are many studies that prove the positive attitudes and perceptions of secondary school teachers on the use of mobile devices in school. However, specifically for Greece much fewer studies have been carried out. What is more, a great number of surveys indicate that the use of mobile technologies, affects positively the education of children with special educational needs such as autism, ADHD, dyslexia etc.

Therefore, this PhD dissertation aims at the design and evaluation of an educational Android application that is expected to help Greek gymnasium's students with learning difficulties to acquire extra skills in mathematics. Firstly, the attitudes and perceptions of Greek special education teachers about the use of ICTs in class have been analyzed to make sure on the one hand that teachers' knowledge on this field is adequate, considering the fact that ICTs' knowledge is not a prerequisite skill for becoming teacher. Additionally, teachers' attitudes towards the use of ICTs in class have been clarified. This stage is carried out via structured questionnaires and the data analysis of the answers has been made with IBM SPSS Statistics software.

Secondly, in the framework of the thesis' elaboration, a new technological Android application has been created, aiming at assisting students with learning difficulties in the field of mathematics. The application development tool that has been used is Android Studio, the official IDE (Integrated Development Environment) for the Android platform. The programming language that has been used is Java, while XML's knowledge was required in order to customize the formatting and the appearance of the application.

The application was to be implemented in integration departments of two secondary Greek schools within a period of six months (finally the period was reduced to two due to covid-19 restrictions). Before its implementation the application was evaluated by 7 teachers specialized in both the area of informatics and mathematics via a structured questionnaire. After its implementation the results were evaluated via interviews with special education teachers and questionnaires addressed to students with learning difficulties in order to estimate on the one hand the opinions and impressions of the students and teachers because of its use and, on the other hand the potential skills that the students may have acquired.

The statistical analysis of teachers' evaluation questionnaires revealed that mathematicians and informatics' teachers have a positive attitude towards the application "Love2LearnMaths". Similar attitudes towards mobile devices and apps in general had been announced by the Special Education teachers of the first phase of our research, as they are described in chapter 5.1. The same positive point of view towards the application "Love2LearnMaths" can be observed in the answers of the interviewees, who are the special education mathematicians.

Students of integration departments on the other hand, appear positively enthusiastic about the use of the application "Love2LearnMaths" as revealed by the analysis of Students' questionnaires for the evaluation of the app.

1. INTRODUCTION

The right to education is undeniable and common to all. Students experiencing learning difficulties or some form of disability should not be excluded or prevented from educational activities. The use of new technologies in special education can function as assistants to many students with special needs giving them the opportunity to discover and cultivate their real skills. Therefore, it is necessary for the relevant international political and educational structures to develop a new organized, universal philosophy regarding special education in connection with the utilization of the ICTs, in order to achieve the development of intellectual individuals irrespective of their particular needs (Makris & Markou, 2015).

> "People with special educational needs are considered individuals who have significant difficulty in learning and adaptation, due to physical, mental, psychological, emotional and social particularities" (Greek Law 2817/2000, article 1, par. 1).

Therefore, the main objective of special education is the education of individuals with disabilities and difficulties in such a way that their personality could be developed and their skills to be improved in order to achieve a better quality of life. Moreira et al. (2017) emphasize that the contemporary education system must take into account the different backgrounds and needs of students. In addition, the educational policy for equality should ensure that the educational practices, curricula, teaching and school programs are developed in such a way, so as to meet the needs of all students.

According to Chee et al. (2017) research about the integration of mobile learning into education has grown over the last decade. This has happened because of the widespread use of mobile devices and their great acceptance by young users. The main advantages of this new form of learning are the strengthening of the learning process, the easy access to information and the exchange of knowledge and communication.

The provision of education for students with learning difficulties differs among European countries. Nevertheless, all European countries agree that providing for the education of all students, is a guarantee for a life of better quality.

The curricula of the European States have included the introduction of information and communication technologies in education to confront educational issues (Toom, 2018).

On the other hand, Chen (2017) declares that mobile phones are very popular. However, in many countries the use of these devices into teaching and learning processes has not yet been successfully implemented, because both teachers and students do not accept the use of such devices in class, do not have access to them, and they are not appropriately skilled.

Referring to appropriate educational skills, the European Commission (2020) has made a plan to confront the need for the development of education's digital capacity. Everyday life and economy has been affected by the digital transformation, so European commission made an effort to support education. This plan of development involves all education structures of all European countries. Thus, the contemporary trend is in favor of online learning, which was further accelerated by the situation of COVID-19 pandemic. Many countries tend to try to integrate ICTs in education as soon as possible with an aim to improve school development and learning status of students. In this attempt students and educators should employ new innovative ways to learn and interact online using the digital technology.

Cheng and Lai (2020) made a research on technology-supported studies. The findings of their research proved that researchers in the area of special education were eventually interested in using technology tools and software applications. In their study is stated that researchers should argue on the subject if different learning strategies for special students' learning and the use of different means of technology are effective and can increase the levels of learning of students with learning difficulties. Moreover, future researchers should adopt many different technology sources and software applications in order to assist special education teachers in selecting the most appropriate ones for their students.

According to Moreno and Gortazar (2020) in the Coronavirus era, schools' readiness for providing digital forms of high quality education to all students is a critical issue. Schools had to face the problem of providing continuous digital

learning to schools between the periods of school closures. This kind of digital learning should have the potential to succeed in rather minimizing learning inequalities between students with different statuses than increasing them. Moreno and Gortazar (2020) also state that the presence of ICT brings a positive sign to education. In their effort to provide distance education due to coronavirus (COVID-19) pandemic, educational policies employ many different educational platforms that aim at the improvement of students' levels of knowledge.

According to OECD (2021) contemporary education could be transformed in the way it is offered to students. Digitalization opens up new educational challenges. Smart technologies can assist education systems to be effective and promote equity. Artificial intelligence can offer through technological devices assistance to both teachers to manage the classroom and to students when they study at home. Thus, people who are responsible to make educational policies are challenged to employ technology in order to improve and to further change education.

Padillo et al. (2023) state that Special Education must serve the educational needs of all students. Thus, they adopted and implemented a technology in the period of the COVID-19 pandemic aiming at making education capable of addressing the needs of special education students. The authors believe that until now even if technology's use has been widespread to all learning areas, it is still mainly focused on students which study to regular classes. Online platforms that have been created to address educational issues in the coronavirus era are not of enough assistance for students with special needs. Such students struggle to keep up with their schoolmates and extra technological aid is needed than this that is offered to them by these online platforms. We should take into account that those students usually have a lack of digital literacy competences and call for more help.

Tomé (2023) argues that the aim of his research is to find out new methods to assist students with special educational needs with the use of new technologies. Today's Schools need these new technologies and resources so that all students become able to gain learning. Contemporary educational system promotes an education that has in mind and cares for the educational needs of all students. New

technologies can replenish this educational need because of the fact that its many resources can be adjusted to address special educational needs of every student. In other words, every learning difficulty, handicap, deficiency, and disability that may exist in school classrooms can be confronted by using many technological resources appropriate for education (Tomé, 2023).

Yngve et al. (2023) claim that secondary school students with SEN could have great improvement in participating in school activities after they have received an effective ICT intervention. ICT such as tablets and smartphones containing relevant software and applications can be of great assistance to students with SEN. Subsequently, when such technology is addressed to the special needs of the student, it can lead to positive educational outcomes and to students' satisfaction with the learning process. Thus, students with SEN can conquer an improved quality of life.

We consider that the potential benefits of a mobile application for integration departments' children with special educational needs will be enormously great, thus we decided to design an application which aims at improving children's learning skills with the use of M-Learning technology and this research is focused on the evaluation of this application.

The project's main focus is to evaluate the functionality of a new educational Android application that could help students with learning difficulties who study in the Integration departments of two Greek schools in the field of mathematics. The application is also going to be designed in the context of this research.

For the purposes of the study, was estimated as necessary to find out the readiness and the attitudes of special education teachers in the area of the research. After that the design, the use in classroom and finally the evaluation of the application followed.

The main objectives of the research are:

- To analyze the readiness, attitudes and perceptions of teachers.

- To evaluate this application's educational effects after having been implemented in the students with educational needs.

The structure of the chapters in this report, except for the Introduction, consists of 7 (seven) parts that are briefly analyzed as follows:

The Theoretical Backgroung is the first part that deals with the following themes: Special educational needs and learning difficulties, Learning Theories and applications for students with learning difficulties, and Use of M-Learning technologies for students with learning difficulties. In each part except from in-depth analysis of each part, relevant research is being quoted.

This chapter has been useful in understanding the problems that students with learning difficulties face when participating in the learning process. Their characteristics are being mentioned according to their condition, which is very useful because we should help them according to their problem (e.g. Problems of distraction). The Greek structures of Integation Departments (Which is the context of this study) are also included in this chapter, a fact that shall help us to understand the situation of those children reffered to their difficulty to be totally included in the mainstream class and compete on equal terms with other students.

Learning Theories and applications for students with learning difficulties are also presented in this chapter. Learnig theories section offers an opportunity to understand how students with learning difficulties can acquire learning and which learning theory and technique is most appropriate considering their condition. Behavioral learning theory is analysed because it has been noted by researchers as mostly assisting in students' with SEN learning. At this context behavioral learning strategy techniques are also included and the most appropriate for students with difficulties is emerged. This is the "Drill and Practice" technique which is being incorporated in the design of the application "Love2LearnMaths". Behavioral theory is the basis upon the application has been designed. This is why Behaviorism, its principals, learning technology and techniques are presented in the stydy's

theoretical background as appropriate to be implemented in the sensitive area of special education.

The use of M-Learning technologies for students with SEN section is refers to the benefits that those students obtain in learning using those technologies. This section offers many added-value benefits that justificate the choice of mobile learning to assist students with SEN. Through a relevant research on M-learning in general and in Special Education we can understand its helpfulness for those students. Furthermore, the research on M-learning in mathematics clarifies the selection of Maths as a course included in the application. All the above research is useful for the design of the app, as it presents very positive results for studens with SEN.

The Design of the App, the second part analyzes how the app was designed and includes the parts: General technical description, Stages of the app's design and extensive instructions for using the app. All these stages are in detail presented and analysed. In General technical description are included the specifications from the behavioral example, which is based on the guidance and instructional systems and the training and exercise systems. The characteristics of the app are explained which are in accordance with the principals of the Behavioral Theory.

Then the stages of the app's Design are explained in detail along with the tools that were used. All the elements (Android Studio's platform, DB Browser SQLite, Firebase Platform) that were used for the app's configuration are described. This was a task necessary to be accomplished for assisting students with SEN. This information will be usefull for the potential users of the app to understand its structure.

Instructions for using the app are also explained as necessary for any reader of this study, or user of the app to understand the app's structure and functions. In this section all the elements, screens and possibilities of the app are presented. For example, users' registration, navigation options, choices between Theory or Exercices. This section provides the app's users with all the relevant information

about its use and capabilities. These instructions were in detail described by the researcher to all the participants who tested and evaluated the application.

Methodology is the study's third part and deals with the justification of the research, the research's Problem, the research's Questions and Objectives, the phases of the research and the followed procedures, the instruments that were used to collect information and the participants of each of the research's phases. At this part the procedures, technics, tools and documentation that were applied to accomplish certain tasks which are relevant to our stydy, are thouroughly analyzed. As a matter of fact this research's goal is to evaluate the efficacy of a mobile application that has been designed in the context of the whole study. To achieve this goal, in the context of methodology both quantitative and qualitative tools were used, that are described in this section, because this kind of approach provides the best opportunities for answering the important research questions of this study, the answers of which rely upon a variety of forms of data.

Results-Data Analysis is the fourth part of the study in which the results of the two phases of the survey are presented. Firstly teachers' readiness questionnaires analysis was carried out using Descriptive Statistics and Inferential statistics (Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test). Then Evaluation of the app followed including Teachers' questionnaires analysis, Students' questionnaire analysis and Special education teachers' Interviews analysis. Questionnaires' analysis was accomplished using Descriptive Statistics and Inferential statistics. Interviews' analysis was carried out using Descriptive Statistics.

Conclusions, the study's fifth part includes discussion on the results and conclusions in relation to research objectives which cover a summary of the answers to the research questions and the inference resulting from the data analysis. Research limitations and future goals are also included presenting on the one hand the obstacles that were encountered and on the other hand suggestions for further studies to be carried out.

Referring to Teachers' Readiness part of the study, the respondents of the first phace of the study are familiar with the use of ICTs and thus, they are digitally competent. Teachers are ready to accept and use in class our application.

As for the evaluation of "Love2LearnMaths" app, both teachers and students found it excellent because it offers many positive capabilities, attracts students' attention and motivates them, makes students' evaluation easier, increases students' learning abilities in Math and many others. Moreover, the design of "Love2LearnMaths" is faultless, as it is elegant and minimal, includes feedback with graphic and sound capabilities, has simple and understandable navigation menus and offers freedom in the choice of the navigation routes. Technical Characteristics of the application "Love2LearnMaths" are also impressively good, because the app is characterized by all stakeholders as easy to use, efficient and reliable.

Referring to the discussion part of the section there are included many results of other studies similar to the results of our study. These are presented in detail in the Discussion part of the relevant section and further reinforce the findings of this study.

References is the thesis' sixth part in which are mentioned all the Citations presented in the text in their full form (authors, years of publication, means of publication, pages, publishers, DOIs, etc), following the APA Style, 7th Edition (2020).

In Appendices, the study's seventh part all the questionnaires, interview's questions, tables including statistical analysis of the entire thesis' data along with the interview's answers are presented.

2. THEORETICAL BACKGROUND

This section studies three significant subjects that are considered necessary to be investigated for our survey's best development:

1. Special educational needs and learning difficulties.
2. Learning Theories and applications for students with learning difficulties.
3. Use of M-Learning technologies for students with learning difficulties.

In each chapter an attempt is made to examine each topic globally, to provide the necessary definitions and to clarify the appropriate terms for our study.

In the first part, which is Special Educational Needs and learning difficulties, we attempt to present the characteristics of children with learning difficulties. What is more, we quote the relevant educational structures (such as integration departments) in which children with special educational needs attend and the legislation which regulates these structures and their function. Ultimately, examples of apps that intent to assist children with learning difficulties are mentioned.

In the second part, Learning Theories and applications for students with learning difficulties, among others we refer mostly to the theory of learning that is the basis for the creation of our application. This specific learning theory is Behaviorism.

In the third part which is Use of M-Learning technologies for students with learning difficulties, we refer to the various definitions of mobile learning, and we quote related research and their results.

2.1. Special educational needs and learning difficulties

The right to education is inalienable and common to all. Students with Special educational needs and learning difficulties should be not excluded from an educational system common to all. The use of new technologies in special education can give many students with special needs the opportunity to discover and cultivate their skills and knowledge. According to Makris and Markou (2015) the relevant educational organizations regarding special education must develop and incorporate into school curricula the utilization of the ICT, to assist the holistic development of individuals with special needs, irrespective of their particularity.

People with Disabilities are considered to be all persons who have one or more serious disadvantages resulting from a physical or mental disorder. More specifically, children with special educational needs are considered those who have severe difficulty in learning and adapting to school environments due to physical, mental, psychological, emotional, and social difficulties. Disability has any child who needs extra help, more than other children, so that they can live a normal life (Hatzigiannoglou 2006). It is estimated that more than 10 % of the Greek student population has some kind of special educational needs (Hatzigiannoglou, 2006).

2.1.1. The characteristics of people with learning difficulties

Children with learning disabilities are a special learning group, with special characteristics and special educational needs. Educational development of the students and their behavior in general can be directly influenced by their learning difficulties (Hatzara, 2016).

More specifically, however, learning difficulties or learning disabilities is a term that describes a big range of disorders that include those referring to understanding and using oral, written, or spoken language (Rourke, 2005).

In learning disabilities are included disorders of reading, writing, spelling, and arithmetic difficulties and disorders involving hearing and acoustic comprehension and speech and socialization of students. They result from disorders in the central nervous system and have a significant negative influence on the person. As Reynolds et al. (2012) state Learning Disabilities is a term that defines other more specific learning disabilities, such as dyslexia and dysgraphia, which are described below.

Learning difficulties are very common among the school population and account for the 40 % of special education's population, 20 % of the students' population and the 1 % of university students. Learning difficulties are more common among boys than girls in proportion 4 to 1 (Zygouris, 2017).

Learning disabilities are considered to be lifelong disabilities, though their treatment and special accommodations at early stages can significantly change the negative effects of the disorder. Students with learning disabilities are also observed to have some other difficulties. Their academic growth is significantly below than what is expected for their age and their functions, such as voice awareness or verbal flexibility are not good enough. Work memory and visual or auditory perception are also below the expected. Students with learning disabilities sometimes have average intelligence, so they can thrive academically with specialized help to overcome their deficits. This may include special teaching and specialized education (Lewandowski et al., 2016).

In addition, learning difficulties are related to various other disorders such as anxiety, fear of failure, physical discomfort, loneliness and anger. Although one learning difficulty can be combined with other disorders that are within the area of special education it cannot be the result of these disorders (Taymans, 2012).

2.1.1.1. Specific learning disabilities

As mentioned above, Specific learning disabilities are the most common subcategory of learning disabilities. The types of difficulties that are included in Specific Learning Disabilities are the following (Zygouris 2017):

- Dyslexia

- Dysgraphia-Dysorthographia
- Dyscalculia
- Social and emotional disorders

Dyslexia

The term Dyslexia means the disorder in which a student is experiencing difficulty in reading and comprehending of a text or otherwise difficulty in reading and comprehending written language. Despite their difficulties with reading and writing, many people with dyslexia are creative, bright, and can academically thrive. A Dyslexic child can succeed academically with proper teaching and emotional support at early school age.

Dyslexia is a learning disability that mainly affects spelling and reading skills. However, it also affects information processing. People with dyslexia may often have difficulties in processing and remembering information they hear and see. The difficulties in the specific fields may affect the learning process as well as the acquisition of literacy skills. Early diagnosis improves the education of the student as well as the psychological consequences of a possible academic failure. Consequences of false diagnosis are affecting negatively future academic development and performance of the student (Giannopoulou, 2021).

On the other hand, dyslexic children need more time for reading and completing their work. Therefore, this means that their level of concentration could be decreased and their behavior could be affected. This condition can affect the quality of their school work. Proper interventions for dyslexic children can help them develop their potential (Siregar et al., 2023).

Yunus & Ahmad (2022) state that reading skills are an important issue for obtaining knowledge. Dyslexia pupils have a major problem with reading skills, thus they face a disorder concerning language learning. Dyslexia could be a long-lasting situation and in many cases lasts beyond adulthood. Dyslexic children are characterized by poor handwriting, have difficulties in written expression, have spelling fluency difficulties, and difficulty in correlating letters with sounds.

Dysgraphia and Dysorthographia

Dimauro et al. (2020) state that Dysgraphia is a learning disorder that causes difficulties in writing both alphabetical and numerical texts. Children with dysgraphia write irregularly, their writing is often incorrect, the position of their bodies and hands is incorrect, while they find difficulty in writing and in the production of written language. This disorder has also been referred to as a specific learning disability. The problem is presented among children who usually have average intelligence and who have not been identified as having neurological problems.

According to Zygouris (2017) Dysgraphia is a disorder characterized by impaired ability of the child to compose a text. This is usually expressed with errors in grammar or accentuation, with poor organization of paragraphs, with many misspellings (spelling) (Dysorthographia), and with very bad writing (non-legible letters). Children have improper posture of wrist when holding the pencil and bad body posture. They write letters with misspellings or incomplete letters and words.

Dyscalculia

Another disorder that is frequently presented with dyslexia is mathematics disorder or dyscalculia. Dyscalculia is the disorder that a child faces difficulties in developing and acquiring mathematical skills. Dyscalculia can be either developmental or progressive. Dyscalculia is classified as a specific learning disorder in DSM5 (American Psychiatric Association, 2013). Many aspects of mathematics depend on verbal skills, e.g., number knowledge, counting, and problem-solving. Zygouris (2017) states that 6 % of the school population has Dyscalculia, a percentage iihigh and argues that children diagnosed with this disorder present difficulty in the solution of linguistic problems, difficulty in understanding numbers, difficulty in counting and calculating and weakness in performing basic arithmetic operations. That's the reason why Dyscalculia often co-exists with Dyslexia (Snowling et al., 2020).

Persons with dyscalculia face difficulties in all sections of mathematics, such as in the processing of numbers and quantities and in performing basic arithmetic

calculations. Other symptoms and disorders that may co-exist with dyscalculia, are dyslexia, attention deficit/hyperactivity disorder (ADHD) and disorders such as anxiety, depression etc., or disorders in behavior, such as aggression (Haberstroh & Schulte-Körne, 2019).

Socio-emotional disorders

Socio-emotional disorders, like other special learning difficulties are based on a neuropsychological basis and usually appear in situations of adaptation to new data, to psychopathology changes, to social events, etc. (Zygouris, 2017).

2.1.1.2. Relevant Disorders

Relevant Disorders are: Attention Deficit Hyperactivity Disorder (ADHD), Dyspraxia, Visual Perceptual/Visual Motor Disorder, Auditory processing disorder and language processing disorder and Memory problems.

Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is not characterized a learning disability. However, researchers indicate that 30-50 percent of children with ADHD also present a specific learning disability, and that these two disorders can interact to make learning extremely challenging. The defining criteria for ADHD diagnosis include the presence and severity of a significant number of symptoms, either in the area of lack of concentration, or hyperactivity and impulsivity. In addition, these symptoms are expected to be present during childhood (before the age of 12 years), when they are observed in two or more environments and are causing negative effects on social, academic or professional functioning (APA, 2013; Lewandowski et al., 2016).

Harpin et al. (2016) claim that Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common mental disorders among students. ADHD can lead to poor self-esteem and poor social function in children. Also many students with ADHD have other additional problems such as depression, or disruptive behavior disorders (Austerman, 2015).

ADHD is often associated with anxiety, conflicting disorders, and behavioral disorder (Lewandowski et al., 2016). Behavioral symptoms may be accompanied by symptoms such as poor time management, inconsistency in academic work, disorganization, and difficulties in making relations with other students.

Generally speaking, ADHD is a developmental disorder of the brain with organic causes, which are related to dysfunctions of specific brain structures and affect the functionality of the child with important consequences in many areas of its daily life. Persistent and important difficulties involving this disorder are experienced by the child as well as by his family and his wider social environment (Hatzara, 2016).

Dyspraxia

Dyspraxia is a developmental disturbance in the function of movement mechanisms. It causes a delay in organizing movements because the brain is unable to process information quickly. Dyspraxia in children also affects their planning on what to do and how to do it. This causes difficulties in thinking, planning and performing motor or sensory tasks. Dyspraxia children are also prone to depressive disorders and have difficulties in emotion and behavior (Siregar et al., 2023).

Visual Perceptual/Visual Motor Disorder

Visual Perceptual Disorder, which is also known as Visual Perceptual Motor Deficit, affects a child's ability to understand visual information. People who suffer from visual perceptual disorder, experience difficulty with reading comprehension, in paying attention in class, in retaining information and in eye or hand coordination. A child with visual perceptual disorder may not even need glasses, but that doesn't necessarily mean they can visually perceive the world around them (Misra & Aikat, 2016).

Auditory processing disorder and language processing disorder

According to DeBonis (2015) Auditory Processing Disorder (APD), which is also known as Central Auditory Processing Disorder, is a condition that affects the way the brain processes or interprets sound. People with APD are not able to recognize

subtle differences between sounds, even when the sounds are very loud and clear. They can also find difficulties in understanding where sounds are coming from. Language Processing Disorder on the other hand, is a specific type of APD, in which individuals find it hard to attach meaning to sound groups that form words, sentences and stories. (LPD) relates to the processing of the language (DeBonis, 2015).

Memory problems

An additional feature of children with learning disabilities is memory impairment. The student with learning disabilities is characterized by limited short-term memory and working memory. In practice, this means that children with learning disabilities forget the beginning of the sentence when they reach its end. Additionally, according to Polychroni et al. (2010) students have difficulty in remembering and performing simple instructions, such as arithmetic problems.

Conclusions

From all the above we are led to the conclusion that Students with SEN usually present: Poor academic performance, low self-esteem, anxiety, emotional instability, learning frustration, lack of learning motivation, difficult emotional state, poor social functions, depression or behavior disorders (Austerman, 2015; Harpin et al., 2016; Haberstroh & Schulte-Körne 2019; Huang et al.,2020; Siregar et al., 2023).

Therefore, it is hopefully expected that students with SEN will be assisted by a mobile application presenting knowledge in a more simplified way in gaining confidence and self-esteem, in staying focused, in being motivated, in decreasing anxiety and frustration, and improving their academic performance.

2.1.2. The Greek educational structures for pupils with learning difficulties

According to Soulidou et al. (2023) over the last century, there have been many changes in social perceptions concerning people with special needs and their

education. From complete rejection and isolation, the situation has changed to the current status of recognition and respect for diversity and the status of co-education and inclusion of all students in the same class, regardless of their particularities. Tomlinson (2015) states that the respect for human rights and a social justice agenda support the provision for children identified with special educational needs. According to UNESCO (1994) Salamanca's Statement aim was to further promote the objective of Education for All through educational policies in order to promote the approach of inclusive education. Towards this direction the Greek Government has gradually through the years voted a series of laws for the integration of students with special needs and their education.

Thus, below are presented the Greek educational structures for pupils with learning difficulties, according to a plethora of legislation and regulations.

2.1.2.1. Parallel Support

Parallel Support is the differentiated education that a student receives from a special education teacher in the ordinary classroom (Velli & Vlachou, 2017).

According to Law 3699/2008 parallel support is provided to students who can, with appropriate individual support, attend the classroom curriculum (Topsi, 2019).

It is also provided to students with more severe educational needs when there is no other special education framework (special school, integration department) or where parallel support becomes necessary because of their specific educational needs. In the latter case, special education support can be provided on a permanent and scheduled basis (Velli & Vlachou, 2017).

In all other cases, the Center for Interdisciplinary Assessment, Counseling & Support (KEDASY) must present precise justification to parents for the decision of providing parallel support to a student (Topsi, 2019). Finally, this decision is not of a permanent nature, but is reconsidered at a regular basis, as referred to Article 28 of Law 4186/2013.

2.1.2.2. Integration Department

The Integration Department or Inclusion Department was established by Greek Law 2817/2000, article 1, par. 1 with the aim of completely integrating a group of students with similar special educational needs or disabilities in the school environment through special educational interventions (Velli & Vlachou, 2017).

The aim of these interventions is the creation of personalized programs and the appropriate adaptation of educational material according to students' needs. By Law 3699/2008, it is declared that Integration Departments operate in typical schools and include students with special educational needs. However, students with more severe educational needs can also attend the Department while attending another personalized educational support program, as well (Topsi, 2019).

Additionally, article 82 of Law 4368/2016, defines that if it is required by the kind of student's special educational needs, the support in a special classroom is implemented. The ultimate goal is the reintegration of the students in the typical classroom when they reach a satisfactory level of knowledge.

Law 4368/2016, article 82 redefined the objectives of inclusion classes (integration departments). It is stressed that the main aim of the inclusion classes (integration departments) is the full inclusion of children with special education needs in the mainstream class environment. Support is only exceptionally provided in a separate inclusion classroom. In this case, the main target of the teaching intervention is the future full inclusion of the pupil in the mainstream class.

According to Law 3699/2008, article 3, par. 1, 2, 3, students with disabilities and special educational needs can be supported in the Integration Departments. To be supported in the Integration Departments students need:

- Official relevant opinion-diagnosis of KEDASY (Center for Interdisciplinary Assessment, Counseling & Support)
- Responsible declaration of parents that they allow their children to attend such programs (Topsi, 2019).

According to article 7 of Law 4547/2018, a decision of KEDASY is necessary to determine the appropriate support framework in school. KEDASY is the official public structure which determines the diagnosis of students' difficulty or disability and recommends:

- The registration, classification and attendance of students in an appropriate school framework
- The utilization of specific methods and means of further support to the learning process.

The purpose of operation of the Integration Departments is the full inclusion of students with SEN in the mainstream school environment with special educational interventions after a period of time (Law 4368/16, article 82, par. 5).

Students of Integration departments belong to the dynamic range of the regular class section and they are distributed among the sections of the same class. Some hours (up to 15/per week) are supported by Special Educators in Integration departments (Law 4547/2018, article 51, as amended by Law 3699/2008, article 6).

Students are examined at the same time as the students of the class they belong, to the same curriculum and subjects via oral or written exams according to their diagnosis of KEDASY and they are evaluated and graded cooperatively by of both general and special education teachers, as stated by Law 3699/2008.

Special education in Greece has already completed a long journey through many different laws and legislation. During this journey a variety of educational structures and diagnostic services were developed, as it can be deduced from the relevant legislation. However, the problem of integration or inclusion continues to persist, because of the separation between Special and General Education, since special education structures are still recognized as a separate system operating in parallel lines with the general education system and students' full inclusion has not yet not been achieved and fulfilled. The situation is the same in other European countries such as England and France (Warnes et al., 2022; Jury et al., 2023).

2.2. Learning Theories and Applications for students with learning difficulties

Learning means acquiring lasting knowledge or skills through instruction. We could say that learning happens when people acquire new information and knowledge and integrate it into their daily lives. According to Korompili & Togia (2015) a number of theories describing the process of "learning" have been developed and the learning process is based on these various theories (behaviorism, constructivism, cognitivism etc.). These theories are used to describe how learning occurs.

Korompili & Togia (2015) argue that constructivism is a learning theory according to which students can construct their own knowledge. New knowledge is based on the knowledge that they already have mastered. Constructivism consists of cognitive constructivism and social constructivism. Cognitive constructivism is based on the theory of Jean Piaget, while social constructivism is based on the work of Lev Vygotsky. According to cognitive constructivism students create their own knowledge through their experience. Vygotsky on the other hand argues that knowledge is built through social interaction.

We reject this theory mainly because we consider that most children with learning difficulties according to their characteristics which were analyzed in chapter 2, section 2.1.1, may not be able to create their own knowledge, either by themselves or through social interaction. However, our application presents information based on students' prior knowledge in mathematics. From this point of view knew knowledge is gained upon the basis of the previous one and our application has some signs of similarity to the idea of cognitive constructivism.

According to Siemens (2004), "Connectivism is a Learning Theory for the Digital Age" (p. 1). On the other hand, Downes (2008) claims that "knowledge is organized in the form of a network of connected nodes and that learning is the ability to build and traverse this network" (p. 2).

Dimitriadis (2015) argues that, according to connectivism, knowledge is a process of network creation and that is continually evolving, while students are nodes and carriers of knowledge in these networks. Siemens (2004) on the other hand argues that the intention of all learning activities is updating knowledge and that decision making is also a learning process. The ability to detect new forms of connections between ideas and concepts is critical to learning.

We didn't chose connectivism's theory as a basis for the creation of our application mainly because we consider that most children with learning difficulties may are not capable of being nodes and carriers of knowledge, of making decisions, of updating knowledge by themselves and detecting new forms of connections between ideas and concepts. On the other hand, we chose the behavioral learning theory as a basis on which we designed our application mainly because as described in section 2.2.1., is appropriate for special education (Komis, 2004; Styliaras & Dimou, 2015).

The development of our educational software comes from the psychological theory of behaviorism that supports traditional or direct methods of teaching.

The behavioral learning theory and the Vygotsky's social learning theory have their origins in similar ideas. The social learning theory agrees with the behavioral learning theory in the area that learner's behavior is influenced from outside. However, the social learning theory additionally suggests that internal psychological processes can also influence a learner's behavior (University of Illinois Springfield, n.d.).

On the one hand, behavioral learning theory is based on external behaviors of the learner. On the other hand, constructivism focuses on the mental processes by which the learner himself constructs his own knowledge rather than simply acquiring existing knowledge. Each of the above theories enriched pedagogical philosophy and provided useful assistance in the design of the teaching process (Korompili & Togia, 2015).

The main representatives of Behavioral learning theory are: Pavlov, Skinner, Crowder and Gagné. Skinner supports "Linear Organization of Information" (Skinner, 1968). Crowder is the lecturer in "Multiple Choice Method" (Crowder, 1959). Gagné is the Lecturer in "Teaching or Instructional Design" (Gagné, 1985). Learning according to behaviorism is the modification of a person's externally observed behavior, while the goal of teaching is to achieve the desired behavior.

In section below we are going to discuss about the behavioral learning theory because according to the research that is quoted below, it is the most appropriate learning theory that suits most to the area of special education.

2.2.1. Behaviorism

Behaviorism was very popular in the mid-20th century and treats learning as a response to a stimulus. Teaching and learning is a process of preparing students to react properly to stimuli, and technology can facilitate this training by providing motivation for learning, such as games or other rewards (Kimmons, 2018).

According to behavioral theory, learning is a process during which individual's behavior is modified, through stimuli and reactions (Komis, 2004). Moreover, according to Skinner, one of the main representatives of this theory, learning must be achieved through feedback and more specifically through positive or negative reinforcement. When people receive positive reinforcement, such as praise and rewards for certain behaviors, those behaviors are strengthened, while negative reinforcement will deter other behaviors (Mehroz Nida Dilshad, 2017).

Behaviorism is mainly based on the work of J. B. Watson and B. F. Skinner. Their studies focused on behaviors that could be empirically observed, such as actions that could be measured and tested, rather than on internal states such as emotions (McLeod, 2023).

According to Korompili, & Togia (2015) in a behavioral classroom instructors implement a pre-organized lesson plan. Concepts are presented linearly and in small

pieces, while students are passively involved in the process of accepting information. These methods are in complete contrast to the views of newer educators who believe that the human mind does not work linearly.

In education, behaviorists implement with success a system of rewards and punishments. They reward the desired behaviors and somehow punish the unwanted ones. Behavioral learning theory is not only important in achieving the desired behavior in mainstream education. Special education teachers have also plans to implement it in order to modify students' behavior. These plans assure success for these students in and out of school (Zhou & Brown, 2017).

The didactic design model introduced by Gagné is very important in the context of behaviorism. According to this model evaluation of the student's needs is initially done, then each activity that will follow is determined and each cognitive goal that must be mastered is specified. Afterwards, the teaching methods and the learning material are selected and finally students are evaluated by answering to relevant tests. These tests give the educator the chance to perceive which and how many cognitive goals the students have conquered (Komis, 2004; Styliaras & Dimou, 2015).

According to the above, behaviorism contributed to the creation of educational training and practice software (tutorials & drill and practice). Such software is considered sufficient for the provision of supervised teaching, consolidation of low level knowledge and skills and finally, it facilitates the work and the evaluation of the students. The above mentioned characteristics indicate a software appropriate for Special Education (Komis, 2004; Styliaras & Dimou, 2015).

Table 1 below summarizes the basic characteristics of the Behavioral learning theory, its main representatives and some examples of learning technologies that can support this approach to learning. An effort was made so that most of those elements (Mainly Gagné's) to be included in the design and the final edition of our application.

Table 1

The main principals of the Behaviorism Learning Theory

MAIN CHARACTERISTICS OF BEHAVIORISM	MAIN REPRESENTATIVES	MAIN ELEMENTS OF LEARNING TECHNOLOGY
• Predetermined teaching and activities, practice and feedback •In teaching we give a stimulus and waite for a student's response (change in behavior) • Students tend to become passive learners	• Pavlov: introduced patterns of association • Skinner: learning by reward and punishment • Gagné : behaviorist with constructivist ideas, instructional design	• Information is presented linearly • Do and review (Drill & Practice) activities • Multiple-choice questions, quizzes • Limited Navigation choices

2.2.2. Behavioral learning strategy techniques for Special Education

The educational software designed according to the principles of behaviorism, are tutorials and drill and practice software. The common element of these two categories of educational software is that they are closed type programs. In instructional designed software the main goal is usually the transfer of knowledge, while in drill and practice software the students can do some exercises to check their level of knowledge. The specific referred applications contain the element of feedback through closed type questions and grading, while they encourage the students to repeat the exercises (learn through repetition) and improve in this way their level of knowledge (Dimitriadis, 2015).

Behavioral Theories are the first Learning Theories, which were used to theoretically support the implementation of technology in education (Solomonidou, 2006; Komis, 2004). The software that incorporates these Theories, tutorials & drill and practice are considered sufficient:

- To provide supervisory teaching
- For the consolidation of a low level of knowledge and skills
- For the evaluation and personal work of the students
- In preschool and early school age
- In special education

A very important part of Educational Software has therefore been built based on Behavioral Theories. The software of tutorials, drill and practice, as well as some arithmetic programs or vocabulary learning programs are usually based on these theories (Apostolopoulou, 2012).

According to University of Illinois Springfield (n.d.) drill and practice is a behaviorist technique in which students are given the same materials repeatedly until learning is achieved. In this case, students are given similar questions to answer or activities to perform.

Drill and practice technique is mainly applied in Kinesthetic, Music, Mathematics, Language and Biological Sciences. Drill and practice activities can also be provided to students to complete them on their own time. Appropriate feedback is provided after they have completed a certain activity. In many mathematics drills immediate feedback without the interference of the teacher can also be provided (University of Illinois Springfield, n.d.).

The above teaching techniques are also applied via the structure of the application we have designed, following the behavioral learning strategy. The fact that the specific educational software is not eligible to changes according to educational purposes could possibly be a deterrent to their use in the educational process. On the other hand, educational software based on behavioral theory are considered suitable for the introduction of new concepts and for the acquisition of basic knowledge in the teaching and learning process (Kapravelou, 2011).

To sum up, our application follows the behavioral learning theory's principals, which according to previous research, are appropriate to be implemented in the sensitive area of special education.

2.3. Use of M-Learning technologies for students with learning difficulties

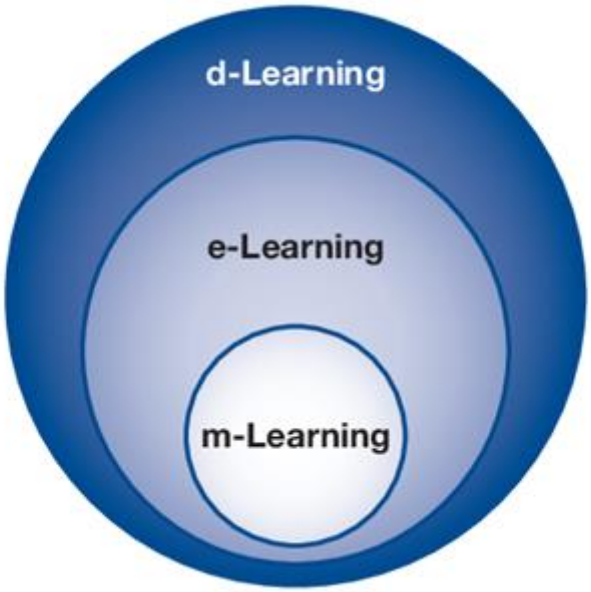
Our era is a period of transition from the information society to the knowledge society. Therefore, there is a growing demand for innovative ways of education, because people are required to acquire new knowledge, skills and competences quickly and effectively. Thus, evolution in computer and network technology is able to provide many different means for supporting learning with its flexibility, portability, and in accordance with individuals' needs.

These rapid changes in learning needs have led to a new era of modern education, where Electronic Learning (E-Learning), Distance Learning (D-Learning), Mobile Learning (M-Learning) increasingly adopted by educational institutions, and governments as promising solutions for successful learning.

According to Behera (2013) d-learning is considered to be an extension of E-Learning, while E-Learning can be shared using mobile devices. Thus, M-Learning is included in the E-Learning area as a subset. The below image describes the above statements.

Figure 1

Relationship between D-Learning, E-Learning, M-Learning



E-Learning is considered difficult to provide a single, comprehensive definition that includes all its features, even though its benefits for learners, educators and the educational system are recognized by the majority of the scientific community. Salinas et al. (2015) in their attempt to define E-Learning, they have pointed out three different concepts: E-Learning, blended learning and mobile learning.

Referring to M-Learning, Sánchez-Prieto et al. (2016) argue that it is a method of learning which is connected to E-Learning, where teaching and learning process can have an electronic context.

Behera (2013) states that both E-Learning and M-Learning play an important role in the field of modern education. Both types of learning encourage teachers and students to take personal responsibility for their own learning and thus, are both beneficial to education. Therefore, teachers need to acquire technological skills in order to succeed in the process of introducing E-Learning and M-Learning into their classes.

Mobile Learning refers to learning which is acquired through small and portable wireless devices such as mobile phones, PDAs, smartphones, small personal computers and tablets. Thus, more flexibility and interaction between teachers and students is acquired (Bukharaev & Altaher, 2017; Alsaadat, 2017). Therefore, teachers and students communicate through mobile devices' services. Communication services are: SMS (text messages), MMS (multimedia messages), MSN (messages msn-hotmail-msn-messenger), GPRS (direct radio) and BLTH (Bluetooth) (Bukharaev & Altaher, 2017).

Kothamasu (2010) states that M-Learning is nothing but learning through the use of mobile devices and it is addressed to those who are continuously moving. Teaching and learning are extended outside the school classrooms and M-Learning opens up new horizons for both educators and learners. Mobility also helps students with different cognitive levels and learning styles to learn autonomously without the teachers' presence and study at their own pace, place and time simply by using their mobile devices, such as: smartphones, iPhones, tablets, etc. (Kothamasu, 2010).

2.3.1. Research on M-Learning

M-Learning, as stated above, refers to learning which is acquired through small and portable wireless devices such as mobile phones, PDAs, smartphones, small personal computers and tablets. Thus, we couldn't do otherwise than, except from other devices, make a special reference to mobile phones. It is remarkable to mention that mobile phone industry has indicated the fastest growth rate worldwide. Laricchia (2023) claims that the mass smartphone use started to grow since 2008.

- In 2020, 5.84 billion of the world's population were smartphone users.
- In 2021 there were 6.23 billion smartphone subscriptions.
- In 2022, 68 percent of the world's population were smartphone users.
- In 2028 smartphone users are expected to rise to 8 billion.

Table 2

Number of smartphone mobile network subscriptions worldwide from 2020 to 2022, with predictions from 2023 to 2028

YEAR	SMARTPHONE USAGE NUMBERS
2020	5.84 billion subscriptions
2021	6.26 billion subscriptions
2022	6.6 billion subscriptions
2023	6.9 billion subscriptions
By the end of 2028	7,8 billion subscriptions

Note. Retrieved from https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

According to Zeng & Luyegu (2012) in the United States in 2018, 69 % of high school graduates and 91 % of college graduates own the latest smartphone models. This fact proves the huge success of technology and that rapid acceptance of smart phones is even higher in developed countries.

Moreover, the latest developments in the field of technology have made mobile devices affordable and available to everyone. This is why such devices influence to such a great extent the field of education (Cobcroft et al., 2006).

All the above findings prove that mobile learning offers many advantages to its users and mobile devices' use has been widespread in the last decades because those devices are affordable and available to everyone. Thus, we are motivated to create an application, using the mobile phone as an educational tool.

2.3.1.1. The advantages and educational possibilities of M-Learning

In this section some research data are presented that prove that students are in favor of the use of mobile devices for educational purposes. Kukulska-Hulme and Taxler (2005) argue that portability is not the only advantage of using M-Learning. The characteristic of collaborative learning is another important advantage of using mobile devices, as their use proves that learners are able to communicate with other students and teachers from different locations, even when they are not in the classroom. Portability of mobile devices combined with collaborative learning makes M-Learning different from any other Learning technology.

Vate-U-Lan (2008) claims that researchers have proved that students are in favor of using M-Learning as an educational tool, because they strongly believe that in this way their educational experience will be enhanced. According to students, the most attractive feature of M-Learning is the ability of their being self-taught at their own pace, place and time.

Saccol et al. (2010) claim that the portability feature allows students from geographically remote locations to be included in the educational process without having to change their place. Theoretically, M-Learning offers students the opportunity to study and learn anytime and everywhere.

Alrasheedi and Capretz (2018) argue that the feature of mobility of M-Learning, has various implications and applications. It allows students to manage their learning content, learning subject and learning space. Students also have the

absolute control over the time and place within which they have access to learning resources.

Flewitt et al. (2015) state that using this form of digital technology is not a difficult technical problem for students because they quickly become enthusiastic and capable users of such technology.

In a study conducted during the school year 2014-2015 by Seralidou and Douligeris (2015) 223 students were asked if they use smartphones and if they believe that the use of new technology helps them with their homework. 98 % answered that they use smartphones and 54.2 % think that they feel more confident about themselves when doing their homework for school.

It is a fact that mobile devices have already changed people's lifestyles. In the near future mobile technologies will undoubtedly be incorporated into education to satisfy both students' and teachers' teaching and learning needs. Moreover, the ways in which mobile devices are used in education will be gradually changed by technology (Quinn, 2013).

Nikolopoulou and Kousloglou (2020) argue that 32 teachers working in two high schools (attended by students aged 12-15 years old) in Greece answered to a questionnaire and stated that the lesson was enjoyable, students were motivated and participated in the process. Students were also familiar with the mobile technology. Moreover, teachers reported positive high school students' emotions (joy, excitement, contentment) when mobile technology was used in the classrooms.

Nikolopoulou (2021) conducted a research on the educational advantages of using portable digital devices in which 530 students of secondary Greek education took part. 83 % of them stated that they use a mobile phone preferring it more than other mobile devices. 83.6 % of the students have positive views about the advantages of mobile education.

Nikolopoulou (2021) in another research about mobile devices and M-Learning in Greek secondary education argues that students reported positive perceptions and high self-efficacy in using mobile devices. Moreover, students could

name some educational activities which they would like to do with their mobile phones in the classroom.

Table 3 below summarizes the surveys' results that were mentioned above and indicate that students are in favor of the use of mobile devices.

Table 3

Research indicating that students are in favor of the use of mobile devices

RESEARCHERS	M-LEARNING CHARACTERISTICS	RESULT
Zeng & Luyegu (2012)	Rapid acceptance of smart phones	Widespread of smart phones between high school and college students
Seralidou & Douligeris (2015)		Use of smartphones by 98 % of students
Kukulska-Hulme & Taxler (2005)	Portability and collaborative learning	Interaction
Nikolopoulou (2021)	Collaboration Easier access to lessons	
Vate-U-Lan (2008)	M-Learning as an educational platform	Study anywhere at their own pace
Saccol et al. (2010)	M-Learning's Portability	
Alrasheedi & Capretz (2018)	M-Learning's Mobility	
Flewitt et al. (2015)	Special knowledge and skills are not required	Positive perceptions in using mobile devices
Nikolopoulou&Kousloglou(2020)	Mobile technology's use in the classrooms	
Nikolopoulou (2021)	Use of mobile devices in the classroom of secondary schools	
Quinn (2013)	Use of mobile devices in education	

We can observe that the above mentioned by Table 3 research confirms that students are undeniably in favor of using mobile devices. Students use mobile devices at a great extent, because they can interact with each other and they can study anywhere and at any time they want. According to the above findings, our software uses the mobile phone as an educational tool, because it is popular amongst students. Additionally, it follows the principles of Behavior Theory as a

framework of instructional design and drill and practice application (as referred in section 2.2).

Teachers' readiness and attitudes towards the use of cell phones and other mobile devices in the educational process, is another important issue that needs to be analyzed. That is why in the first phase of this survey detecting and identifying teachers' perceptions on this area was attempted.

In fact, according to İlçi (2014) students' and teachers' readiness and acceptance of M-Learning are highlighted as important areas of research, if we consider the rapid development of M-Learning.

However, according to international literature, teachers' views towards the use of mobile devices in the educational process are positive. For example, Ekanayake and Wishart (2011) reported in their study a teachers' positive attitude towards the use of mobile phones.

In a study of Seralidou and Douligeris (2015) is stated that secondary level school teachers seem to have a positive attitude toward the use of smart mobile devices during their teaching in their classes. 88.2 % of the teachers who answered the questionnaire stated that they believed that smart phones can be used effectively in education. Although only 30.7 % of the teachers had used smartphones in class, even the rest 62.1 % of them commented that they are positive about the use of smartphones in the future. Teachers believe that the use of smartphones facilitates and improves the teaching process. Thus, a large number of teachers think positively about the use of smart devices in their classroom, they are willing to use them and they believe that their lessons will be improved in this way (Seralidou & Douligeris, 2015).

Teachers are finally embracing the use of smartphones in their teaching process. Students on the other hand have already been using them and they feel more confident about dealing with school projects using new technologies.

Educators who understand and accept M-Learning should change their teaching strategies and prepare students for a technology-based environment (Chen,

2017). This view is also supported by Mahat et al. (2012) who state that prior to designing and implementing an M-Learning app, it is important to assess future users' perceptions of M-Learning, because these perceptions significantly affect their willingness to adopt M-Learning.

To sum up, from the research of Kousloglou & Syrpi (2018) regarding the attitudes of secondary school teachers towards the use of mobile phones, it appears that most of the teachers approve of the use of mobile phones for educational purposes.

Nikolopoulou and Kousloglou (2020) made a research to analyze the perceptions of high school teachers on the use of mobile technology in the classroom. The participants were 32 teachers working in two high schools in Greece. Most teachers acknowledged the benefits of mobile devices' usage in class. Such advantages are that the lesson became enjoyable and that students were motivated and participated in the learning process. Additionally, another advantage is that students became familiar with the use of technology.

Nikolopoulou et al. (2021) at their research about educators' readiness to adopt M-Learning in classrooms indicate that most teachers' have positive perceptions of M-Learning readiness, ICT training and use of mobile devices in the classroom. Most teachers are capable of implementing M-Learning in their classrooms.

Nikolopoulou (2021) at another research about mobile devices and M-Learning in Greek Secondary Education argues that the use of mobile phones among secondary school students is very common. She also states that M-Learning research in secondary education in Greece is still limited. The topic of M-Learning in the Greek context is not covered enough by the relevant literature. However, the findings indicated that teachers have positive perceptions towards M-Learning's usage in classrooms.

Table 4 summarizes the above mentioned researches' results which indicate the importance of M-Learning readiness and acceptance of teachers and their positive attitudes regarding mobile devices.

Table 4

Research indicating the teachers' readiness and positive attitudes towards mobile devices

RESEARCHERS	RESULT
İlçi (2014)	M-Learning readiness and acceptance of students and teachers is an important area of research
Ekanayake & Wishart (2011)	Positive attitude towards the use of mobile phones
Seralidou & Douligeris (2015)	Beliefs of Secondary level school teachers that smart phones can be used effectively during an educational process
Chen (2017)	Acceptance of M-Learning, changing of teaching strategies and preparation of students
Mahat et al. (2012)	Acceptance of M-Learning and evaluation of users' perceptions
Kousloglou & Syrpi (2018)	Most of secondary school teachers accept the use of mobile phones for educational purposes
Nikolopoulou & Kousloglou (2020)	Teachers' positive attitudes about the benefits of mobile devices' usage in class Enjoyable lesson Students' motivation and participation Students' familiarity with the technology
Nikolopoulou et al. (2021)	Teachers' positive perceptions of M-Learning readiness, ICT training and use of mobile devices in the classroom
Nikolopoulou (2021)	Teachers' positive perceptions towards M-Learning Teachers' awareness of the pros and cons of mobile devices' usage in classrooms

The previous research proves that generally speaking teachers have a positive attitude regarding M-Learning and are ready to include M-Learning in their teaching practices. Teachers think that the lesson becomes enjoyable, that students are motivated to participate in class and that students are familiar with the mobile technology, as well. These results strongly concur with the findings of our relevant research, as they are described in section 5.1.

Numerous of studies have demonstrated the benefits of using mobile devices in the learning process.

According to Mannade and Hazare (2017) mobile devices are of low cost, offer easy access to learning material and provide useful tools that students can use to construct new knowledge and support the learning process, regardless of spatial and temporal limitations.

The portability, the immediacy of use, and the extensibility which allow the interaction with other devices are also emphasized in the research of Zayim and Ozel (2015) as advantages.

According to Lohnari (2016) due to the portability, ease of use, and the speed of mobile devices, information can be accessed beyond the boundaries of the classroom, anywhere and at anytime.

Lu et al. (2014) claim that instant access to information and digital content anywhere facilitates personalized instruction, which means that students can learn according to their preferences and at their own pace.

Jahnke and Kumar (2014) agree that M-Learning systems allow feedback during the learning process. Their use offers the user opportunities for communication, collaborative learning and encourages students to participate more in the educational process (Reychav & Wu, 2015).

According to Clarke and Svanaes (2014) wireless technology seems to be able to improve the learning process and especially support students with learning difficulties.

Glaroudis (2012) states that mobile devices, can replace bulky textbooks and stimulate students' interest. He also states that mobile devices can be useful tools for students with special educational needs.

Jahnke and Kumar (2014) state that M-Learning, can help students improve their math, literacy and language learning skills. Moreover, they argue that Mobile devices encourage collaboration and communication between students and teachers and increase students' interest in learning, as they play a more active role in learning (Gerger, 2014).

According to the studies of Castillo-Manzano et al. (2016) and Alhassan (2016) mobile devices provide motivation for student's participation and improve collaboration between students, as well as between teachers and students.

Additionally, Kothamasu (2010) declares as Key Observations in his study:

- M-Learning helps learners to improve their literacy and numeracy skills and recognize their real abilities.
- M-Learning can be used to encourage both independent and collaborative learning.
- M-Learning helps students to understand issues when they need help and support.
- M-Learning inspires and makes students to be occupied with their lessons.
- M-Learning helps learners to remain more focused and for longer periods.
- M-Learning helps students to raise their self-confidence.

Table 5 briefly outlines the the beneficial results of mobile devices in education gained by both students and teachers, resulting from the aforementioned research. Those benefits concern in addition to general education, special education as well.

Table 5

Research indicating the advantages of mobile devices' use in education

RESEARCHERS	M-LEARNING CHARACTERISTICS	BENEFITS
Mannade & Hazare (2017)	Low cost of mobile devices	• Easy access to learning material • Useful tool to construct new knowledge • No spatial and time limitations
Zayim & Ozel (2015)	• Portability • Extensibility	Interaction with other devices
Lohnari (2016) Lu et al. (2014)	• Portability • Ease of use • Speed	• Information can be accessed anywhere, anytime • Personalized instruction
Jahnke & Kumar (2014)	• Feedback potentiality • Chance for collaboration	• Participation of students in the educational process • Increase students' interest • Improvement in math, literacy and language learning skills
Reychav & Wu (2015)	Opportunity for collaboration and communication	Students are encouraged to participate in the educational process

Clarke & Svanaes (2014)	Wireless technology	• Improvement of learning • Support of students with learning difficulties
Glaroudis (2012)	Mobile devices can replace bulky textbooks	• Stimulate students' interest • Can be useful tools for students with special educational needs
Gerger (2014)	Opportunity for collaboration and communication	• Increase of students' interest in learning • More active role in designing instruction
• Castillo-Manzano et al. (2016) • Alhassan (2016)	Improvement in collaboration between students & between teachers and students	Motivation for students' participation
Kothamasu (2010)	Many advantages	• Improvement of literacy and numeracy skills • Encouragement of independent and collaborative learning experiences • Help in identifying areas where assistance and support is needed • Engagement of reluctant learners • Students remain more focused for longer periods • Increased students' self-confidence

As we can observe in column "BENEFITS" of Table 6 there are indisputably many and strong advantages and benefits resulting from mobile devices' use in education. Thus, these devices' use could greatly benefit students with special educational needs, as well.

2.3.2.2. The disadvantages of M-Learning

The disadvantages of these devices could not be missing from the literature. The use of mobile devices can create a series of problems, such as distraction from a huge amount of information, which can sometimes lead to misinformation. Another disadvantage is that most students prefer rather using mobile devices for their entertainment than being occupied with some educational material. Some research's statements referring to the disadvantages of mobile devices are presented below.

An important disadvantage is the fact that technical problems may exist and that there is a significant lack of properly designed educational software (Alhassan, 2016; Viberg & Gronlund, 2013).

Lin et al. (2016) state that the lack of proper educational software, the high costs of the devices, the lack of teacher training and the issue of student's distraction when studying using mobile devices requires absolute concentration, are main issues which can be added to the devices' disadvantages.

Tzoumerkiotis (2016) mentions as additional disadvantages, poor connectivity, limited battery life, small screen size and limited storage memory of the devices. Disadvantages are also the issue of the device's security and the issue of copyright. Lohnari (2016) mentions that M-Learning cannot replace classroom teaching but it should be used only to support teaching.

Pachler et al. (2010) state that most students prefer to use mobile devices for their entertainment, such as listening to music, watching videos, communicating with friends through Social Media rather, than being occupied with some educational material.

Table 7

Research indicating the disadvantages of mobile devices' use in education

RESEARCHERS	M-LEARNING CHARACTERISTICS	DISADVANTAGE
Alhassan (2016) Viberg & Gronlund (2013)	• Huge amount of information • Possibility of technical problems • Lack of properly designed educational software	• Distraction • Misinformation
Lin et al. (2016)	• Lack of educational software • High costs for the maintenance and technical support • Continuous development of technology • Lack of teacher training	• Creation of problems while used in the educational process • Distraction
Tzoumerkiotis (2016)	• Connectivity • Battery life • Small screen size • Limited storage memory • Device's security • The issue of copyright	Limitation in the use of Mobile Technology in teaching
Lohnari (2016)	Teachers determine the context	Cannot replace classroom teaching
Pachler et al. (2010)	Use for entertainment (music, videos, games etc.)	Students do not recognize that mobile devices are not only a means of entertainment

Table 6 above indicates the disadvantages of of mobile devices' use in education. Among them are: possible distraction of studens, classroom teaching cannot be replaced, possible misinformation, limited battery life and students' use of mobiles as a means of entertainment in class.

However, according to the studies that are presented above by both table 5 and 6 the advantages of M-Learning overcome its disadvantages to a considerable degree. Additionally, the aforementioned great benefits of using mobiles as educational tools in the sensitive area of Special Education, as explained below in section 2.3.4, motivated us to adopt M-Learning for the purposes of our study.

2.3.2. Greek Legislation about Mobile Use in Education

In Greece, until recently there has been strict legislation on the use of mobile phones by students in primary and secondary schools. Only teachers were allowed to use their own electronic equipment during the teaching act, as well as the P/Cs, laptops, tablets, interactive boards that are given to them by the school unit. This fact is in total contrast to the views of teachers and students discussed above.

More specifically, with the implementation of the Circular of the Greek Ministry of Education, no F.25/103373/D1/22-6-2018 the following were stated:

1. Students are not allowed to own mobile phones within the school space.

2. Students cannot hold mobile phones and any other electronic device that has a processing system in school. The appropriate electronic equipment available to them is used exclusively during the teaching act and the educational process in general and only under the supervision of the Educator.

3. Teachers in addition to the electronic devices available at school e.g.: P/Cs, H/Y, laptops, tablets, interactive tables, etc., they may also use their own electronic equipment during the teaching act and for the purposes and in the context of the educational process in general, according to the safety rules and the relevant provisions on the protection of personal data of both pupils and teachers (Law 2472/1997 and Law 3471/2006).

Nowadays, a recent ministerial decision of the Greek Ministry of Education (F8/44778/D4/09-04-2020) for the implementation of the E-Learning in Primary, Secondary and High Schools, gives to schools and teachers the possibility of covering the educational subjects of the curriculum, moving from the aspect of learning through communication, creative employment and repetitive work, to the teaching and learning of new concepts of partial educational subjects that seem mostly interesting to students. Distance learning is beginning to be implemented in Greece, though there have not still been conducted any thorough and detailed designs for its implementation.

However, during the last two years 2020 and 2021 mobile devices have been widely used in distance learning processes that have been implemented for long school periods. Especially in the school years 2019-2020 and 2020-2021 the Greek Ministry of Education in their effort to deal with the consequences of Covid-19 issued two Ministerial Decisions: Ministerial Decision 120126 / CD4 / 12-9-2020 entitled “Provision of modern distance education for the school year 2020-2021” and Ministerial Decision 111525 / CD4 / 10-9-2021 entitled “Provision of modern distance education for the school year 2021-2022”. Those Decisions encouraged and allowed the use of mobile devices for both teaching and learning purposes.

In this way, the value of mobile phones as educational tools was finally recognized by the Greek Ministry of Education.

In the near future, it is expected that learning using mobiles will move outside the classroom, in all stages of education but especially in higher education. Considering its numerous and huge advantages, it is hopefully expected that M-Learning will be extended to all Stages of Education, as well.

2.3.3. Research on M-Learning in Special Education

In Europe and in Greece approximately 10 % of the population has some form of disability, while 1 to 5 pupils is in need of special education. According to the

OECD (2000) at least 2 % to 18 % of the school population, are students with special educational needs

The provision of education for students with disabilities differs between European countries. Nevertheless, all European countries concerning students who need special education recognize that new technologies in education are an important step to confront educational problems. Thus, smart new technologies were included in the curricula of European counties (Toom, 2018).

Below some research data about the effects of the use of mobile technologies and tablets in the area of teaching students with learning problems and disabilities are presented.

Whalen et al. (2010) conducted a research on students at the age of 3 to 6 years' old who were diagnosed with the autism spectrum, but their condition was considered mild. The researchers claimed that the intervention which employed the use of the computer had positive consequences, since teaching techniques involving visual stimuli attracted students' interest. Additionally, students showed improvement in academic and cognitive skills.

Another investigation was held in Spain by the University of Granada. The researchers Fernández-López et al. (2013) demonstrated that the use of mobile devices contributes positively to the education of children with special educational needs. This research involved 39 students. Some of them presented autism, others Down syndrome, and others Attention Deficit Hyperactivity Disorder (ADHD) with mental retardation, or Pervasive Developmental Disorder. Positive effects were also observed in the development of their behavior, communication and relationship with their environment. On the other hand, their learning abilities on subjects such as mathematics were significantly improved.

McClanahan et al. (2012) conducted a survey that refers to the use of mobile technologies and more specifically the IPad as a teaching tool for a student with Attention Deficit Hyperactivity Disorder (ADHD), in the fifth grade of elementary school. The whole process had positive results for student's development. The

student showed great interest in using this attractive method of learning and made great progress, not only in his reading ability, but also in his attitude in general. He was excited to use the IPad and seemed to have an improved attitude towards both school work and himself.

Kagohara et al. (2013) studied about the use of mobile devices for people with special educational needs and more specifically Autism and cognitive impairment. The whole process had positive results. An IPad device was used by two students of 10 and 11 years with Asperger's syndrome and Attention Deficit Hyperactivity Disorder (ADHD). This device was used to check spelling from their computer's text editor. Finally, the results showed that the participants performed better in using the word processor, at a point that it reached 100 % of development.

Campigotto et al. (2013) held a survey at two public special schools at Toronto that involved students of all classes. It was argued that the use of mobile technologies contributed positively in teaching students with special educational needs the correct spelling of words. This survey lasted five months and included pupils who needed some extra help to have a satisfactory performance at school. Teachers selected and used tablets and mobiles. The intervention was quite successful and students were given the opportunity to feel important, gain confidence and communicate, as well as cooperate with each other, while their motivation and interest in learning was increased.

Another study was conducted by the University of Washington and the researchers Berninger et al. (2015) in order to examine the effect of the computer on teaching students with diagnosed special educational needs concerning the production of oral and written speech. It was argued that the results were particularly encouraging. More specifically, the research was conducted on 35 students (13 diagnosed with dysgraphia, 17 with dyslexia and 5 with difficulty in producing oral and written speech). Students were aged from 10 to 15 years and attended general primary schools and high schools. The results of this study showed that students, although they were not at the same age and level, made great progress as shown by the researchers' evaluation.

The data of another survey, which was intended to examine the effect of mobile technology devices on teaching language skills to a student with mental disabilities and, therefore learning disabilities. The whole process proved particularly effective. Student's skills until then were simply to express desires and needs using alternative devices and ways of communication, to count from 1 to 10 and to copy the letters of which student's name was consisted in the correct order. The results of the investigation showed that the student had made impressive progress (Rivera et al., 2016).

Skiada et al. (2014) conducted their research at the "Speech Therapy Center", Greece. The study involved the design and evaluation of a mobile application for students with dyslexia. Five students with dyslexia were involved in the evaluation process and were of ages 7 to 12. All of the children's responses involving the mobile phone and the tablet were positive and they showed great interest while using it, without any sign of frustration. Most of the students indicated a higher performance compared to their previous evaluation and progress, in reading and recognition of words.

Novack et al. (2018) conducted a study in order to evaluate the effectiveness of a mobile application when teaching language skills to children with autism spectrum disorder. Data analysis revealed significant progress in the control group after having used the application. What is more, it was observed that the skills that the group of students had acquired remained for a long period after the end of the application's usage. The results prove that the application was effective in teaching.

Pitchford et al. (2018) state that SEND pupils could be benefited by a new digital technology intervention which uses touch-screen tablets to deliver interactive apps designed to teach basic mathematical skills. The findings demonstrate that interactive apps can raise learning levels in pupils with SEND but may have limited benefit for pupils with severe difficulties. It is also stated that modifications of the software were needed to address specific areas of difficulties that prevent pupils from progressing.

Kamaruzaman et al. (2017) at their study designed an application that was tested with several children with autism. Based on their observations the researchers stated that the users showed positive attitudes towards the application and that the test had positive outcomes, as well.

The next Table 7 briefly presents the results of the above mentioned research that indicate that M-Learning in Special Education has a positive effect.

Table 8

Research indicating the positive effect of M-Learning in Special Education

RESEARCHERS	LEARNING DIFFICULTY	TOOL	RESULTS
Whalen et al. (2010)	Mild condition of autism spectrum	Computer	• Attraction of students' interest • Improvement in academic and cognitive skills
Fernández- López et al. (2013)	• Autism • Down syndrome • ADHD with mental retardation • Pervasive Developmental Disorder	Tablets	• Development of students' behavior, communication and relationship with their environment • Improvement of their learning abilities on mathematics, language, environmental sensitivity, autonomy and sociability
McClanahan et al. (2012)	ADHD	IPad	• Great interest in using this method of learning • Tremendous progress in reading ability • improved attitude towards both school work and himself
Kagohara et al. (2013)	• Asperger's syndrome • ADHD	• IPad • IPod	100 % development in using the word processor
Campigotto et al. (2013)	Dysgraphia-Dysorthographia	• Tablets • Mobiles	• Feel important • Gain confidence • Communicate and cooperate with each other • Increase of motivation and interest in learning
Berninger et al. (2015)	Dysgraphia Dyslexia Difficulty in oral and written speech	Computer	Students made great progress after completing 18 hour lessons
Rivera et al. (2016)	Mental Disabilities	• Mobile devices • IPad	Impressive progress in language skills
Skiada et al. (2014)	Dyslexia	• Mobile phone • Tablet	Progress, in reading and recognition of words

Kamaruzaman et al. (2017)	Autism	• Smartphones • PDAs, tablets	Support for learning basic numbers The attraction, practising and doing exercises, attainment of learning interests and achievement of self-independence
Novack et al. (2018)	Autism Spectrum Disorder	• Mobile Application	Effective in teaching receptive language skills demonstration of relatively high rates of learning
Pitchford et al. (2018)	Children With Special Educational Needs and Disabilities SEND	Interactive Apps on touch-screen tablets	Promotion of Learning of Basic Mathematics in Children With Special Educational Needs and Disabilities

After revising all these studies summarized in Table 7 we can observe that M-Learning in Special Education has a positive effect. It is obvious that children with various types of learning difficulties can greatly be benefited from the use of M-Learning applied through different tools and devices in the learning process. Some of the benefits noted above are: Attraction of students' interest, Improvement in academic and cognitive skills, Gain of confidence, Communication and cooperation with each other and Increase of motivation and interest in learning.

However, in Greece which is the Environmental context of the study have not been carried out many researches because mobile devices are not fully integrated into the learning procedure. This is not a strange thing because until recently the use of mobile devices in Greek schools was forbidden by law as referred in section 2.3.3. Skiada et al. (2014) along with Nikolopoulou and Kousloglou (2020) clearly state that specifically for Greece much fewer studies have been carried out, although it is certain that the integration of of M-Learning in the learning process will not take long, taking into account that the results of the so far conducted research are extremely encouraging.

Nevertheless, it should be indicated that the next years, mobile devices will be under the scope of detailed and thorough investigation and efforts will be made by the Government to integrate them into the educational process, mainly involving students with learning disabilities, who need further support to facilitate their learning process. This fact has given impulse to start our research in order to collect new information about the subject in Greece and add new knowledge on the few existing so far researches' data and findings.

In general, the researchers' findings suggest that mobile devices can greatly help in teaching language and other multiple skills to students with special educational needs, because the skills they acquire are essential for their knowledge's and self-confidence's development. Moreover, the way they acquire those skills is motivating and attractive.

2.3.4. Mobile Learning

The term mobile learning describes the total set of issues referred to educational opportunities provided by wireless technologies, mobile devices and the development of E-Learning. In international literature multiple and various definitions of this term have been proposed. Some of them are presented below.

Mobile Learning or (M-Learning) is a system of services and technologies through which the student is accessing educational content aiming at gaining knowledge, without time and space limitations (Lehner& Nosekabel, 2002). Georgiev et al., (2004) state that M-Learning is a type of E-Learning and D-learning. According to Kukulska-Hulme and Traxler (2005) M-Learning is any educational process where the mobile devices are the only technologies provided. Romero-Rodriguez et al. (2020) state that M-Learning spreads out the teaching-learning process by using mobile devices.

Other definitions of this concept are the following ones: M-Learning is acquiring knowledge and skills through mobile devices anywhere and anytime, so user's behavior and perceptions are changed (Dye et al., 2006). M-Learning, using mobile technologies enables learners' learning anywhere and at any time (Vosloo, 2012). On the other hand, Kilmova & Poulova (2016) argue that some authors think that M-Learning is a learning environment characterized by the mobility of technology, of students and of learning. Klimova (2019) states that M-Learning is a well-established learning methodology thanks to its countless benefits such as accessing learning content anytime and anywhere, adjusting the content to students' needs, and timely feedback.

The above mentioned definitions of M-Learning emphasize on the characteristics and capabilities that M-Learning offers to pupils for self-studying always and everywhere, exclusively through mobile devices (PDAs, tablets, smartphones, etc.). Therefore, M-Learning is indicated as a promising and effective tool for helping students with learning difficulties as it gives them the opportunity of accessing learning content anytime and anywhere and adjusting the content to their needs (Klimova, 2019).

International research reinforces the aforementioned statement. Smart mobile devices can be used as an educational tool by supporting certain aspects of children's teaching and learning process such as Literacy and Mathematics (Kyriakides et al., 2016; Neumann and Neumann, 2015).

According to the above definitions application “Love2Learnmaths” for smartphone devices was designed with the option for students and teachers to use it anytime and anywhere based on the model of M-Learning.

2.3.5. Research on M-Learning in Mathematics

Mobile learning facilitates students in adapting the mathematic material with various science concepts. Data collection, data analysis, probability and statistics, which form the central themes in mathematics, can be much easier collected and analyzed by mobile devices and thus can equip students. One research made by Crompton and Burke (2017) is a review of the use of M-Learning in mathematics’ teaching. It is a systematic review of 36 studies in mathematics’ M-Learning since the year 2000 until recently. The following important findings emerged from their research.

- The general purpose of most studies was the evaluation of M-Learning.
- The main research methods were Case studies and experimental designs.
- Most studies report positive learning outcomes. 71 % of the studies reported positive learning outcomes. 10 % of them reported neutral

learning outcomes. On the other hand, there wasn't any study that reported negative learning outcomes.

- Mobile phones were the most used portable devices (38 %). Tablets were referred as the next most commonly used (31 %), iPads and iPods followed with 10 % each.
- Surveys were mostly conducted in elementary schools (34 %), 29 % of them in secondary schools, 21 % in high schools, 13 % in higher education and only 2 % of them were carried out in Special Education.
- The majority of the researchers did not study a particular mathematic concept.
- The majority of studies were conducted in formal school environments.
- Research on M-Learning in mathematics is geographically different. United States was the country with the highest number of studies (34 %), followed by Israel with 20 % of studies. In Taiwan 10 % of the studies were carried out, while in the Caribbean the 8 % of them. In each of United Kingdom and Chile 4 % of the studies were conducted. In Spain, United Arab Emirates, Sweden, Australia, Nigeria and India were carried out in each of them 3 % of the studies (Crompton & Burke, 2017).

According to Al-Mashaqbeh (2016) M-Learning provides two key advantages to Mathematics' teaching: using various graphics and images during practicing makes Maths more fun and math's concepts and ideas are more approachable, clear and easier to understand.

Portable educational tools (tablets, ipads, smartphones, PDAs) for mathematics are an aid to students not only in solving problems, but also in strengthening the understanding of mathematical concepts, providing dynamic representational models of ideas (Audi & Gouia-Zarrad, 2013; & Pappas, 2015). The unique features of the tablets allow the user to easily write symbols and graphics of mathematical information online. In this way, the appropriate tool in the form of educational applications or programs to explore mathematics from many perspectives is provided to teacher and student. Furthermore, according to Galligan

et al. (2010) M-Learning offers the adaptation of teaching and learning according to the needs and preferences of students.

Chen et al. (2017) recommend that the use of pen-tablets during the process of solving mathematical problems that require a lot of math calculations or writing was beneficial to students. The more students perform movement of the pen when solving mathematical problems, the greater the degree of their personal involvement in the lesson. They were also staying focused by moving the pen and thus, they increased their attention to the problem solving.

The below Table 8 below describes the positive effect of M-Learning in Mathematics as presented by the above research.

Table 9

Research indicating the positive effect of M-Learning in Mathematics

RESEARCHERS	TOOLS	RESULTS
Al-Mashaqbeh (2016)	Mobile devices	• Graphics and images make Maths more fun • Math's concepts and ideas become more approachable, clear and easier to understand
Audi & Gouia-Zarrad (2013) Drigas & Pappas (2015)	• Tablets • Ipads • Smartphones • PDAs	• Strengthening the understanding of mathematical concepts • Providing dynamic representational models of ideas and encouragement • Sharpening students' general metacognitive abilities
Galligan et al. (2010)	Mobile devices	Adaptation of teaching and learning according to students' needs and preferences
Chen et al. (2017)	Pen-tablets	• Personal involvement in the lesson • Increasing their attention to the problem solving

The above research proves the indisputably immense positive outcomes of the use of mobile devices in Mathematics' teaching and learning process. Graphics and images make Maths more fun, Math's concepts and ideas become more approachable, clear and easier to understand, understanding of mathematical concepts is strengthened, students' general metacognitive abilities are sharpened, teaching and learning are adapted according to students' needs and preferences, students are personally involved in the lesson and their attention to problem solving is increased.

Thus, students can considerably benefit from the use of such devices in Mathematics.

2.3.5.1. Research on math apps in education

Drigas & Pappas (2015) declare that in recent decades, researchers, scientists and educators, government educational organizations and companies that are interested in the quality of mathematics' education have designed and developed many applications (apps) and tools of mathematical content to improve learning practice, because they had recognized the success and the engagement of students in mathematics when using those apps.

Carr (2012) refers that students of High School in mathematical fields, such as that of Algebra, by using the hMh Fuse application, presented greater success rates, attention and diligence in class and they seemed more interested in the cognitive content of algebra itself.

Riconscente (2013) insisted that elementary school students face difficulty in the concept of fractions. She argued that the construction of mental number lines through physical, embodied interaction with the Motion Math online application on personal iPads, makes numerical problems' solving easier, providing a dynamic structure that improves the encoding, storage and retrieval of numerical information. The entertaining mood of the game, the physical activation of the students (they move the tablet in order for the target number to fall on the correct spot on the number line), the direct feedbacks, the graphics and the sounds contribute to the development of not only a positive attitude towards math, but in the development of self-confidence, self-engagement and self-efficacy. Students finally achieve their personal learning.

In the research of Drigas & Pappas (2015) is indicated that the Kindergarten children through the appropriate use of online mathematical applications with the use of mobile devices, have the opportunity to have a satisfactory first contact with

mathematical concepts, such as those of numbers, quantities and ratios (Zanchi et al., 2013).

Al-Mashaqbeh (2016) in her research indicates the positive contribution of tablets in the teaching of mathematics, in a 1st grade elementary school class. The students who used the tablets achieved higher test scores than those who followed the traditional conventional teaching process. Students were more interested in the lesson, enjoyed it, made progress in understanding concepts and problem solving and developed both their knowledge and their creativity.

According to Piatt et al. (2016) students of a 6th grade primary school preferred the use of tablets when developing the assessment number size on the number line through the applications Estimation Line and MathGlow, due to the ease of design.

Pitchford et al. (2018) state that Interactive apps presented on touch-screen tablets may be beneficial for children with Special Educational Needs and Disabilities (SEND) in the process of teaching them basic mathematical skills, as they can promote high levels of engagement with the learning task and an inclusive learning environment.

Outhwaite et al. (2019) in their research after a 12-week intervention period of using interactive math apps designed for early years' education in the United Kingdom with 389 children aged 4–5 years, they found that teaching with interactive apps can deliver to all students a math instruction of high-quality in a classroom and can effectively raise achievement in early math.

Math apps' use in education has also a positive effect on students' learning, as indicated by the below Table 9. Students showed greater success, attention and diligence rates in class. They were more interested in algebra and presented positive attitudes towards math. Their self-confidence, self-engagement and self-efficacy were developed. Students themselves were involved in the choice of the app. There was also noted an increase of learning standards in pupils with SEND.

Table 10

Research indicating the positive effect of math apps in education

RESEARCHERS	APP	RESULTS
Carr (2012)	hMh Fuse App : https://itunes.apple.com/us/app/hmh-fuse-algebra-1	• Greater success rates • Attention and diligence in class • More interested in algebra
Riconscente (2013)	Motion Math : https://motionmathgames.com	• Positive attitude towards math • Development of self-confidence, self-engagement and self-efficacy
Drigas & Pappas (2015) Zanchi et al.(2013)	Online mathematical applications	Satisfactory first contact with mathematical concepts
Al-Mashaqbeh (2016)	Mathematical applications	• Higher test scores • More interest in the lesson • Progress in understanding concepts and problem solving • Development of knowledge/creativity
Piat et al. (2016)	Estimation Line : https://hume.ca/ix/estimationline/ MathGlow App : https://www.mathsglow.com/	Involvement of students themselves in the choice of the app
Pitchford et al. (2018)	Interactive math apps on Touch-screen tablets	Increase of learning standards in pupils with SEND
Outhwaite et al. (2019)	Apps with interactive touch-screen tablet technology	Quality instruction and promotion of the development of early math skills

There are many math applications used for educational purposes. The few research's results presented in table 9 are indicative of the positive effects which are accomplished from the use of such applications for children of different school grade levels.

All the above mentioned researches referred in section 2.3, indicate the increasing use of digital mobile devices and their high popularity among secondary school students. International studies state that Mobile devices could positively support M-Learning in school classrooms.

Many researches, as referred in section 2.3.2., indicate that generally speaking new technologies enhance the teaching process, develop the abilities of students, excite their interest and improve their performance. Of all the aspects of New Technologies, however, less research has been conducted in the field of M-Learning (Nikolopoulou, 2021).

Whilst the adoption of mobile phones by students has been explosive in the last decade, the potential of using these devices to transform teaching and learning has not yet been fully investigated and acknowledged (Chee et al., 2017).

2.3.6. Examples of apps for students with learning difficulties

Applications or apps are mobile device programs designed to perform specific, useful functions for their users. They are small and individual software units with limited functions and provide their users with many services. They are installed even in the most economical devices. There are applications related to sending and receiving messages, text and picture messages, web browsers or multimedia player applications. Many other apps can be obtained by the user for free or for a fee from online stores such as Google Play or App Store.

According to Domingo and Gargante (2016) the increased use of mobile devices in education is a result of the creation of many new and impressive applications aimed at this field. These applications are suitable for the development of students' skills or for the management of information because they allow students to practice and provide them with immediate feedback.

Figure 2 below displays some apps for Greek students, while figure 3 displays some basic applications for teachers. There is no doubt that the teaching profession is not always an easy task. Fortunately, modern technology can enhance teaching methods as it offers a plethora of apps.

Figure 2

Basic applications for students (Android list, 2020)

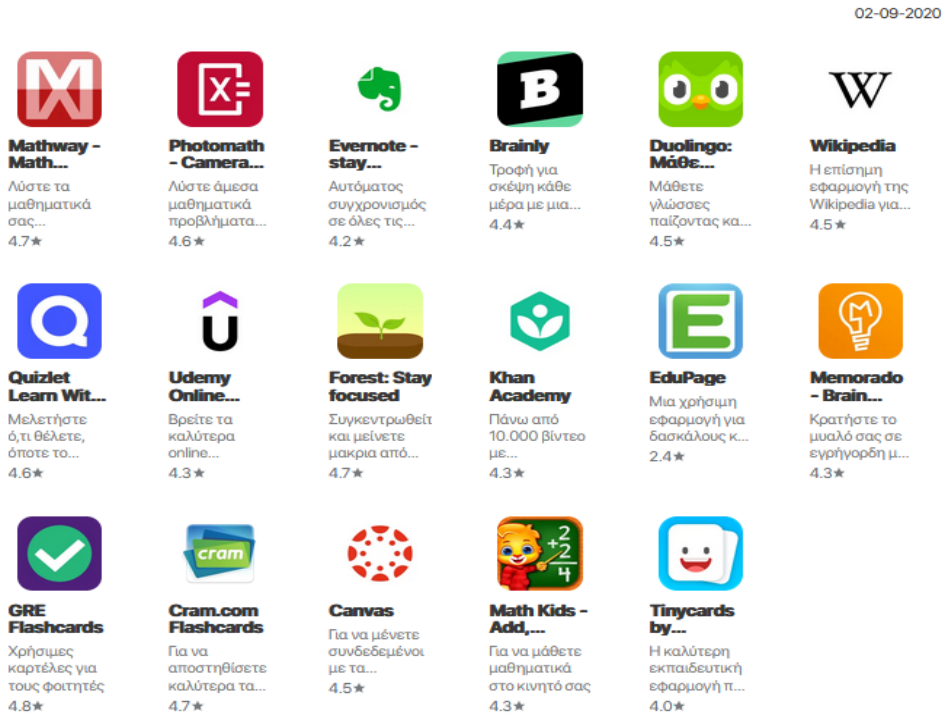


Figure 3

Basic applications for teachers (Android list, 2022)

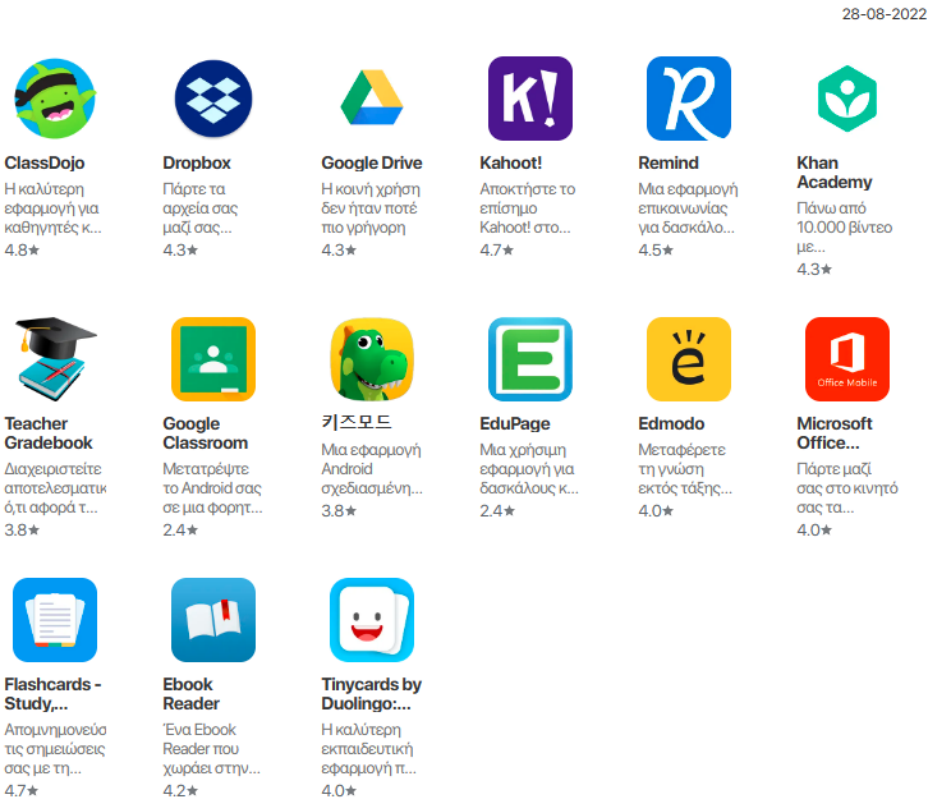
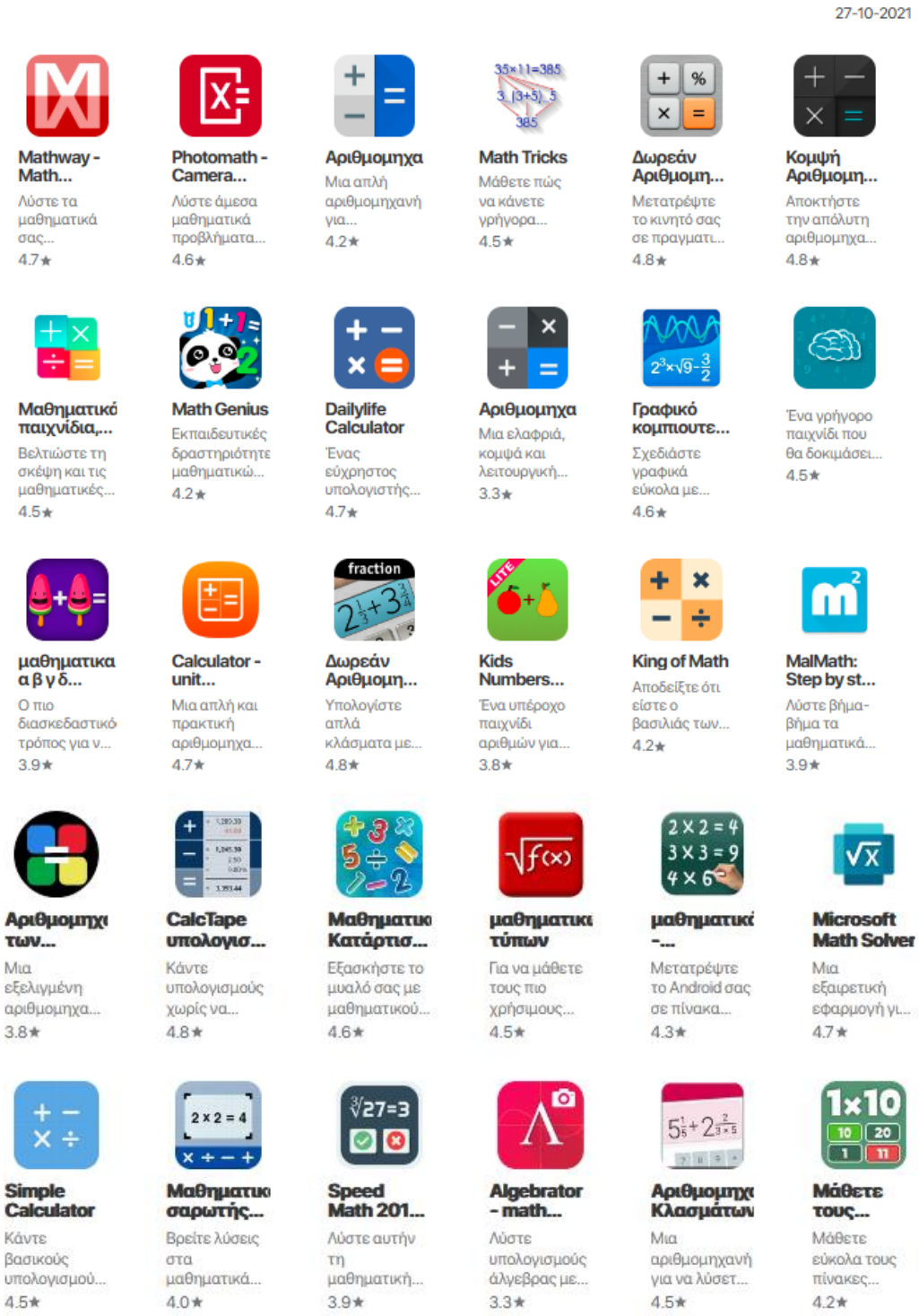


Figure 4 below presents some basic math applications. Android list is an internet site that in the case of Basic math applications encourages students to find and use the many different school apps offering promises that the apps woud help students to study and get better organized for the new school year!

Figure 4

Basic math applications (Android list, 2021)



Lynch (2017) has gathered many math apps with which students can individually learn, practice, and have fun. Thus, he created a list of 54 of the best, (as he claims), math apps, tools and resources, that are presented to http://www.theedadvocate.org, an online magazine that was created to enhance the quality of education and the opportunities for learning afforded to P-20 students in America.

As we can observe there are many applications that can help students learn math. Many of them can be used for educational purposes. However, we believe that integration departments' students need more specialized and adapted to their needs educational applications in order to be helped with their possible difficulties in math. Application "Love2LearnMaths" is expected to assist these students to overcome to some extent their learning difficulties in Mathematics.

3. DESIGN OF THE EDUCATIONAL APP

After detecting the digital ability and readiness of Special Education teachers to accept a new software in their classrooms that was reflected in their answers to the questionnaire of the first phase, we considered that we should design an easy-to-use software that addresses even teachers with minimal ICT knowledge. On the other hand, we considered that the software should generally be aimed at special education students with learning difficulties who attend integration department classes in two mainstream schools. Thus, we will meet the needs of a large number of students.

As stated by Mannheimer Zydney & Warner (2016) for the design of an educational application it is very important to include characteristics that integrate learning theories with practice. In this way, an M-Learning environment that includes features relevant to some theoretical base of learning can be designed.

Our software uses the mobile phone as an educational tool, because it is popular amongst students as referred to numerous surveys in section 2.3.2. The software follows the principles of Behavior Theory as a framework of instructional design and drill and practice application that suits students in special education, as referred in section 2.2.

We also chose mathematics as the subject of the software, because it concerns one of the main learning difficulties in Greece (OECD, 2019). It is well recognized that many students find mathematics a difficult subject in school and may experience significant learning problems and frustration. It is also suggested that approximately 6 per cent of students have difficulties in learning mathematical concepts and skills (Fleischner & Manheimer, 2019; Zygouris, 2017).

Since we are referring to the use of the software in the Integration Departments, the software had to be mentioned in the curriculum in a way suitable for the special education. The integration department aims to prepare students with learning difficulties for their transition to the regular classroom, as referred by the relevant Greek legislation. We chose the Gymnasium School, because while there is some math software for elementary school children, there is not enough for high

school. Even in high school, almost all students have and widely use mobile devices (Seralidou & Douligeris, 2015).

The app Love2LearnMaths includes some innovative elements. There are not many similar educational applications for this particular use, up today. The application is in Greek language, is intended for special education teachers and students of integration departments of secondary education gymnasiums and follows the class curriculum. On the other hand, many similar and relevant applications which were developed by researchers in other countries, such as by Oyelere & Suhonen (2016), Szklanny et al. (2017) and many others are mainly in English language, thus they cannot be used in Greek classes, because of their different content, design, and language. In addition, the structure of the application Love2LearnMaths can support both formal and informal learning by providing students the option to use it at school or out of the classroom, for instance at their home.

The System Management of Learning (mobile application) that we implemented was based on the theory of behaviorism while for the planning of the teaching project was used as a developmental guide the model ADDIE. Thus, for the design and evaluation of our application we followed the phases which are dictated by the ADDIE model. The ADDIE model covers the whole development of applications getting started from the stage of requirements up to the stage of evaluation and for this reason the design of our application is based on this standard model.

The ADDIE model includes five distinct stages. According to Davis (2013) we can consider it as one framework within which a design is systematically approached. It consists according to its acronyms (ADDIE) of 5 phases, which are: Analysis, Design, Development, Implementation, and Evaluation.

- At the stage of **Analysis**, we recognized the problem of students of integration departments, we defined the teaching objectives, which are to help those students in mathematics, we recognized their learning disabilities and we decided to offer the Teaching Intervention in the form of an Android application

for mobile phones, following the class curriculum and the behavioral learning theory of Gagné's instructional design.

- At the stage of **Design**, we employed the Android Studio and we decided the teaching material of math to be presented according to the class curriculum in the form of easy to understand, divided in small parts theory which would be followed by easy multiple- choice questions. We considered adding immediate feedback and rewards. What is more, we designed the user interface using sounds and graphics enough in our opinion to motivate students, but not too much in order to avoid students' distraction.

- In the **Development** phase are created and combined all the elements of the design phase. In this phase they are used Android studio's tools, such as the relevant technologies that were developed and completed. We also tested the app, going through all its functions to see if possible modifications should be done to the initial design.

- In the **Implementation** process, procedures are developed, such as the training of the participants (teachers-students). Emphasis is firstly placed on teachers, concerning the course content, the results, the teaching intervention methods used and the control procedures. Emphasis is also placed on students' training in the new tools, in familiarizing them with entering the system and in the development of relevant supporting materials (help files).

- At the stage of **Evaluation**, we didn't chose the Formative assessment (Formative evaluation) which takes place in each stage of the model (app) mainly due to lack of required period of time. We finally chose cumulative or final evaluation (Summative evaluation) which is a targeted action after the end of development and implementation of the app. We chose to evaluate Learning outcomes, Learner-environment interaction and Technical efficiency of the app.

We also chose our evaluators:

- 7 Educators who teach the subject: mathematics' and informatics' teachers,

- 3 Special education Teachers who used the app in their Integration departments or in Parallel Support classes of mainstream schools,
- 16 Students with learning difficulties attending integration department classes, who tried and used the app.

3.1. General technical description

In creating the software, we considered the specifications from the behavioral example, which is based on the guidance and instructional systems and the training and exercise systems. As described in the chapter on behaviorism (Komis, 2004; Styliaras & Dimou, 2015) such software should ensure the following:

A) Student motivation. To increase student motivation, we used graphics with images and sound, taking care to focus student attention on the lesson and not on the graphics themselves. Thus, the graphics were not too extensive to avoid distracting the students. Another element that motivates students is immediate feedback, whether positive or negative (Mehroz Nida Dilshad, 2017). Even in the case of negative student outcomes, we provide feedback comments that encourage them to continue rather than be disappointed and give up on their efforts because, according to Lewandowski et al. (2016) anxiety and fear of failure are common among children with special education needs. Harpin et al. (2016) on the other hand, claim that some mental disorders can lead to students' low self-esteem, a situation that should be avoided.

B) The presentation and organization of the information or content of the exercise. We organized and presented the necessary content linearly and in small and easy-to- understand parts according to the principles of both the behavioral learning theory and the course curriculum.

C) The questions that the system asks and the answers that the system can handle. The theory thus presented was followed by multiple-choice questions, for which there were easy-to-understand specifications that fully corresponded to the theory.

D) The provision of feedback and additional information. We provided immediate feedback, either positive or negative, making sure that the feedback given encouraged students to continue rather than being disappointed and abandoning the effort (Mehroz Nida Dilshad, 2017).

E) The simple and easy end of each section – closing. We designed the app to provide a simple and easy ending to each section. Students can also very easily close a section whenever they want and switch to another section or chapter. After the students' first attempts with the app's menu under the teacher's supervision, they will be able to use and work through the app independently.

The "Love2LearnMaths" application can be installed and operate on Android smartphones or tablets.

Android is a complete, open and free platform for cell phones that includes an operating system (OS), necessary middleware, libraries and core applications. The Android System Development Kit provides developers with all the tools and APIs to start developing software for the Android platform using the Java programming language. Android is a unique platform that enables the development of software applications that take full advantage of the capabilities of a compatible device. Android is an open source platform, which means it can be easily extended and modified to keep up with and adopt the latest technologies and developments (Mullis, 2017).

During the design process, the form of the application's database was created, where user data is stored. The database was created in SQLite and installed on a web server.

The application was developed in Android Studio software using Java programming language and configured for Internet access. The internet access is necessary so that:

- The application could be synchronized with the database.
- New data can be registered so that they are available to all users.

The functions of the application are divided into two categories:

- Functions that make changes to the database: These functions communicate via APIs developed in PHP to update the database. With the help of the corresponding PHP code, communication between the application and the

database was performed for data exchange and information purposes. Thus, through a PHP application programming interface (API), a request from the application sent over an Internet connection can be transmitted to the database hosted on the web server. The result is returned to the application as a response to the previous request.

- Data recovery operations: data recovery is performed using the local application database. This avoids the constant exchange of data with the web application.

For the development of the application we used Android Studio, DB browser (SQlite) and Firebase (real-time database and authentication) (Mullis, 2017).

3.2. Stages of design

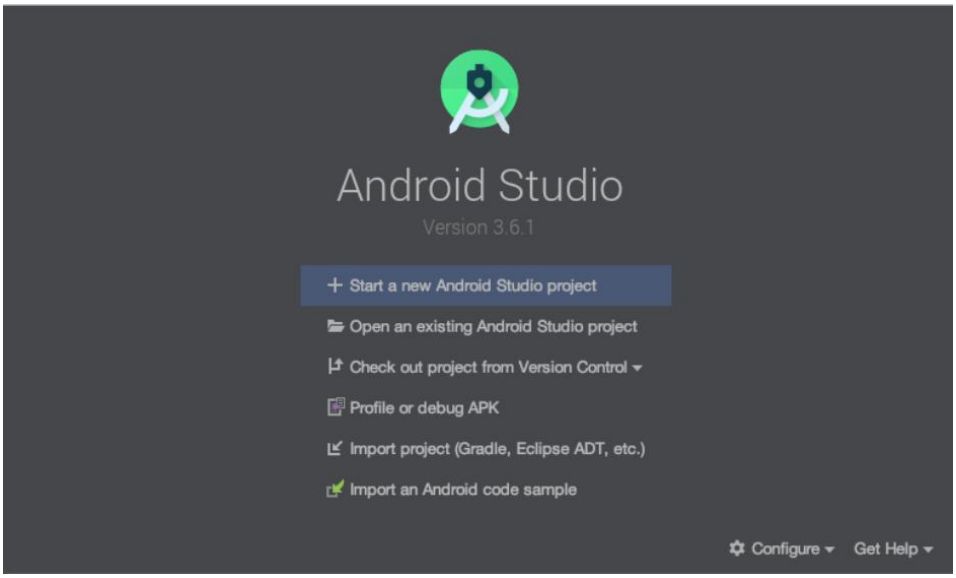
Implementing the application required the use of a number of different tools, techniques and technologies. First, the application runs on Android software, so it was necessary to use the Android Studio program to implement it. Then, all the data displayed to the user is stored in a database, for the processing of which the program DB Browser (SQLite) was used. Finally, the Firebase platform was used to authenticate the application and store the data.

3.2.1. Android Studio

Initially, as soon as a user opens the program android studio for the first time, the following image appears:

Figure 5

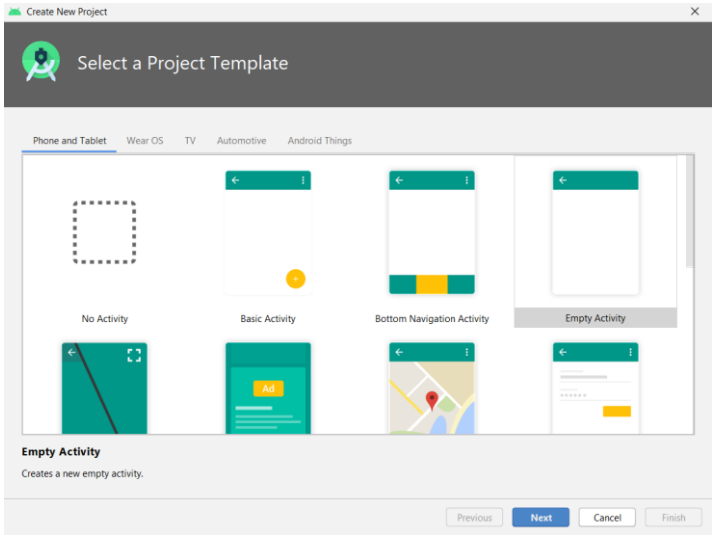
Android Studio's home page



If someone has already created a project, he clicks to open an existing android studio project; otherwise they choose to start a new android studio project. Then the following screen appears where the template of the application can be selected. The default application was chosen in our case.

Figure 6

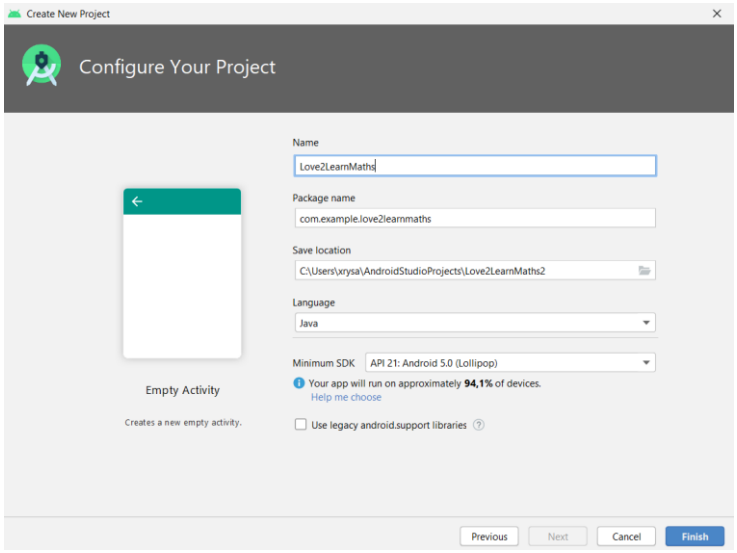
Select a Project Template page



Then, on the next screen that will appear, the name of the application should be filled in. The package name is automatically filled in. However, someone can name it according to their preferences. The save folder should be selected. There are two options for the writing language of the application, java or kotlin. Our application has been developed in Java language. Then the Minimum SDK should be selected, which means the smallest software version in which the application can run. With this choice, as it is being displayed in the figure below, the application will be compatible with the 94.1 % of the available mobile devices.

Figure 7

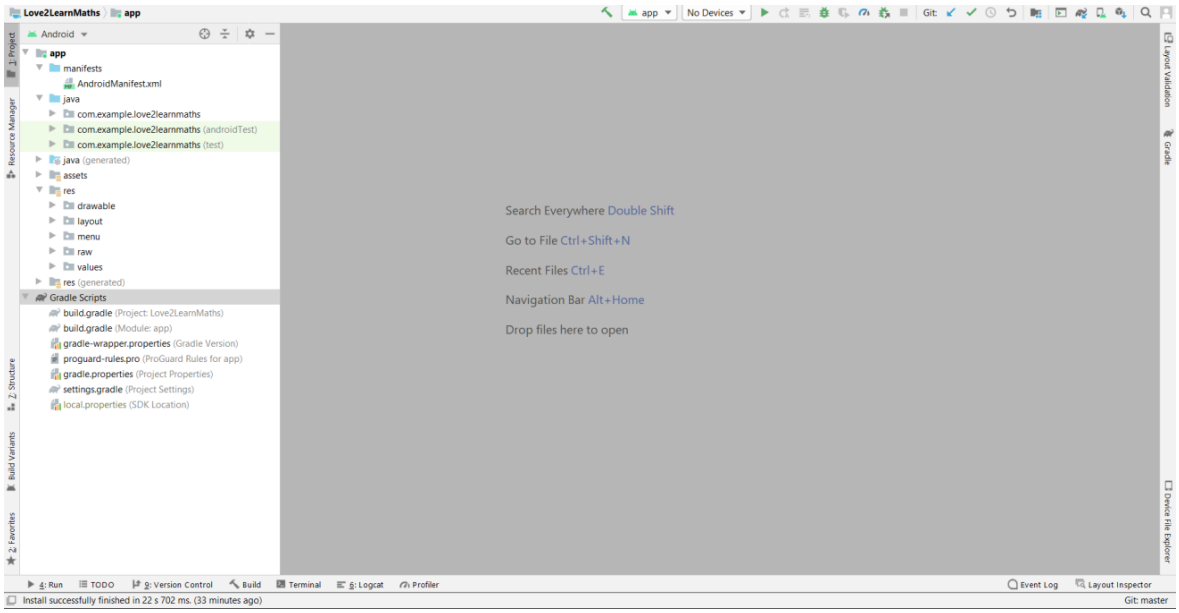
Project Configuration page



After completing the previous steps, the developer can then start configuring the application both in terms of functionality and presentation of the graphical elements that will be displayed to the user. The programming languages used are Java, which is mainly related to the functions of the application, and XML (Extensible Markup Language), which is used to mainly outline the graphical environment of the application (“Extensible Markup Language(XML)”, 2023). The following image shows the application environment.

Figure 8

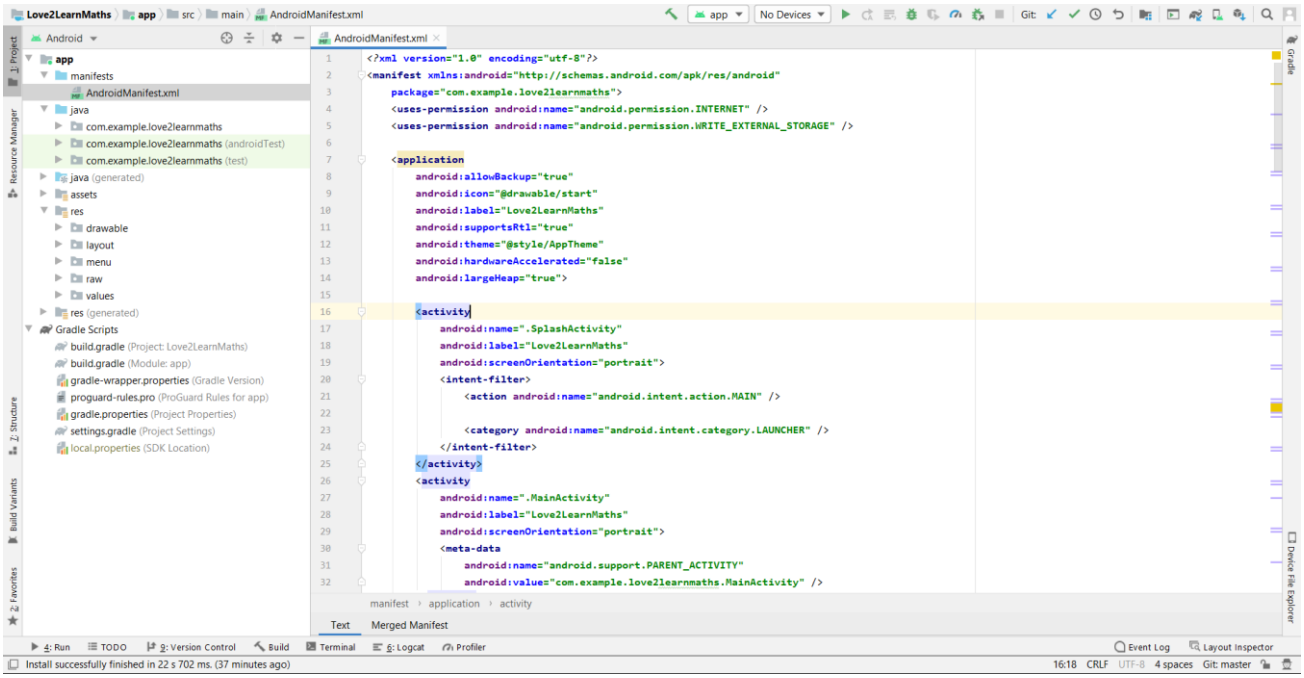
The Application Environment



The AndroidManifest file is in the manifest’s folder. This file defines the access rights of the application and all the activities which can be created in the application’s environment. It indicates the basic information needed by the Android system to run the application: package name, version, activities, licenses, intentions, or required hardware. Figure 9 below presents the AndroidManifest file of our application.

Figure 9

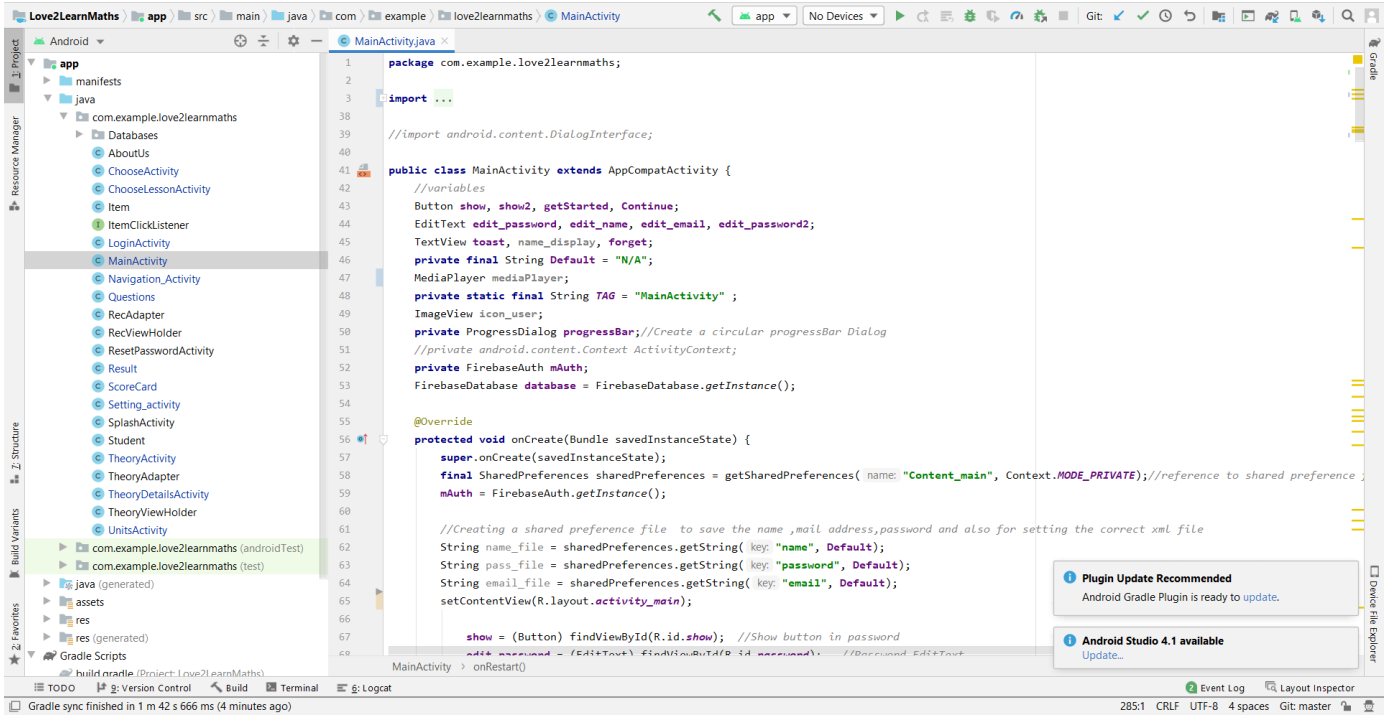
The AndroidManifest file



In the Java folder all the files of the activities or the services are being stored. This folder contains all Java classes. Figure 10 below displays all the Java activities of the project, along with the Main Activity's Java code.

Figure 10

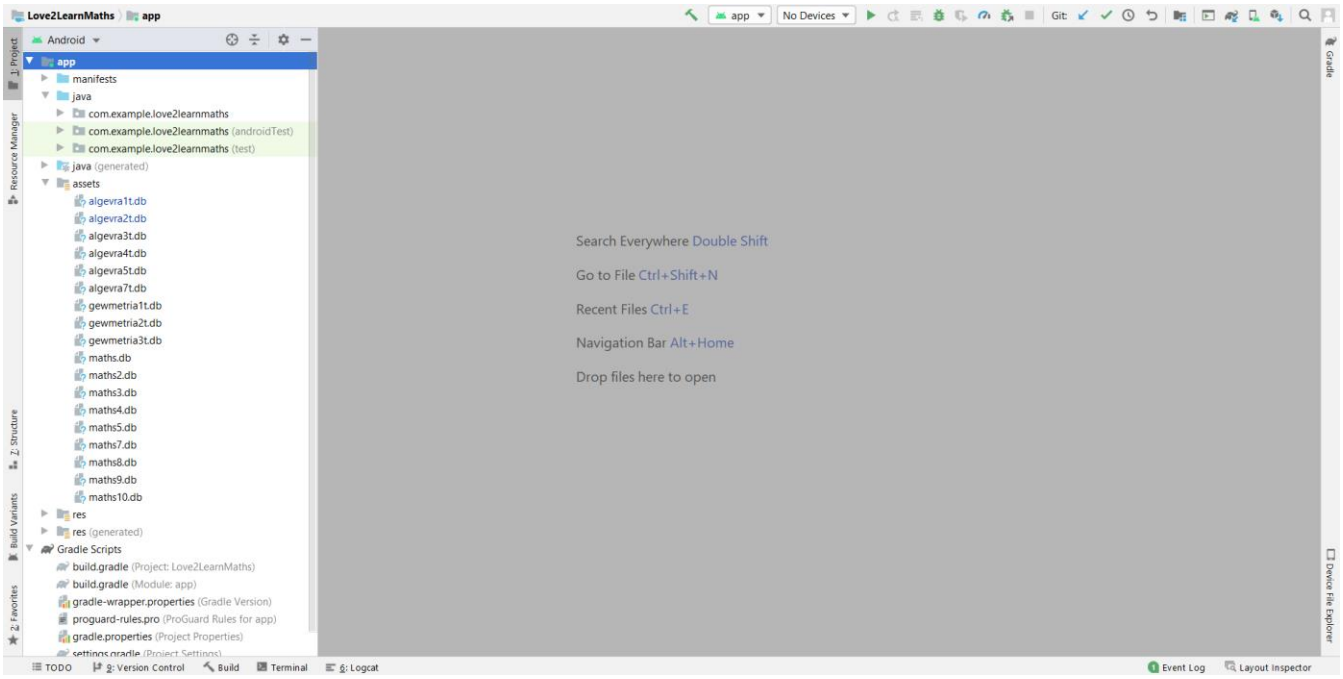
The Main Activity of the Java folder



The assets folder stores all the databases which have been used to create the application.

Figure 11

The Databases of the assets folder



The res folder stores all the xml files that identify the layouts, menus or image files as explained below:

• drawable /: Contains bitmap files (PNG, JPEG, or GIF) and XML files that describe Drawable shapes

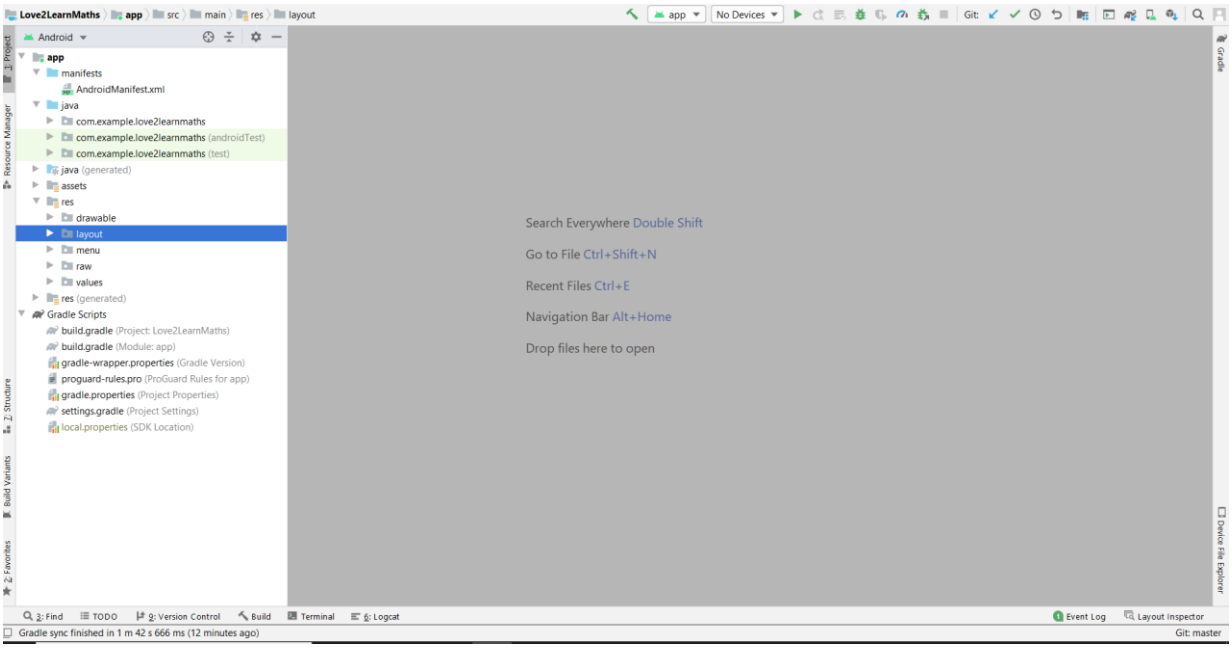
• layout /: Contains the XML definitions of the views and their elements.

• menu /: Contains the XML definitions of the application menus.

• values /: Contains the XML files that define 'name-value' pairs of sets. These values can be colors, alphanumeric or style. There are different value folders that are categorized according to the different screens options to customize the interface. For instance, to expand the components or fonts when the application is running on a tablet.

Figure 12

The xml files of the res folder

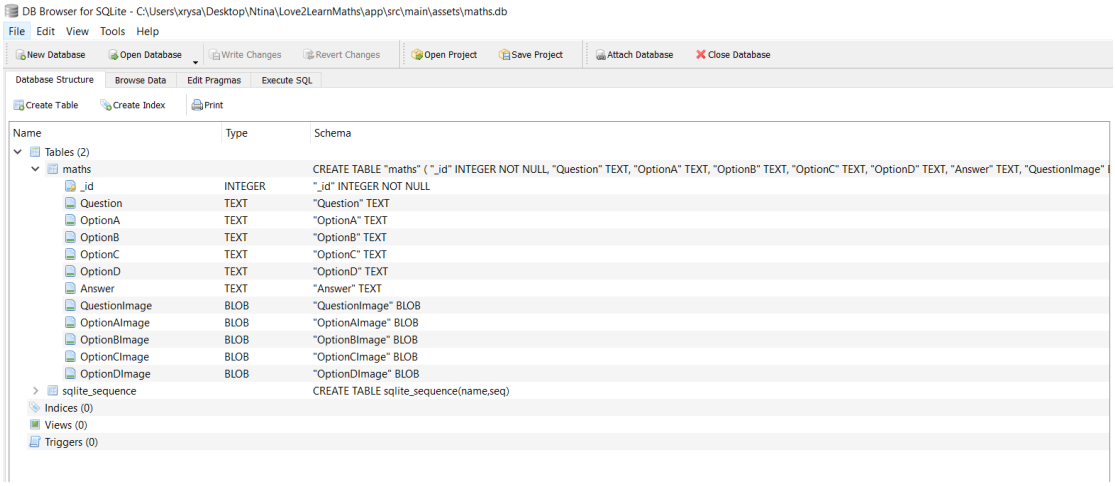


3.2.2. DB Browser SQLite

For the purposes of the application, 18 databases were created through the DB Browser SQLite program. The following image is the structure of a database in which the multiple choice questions that appear in the exercises in the first chapter are stored. The rest of the bases for the exercises are structured in the same way.

Figure 13

The Databases structure for exercises to be stored



There is the id field which is an auto increment number that indicates the registration number in the database.

The Question field is the title of the question in text format. It is not possible to display powers, fractions and some other mathematical properties in the android studio environment and save them in the SQLite. So, for the best appearance and understanding of the questions that contain powers, fractions etc. by children, we chose them to be appeared as images. For that purpose, the QuestionImage field was created.

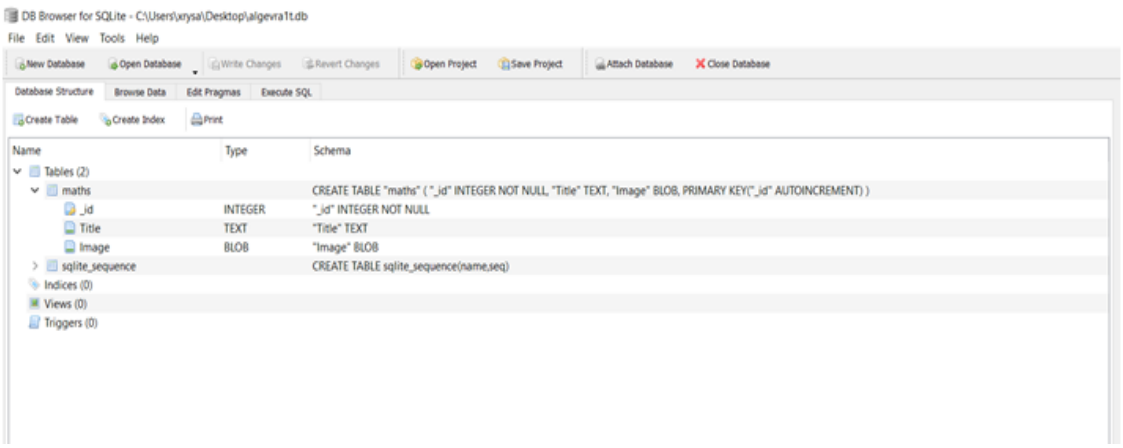
The four answers to the question are stored in the OptionA, OptionB, OptionC, OptionD fields. Because it is not possible to display powers, fractions and some other mathematical properties in the android studio and save them in SQLite, for the best appearance and understanding by children the answers that contain powers, fractions etc. appear as images. That's why the OptionAImage, OptionBImage, OptionCImage, OptionDImage fields were created.

The Answer field contains the answer to the question whether a, b, c or d.

The following image displays the structure of a database in which the theory modules which appear in first chapter's theory are stored. The rest of the bases for the exercises are structured in the same way.

Figure 14

The Databases structure for theory to be stored



There is the id field which is an auto increment number that indicates the registration number in the database. The Title field is the title of the section. The Image field is the text of the corresponding section. It is saved in the database as an image because some formatting in the text was desirable.

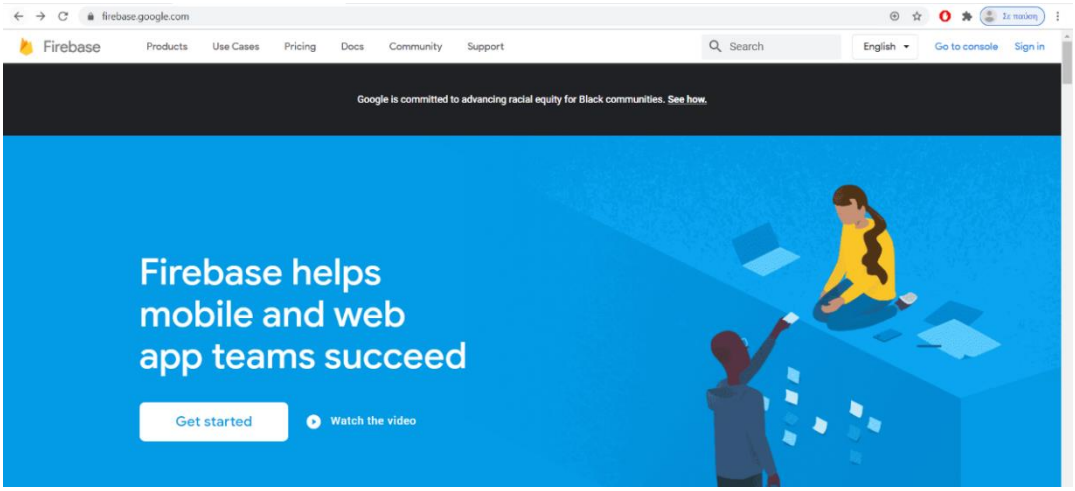
3.2.3. Firebase

The firebase platform (https://firebase.google.com/) has been used for the authentication and realtime database functions. More specifically, as soon as the student registers in the application, some data are stored in a database so that they can use them the next time for their connection. Then, in order for a student to log in to the application, it is required to enter the email and password they used in their registration and to do the authentication with email and password, which means to check that the information they provided is correct.

For this purpose we must enter the google firebase platform following the link: https://firebase.google.com/.

Figure 15

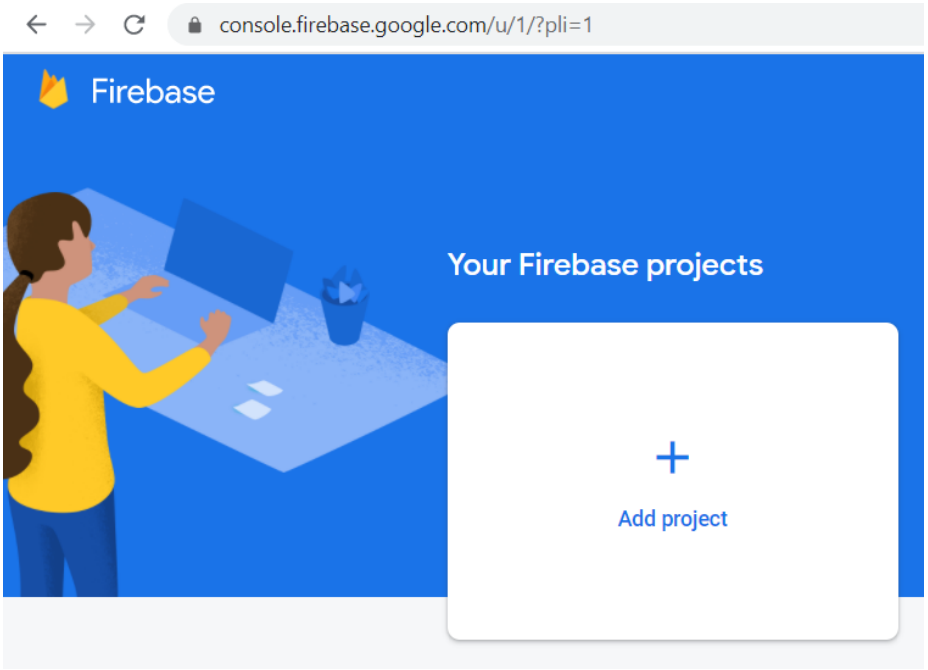
The Firebase Home page



Then we click Go to console and on the page that will appear we should click Add Project.

Figure 16

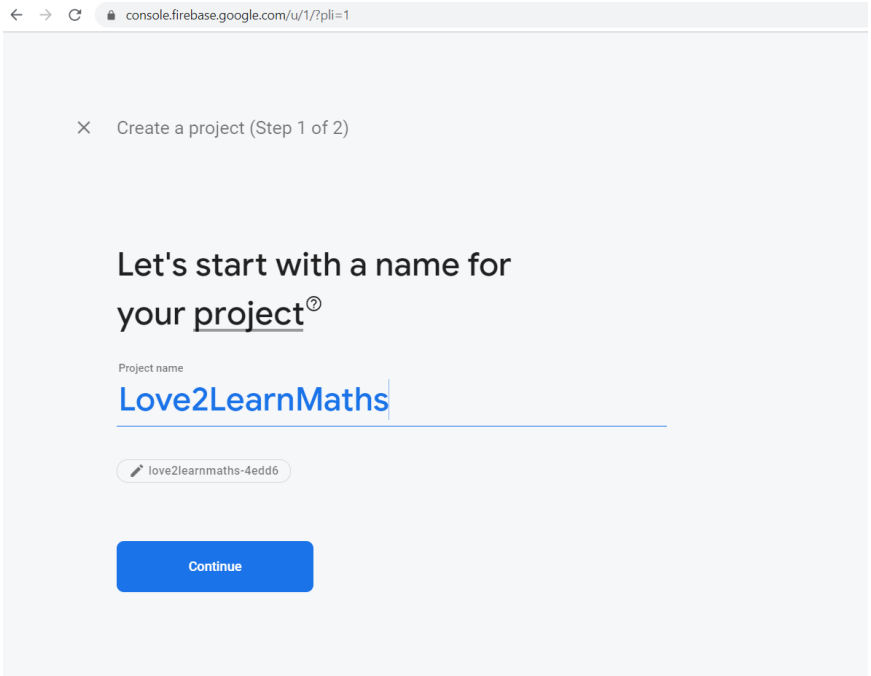
Add a new Firebase project



We give a name to the project we want to create.

Figure 17

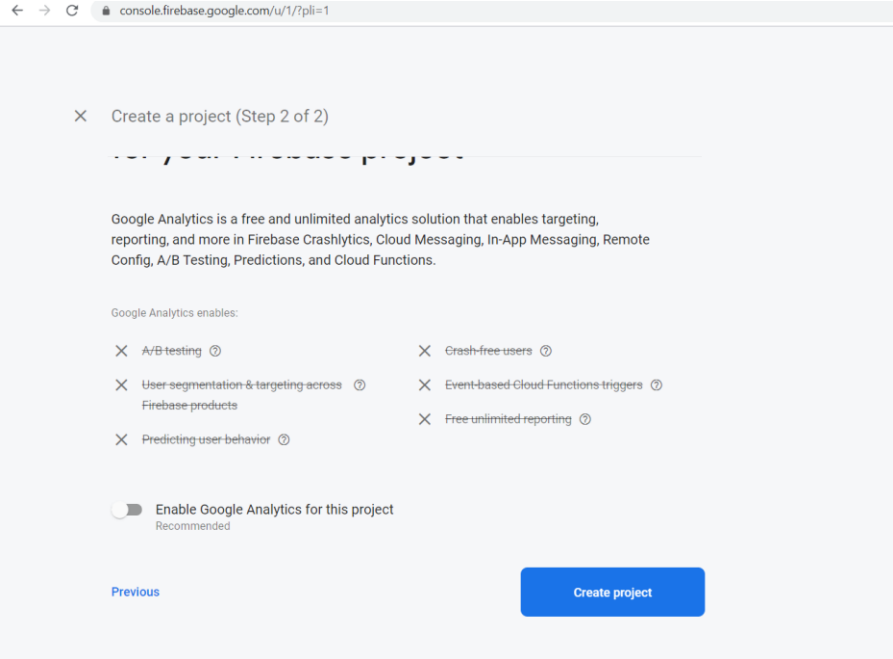
The project name-Love2LearnMaths



And on the next screen we disable the option for google analytics and click create project.

Figure 18

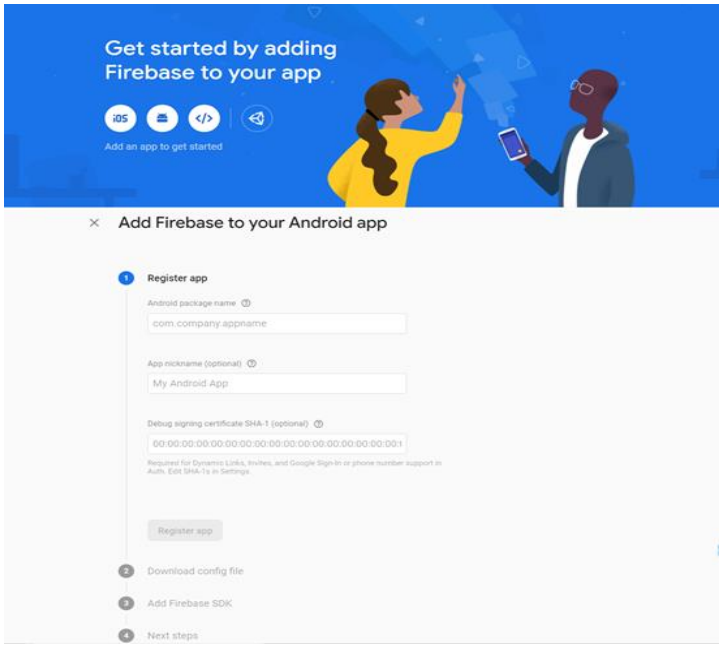
The Firebase project creation



Then we have to connect the project we created with our application. In the page that will appear as soon as we click create project we select the android logo and the following image appears in which we have to enter the package name of our application, which we have entered when we set up our project in android studio, and optionally the application's name and click Register App.

Figure 19

Firebase project and Android application connection



The next step is to download the google-services.json file that was created and paste it into the app folder in Android Studio. Then we must find the build.gradle file of the project in the Android Studio and add the following:

Figure 20

Addition of the Google services plugin

```
buildscript {

 repositories {
 google() // Google's Maven repository
 }
 dependencies {
 classpath 'com.google.gms:google-services:4.3.4' // Google Services plugin
 }
}
allprojects {
 repositories {
 google() // Google's Maven repository
 }
}
```

Then we go to build.gradle file of the app in Android Studio and add the following:

Figure 21

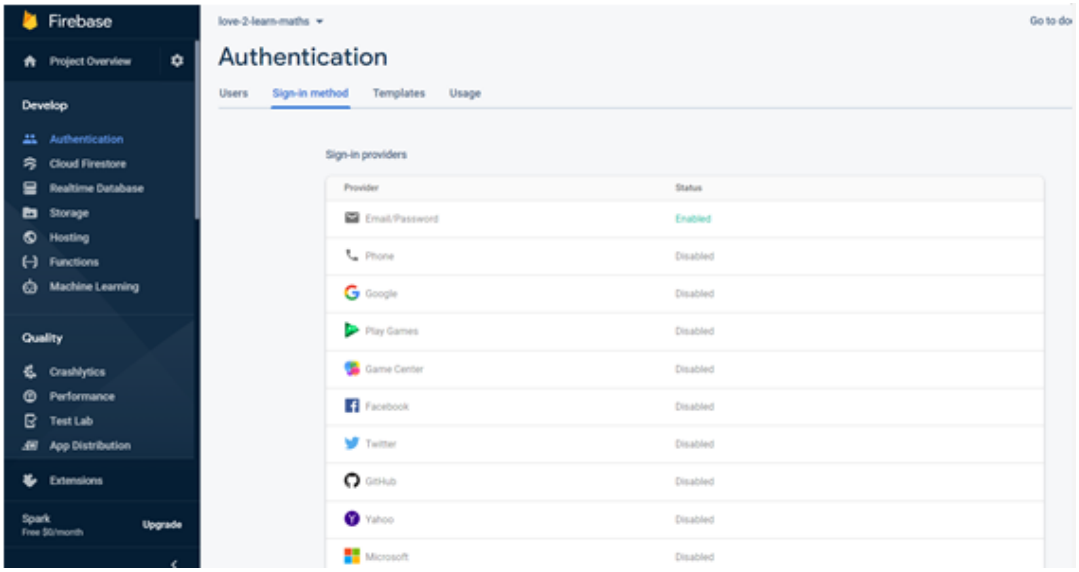
Addition of the Google services plugin as a buildscript dependency

```
apply plugin: 'com.android.application'
apply plugin: 'com.google.gms.google-services' // Google Services plugin
android {
}
dependencies {
 implementation 'com.google.firebase:firebase-auth:11.4.0'
 implementation 'com.google.firebase:firebase-database:11.4.0'
}
```

To be able to use firebase authentication we have to go through the console to activate the email / password method. We select from the left of the Authentication menu, the sign-in method and we set the email / password to be enabled.

Figure 22

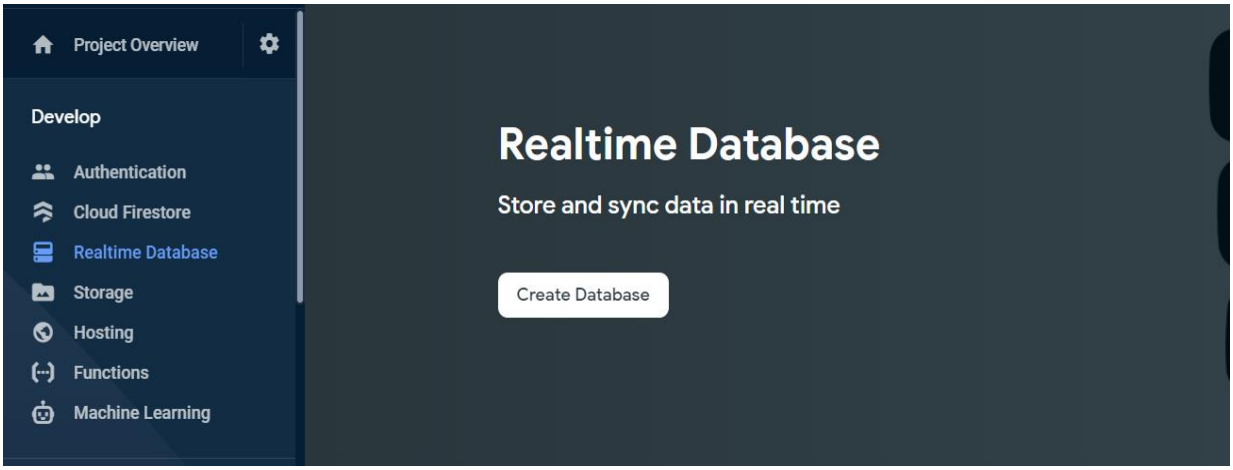
Use of the firebase authentication



We also use the Realtime Database in our application to store user data such as the data that users use to connect. To be able to use it, from the menu on the left we select Realtime Database and then Create Database.

Figure 23

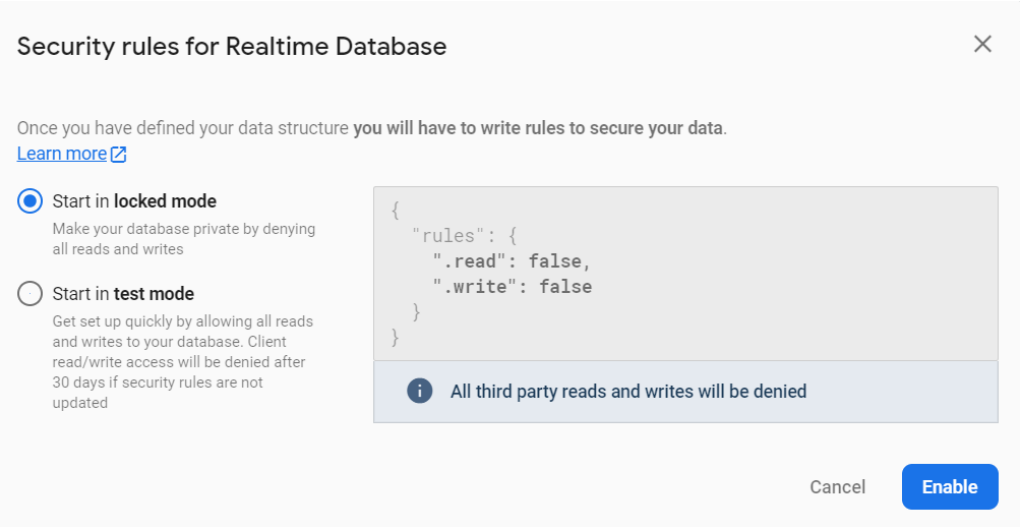
Use of the Realtime Database



We then select the security rules of the database and press enable as shown below in figure 24.

Figure 24

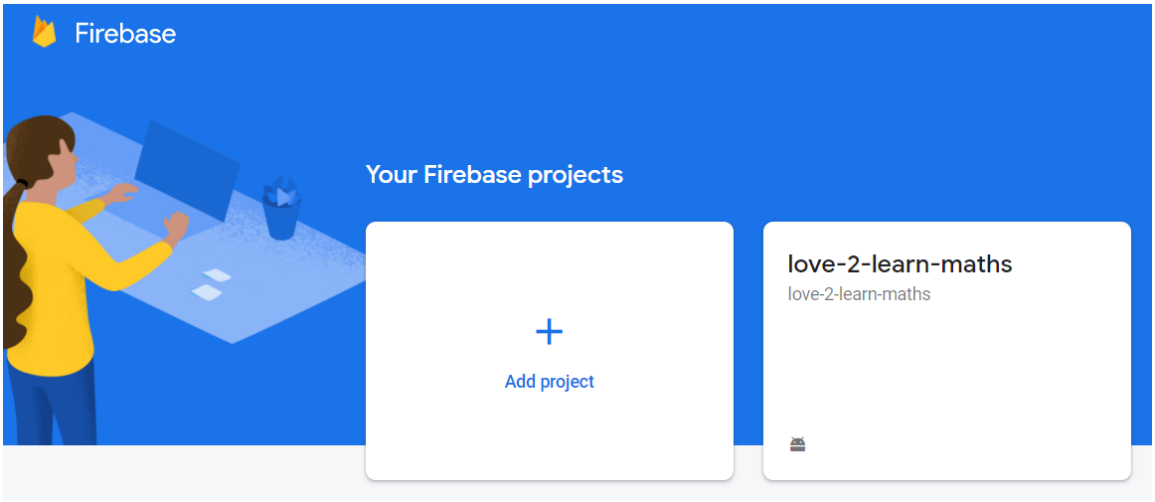
Enable the security rules of the Realtime Database



After we have followed the steps which are described above among the projects that already exist in the console, the project we have just created appears.

Figure 25

The appearance of Love2LearnMaths in the Firebase platform



After the above, every time a user logs in to the application, the authentication will be done with the email / password method of firebase and the user's data will be stored in the Realtime database.

3.3. Instructions for using the app

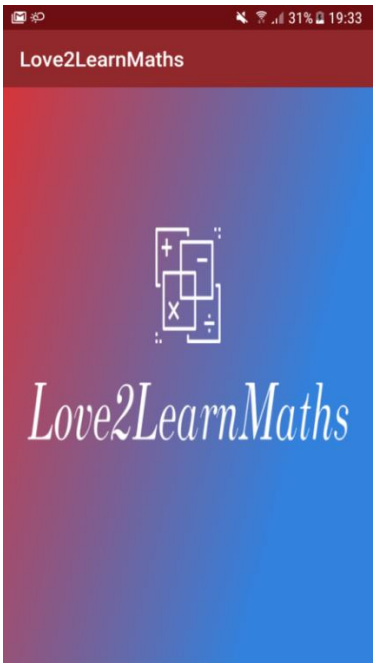
In the following section detailed instructions to all stakeholders for using the app are presented. Those instructions were distributed in the form of the below document as a brochure, firstly to the seven mathematicians and informatics teachers and secondly to the three Special education mathematicians. The aim of the brochure was for the teachers to become familiar with all the functions and the features of the app in order to be able to utilize and evaluate it. Instructions were provided to students by their educators as soon as the second ones got well acquainted with them.

3.3.1. Splash Screen

Once the application is opened, the user is shown a Splash Screen with the application logo. Splash Screen is a screen that appears to the user as soon as he enters the application and its duration is a few seconds.

Figure 26

Love2LearnMaths Splash Screen



3.3.2. Register – Login

The same device is intended to be used by different students so as they would be able to be provided by the app with personalized information such as their score. For that purpose, each student as soon as they enter the application for the first time, they should register in it. They should give a name or nickname, an email and a personal password, as it is asked below in Greek, which is students' language.

If a student has difficulty in registering, he / she can press the help button that will guide him / her. Figure 27 and Figure 28 below displays the aforementioned procedures.

Figure 27

Love2LearnMaths Register Screen

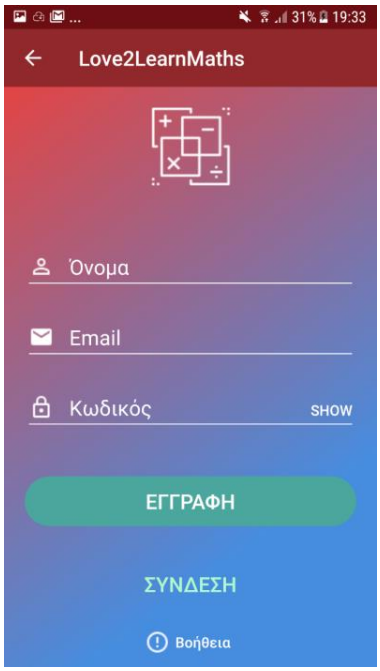
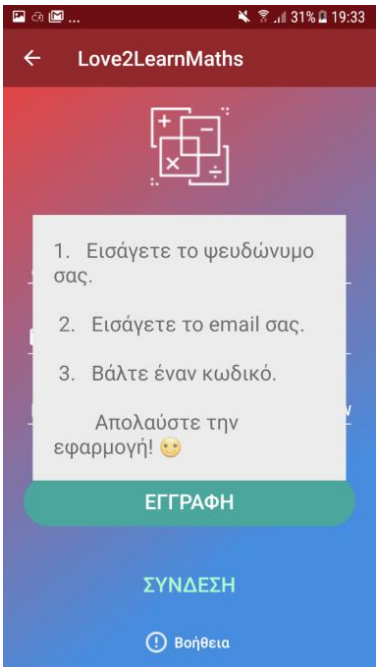


Figure 28

Love2LearnMaths Help Screen



The next time student will try logging back into the app he will use the information he provided in his registration and click Login. When logging in, student only needs to enter his/hers email and password.

In case a student has forgotten his/her password, he/she is given the opportunity to recover it by pressing Forgot your password? Afterwards the following screen appears. Student must then enter his/her email and then checks the

email he/she gave to follow the recovery instructions, as displayed by Figure 29 and Figure 30 below.

Figure 29

Love2LearnMaths Log-in Screen

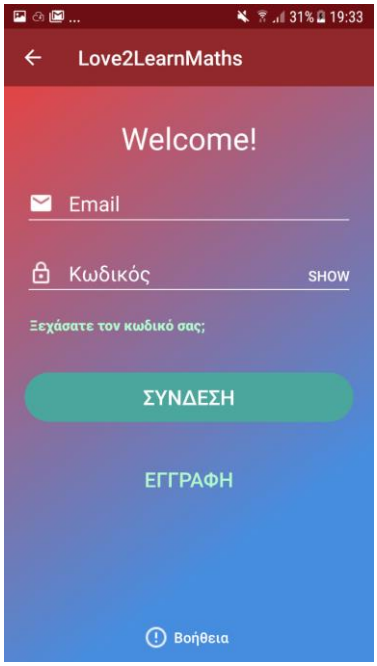
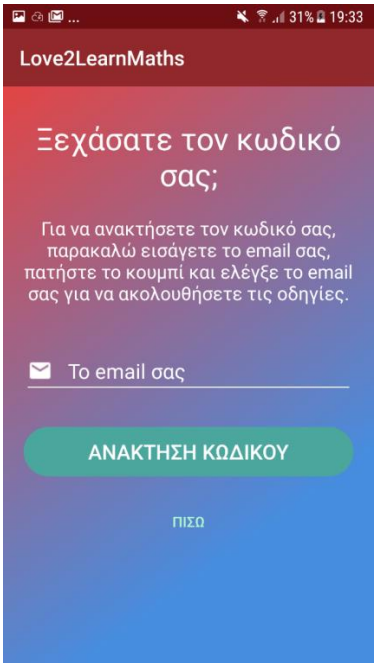


Figure 30

Love2LearnMaths "Forgot your password" Screen

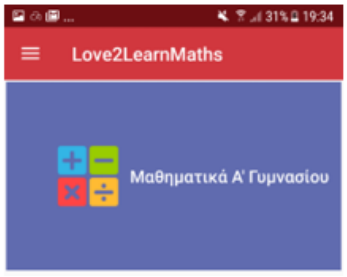


3.3.3. Main Screen

Once someone enters in the application the first screen that appears is the following. On this screen there is only the option Mathematics A' Gymnasium. However, according to the app's design and nature other courses can be added too, either of the same class or mathematics courses from other classes.

Figure 31

Love2LearnMaths Main Screen

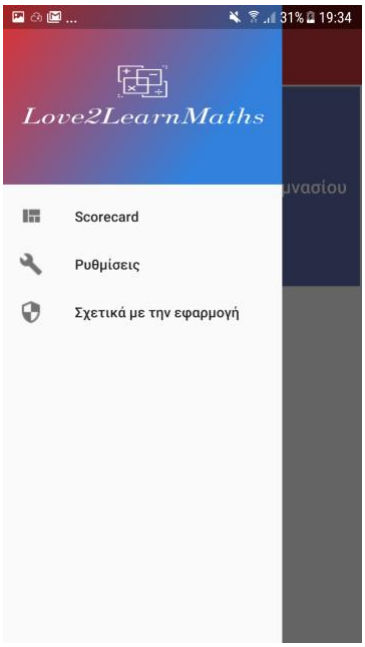


3.3.4. Navigation Drawer

The navigation drawer appears when the user taps the three lines  on the upper left corner of the main screen and displays the application menu to the user. More specifically, the following options are displayed: Scorecard, Settings, and About the Application. Figure 32 presents those options.

Figure 32

Love2LearnMaths Navigation drawer



3.3.4.1. Scorecard

This scorecard screen displays the High score for each module in the Mathematics lesson. Each time a student practices the math exercises according to their correct answers a score is calculated. This screen displays the highest score achieved by the student for each unit.

Figure 33 below shows the initial scorecard screen before any score has yet been achieved.

Figure 33

Love2LearnMaths "High Score" Screen

3.3.4.2. Settings

Through this screen the student has the opportunity to restore the high score he has achieved in the exercises. Once the student presses Reset Highscore, all scores for all sections displayed on the ScoreCard are automatically reset. Students also have the ability to press either Start Music or Mute Music.

As soon as students enter the Main Screen music starts playing in the background. Students can turn it off from the settings. Depending on whether the music is playing, the corresponding message is displayed (Start Music or Mute Music).

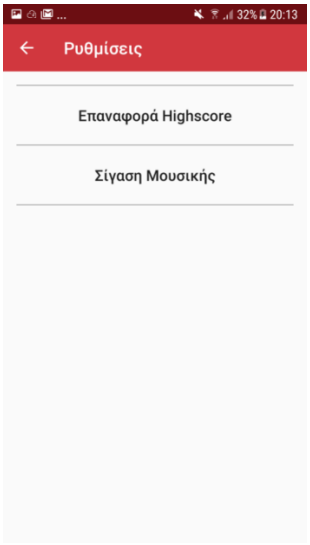
Figures 34 and 35 below display the Settings screens for restoring the score and start or mute the music.

Figure 34

Love2LearnMaths Settings/Start Music

Figure 35

Love2LearnMaths Settings/Mute Music

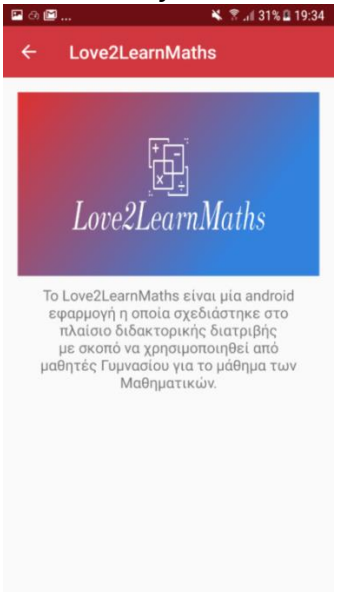


3.3.4.3. About the application

This screen displays some information about the application and its purposes as well as the Logo of the application.

Figure 36

Love2LearnMaths Information Screen



The text in the “About the Application” tab mentions: Love2LearnMaths is an android application which has been designed in the framework of a doctoral

dissertation in order to be used by Gymnasium students for the Mathematics course of the Curriculum of studies.

3.3.5. Choose Lesson

As soon as the user presses his Mathematics on the Main Screen, the next screen appears (figure 37) in which he can choose the lesson of ALGEBRA or GEOMETRY.

Figure 37

Love2LearnMaths Selection Screen (ALGEBRA/GEOMETRY)

3.3.6. Units Activity

Depending on which subject students have chosen, the corresponding sections are displayed, which are based on the school curriculum. If students choose ALGEBRA, the screen below is displayed. Algebra consists of the following chapters:

1. natural numbers
2. fractions
3. decimal numbers
4. equations
5. percentages
6. positive and negative numbers

On the contrary, if students choose GEOMETRY, the following chapters are displayed:

1. Basic geometrical equations,
2. Symmetry-Parallel lines,
3. Triangles-Parallelograms.

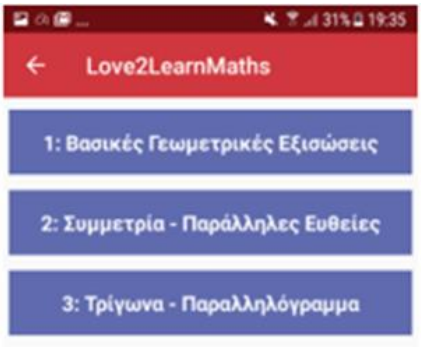
Figure 38 and figure 39 below present the screens of Algebra and Geometry menu correspondingly.

Figure 38

Love2LearnMaths ALGEBRA Menu

Figure 39

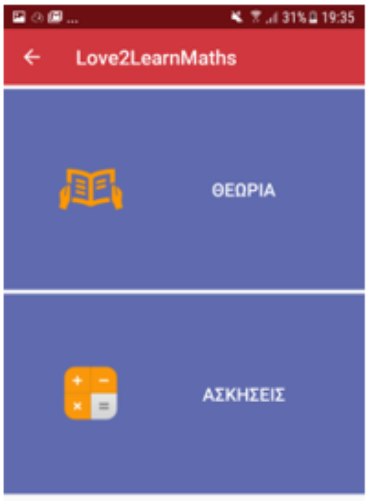
Love2LearnMaths GEOMETRY Menu



Once the student selects the unit on which he / she wants to practice, the next screen appears in which he / she can choose between theory and exercises.

Figure 40

Love2LearnMaths Selection Screen (Theory/Exercises)

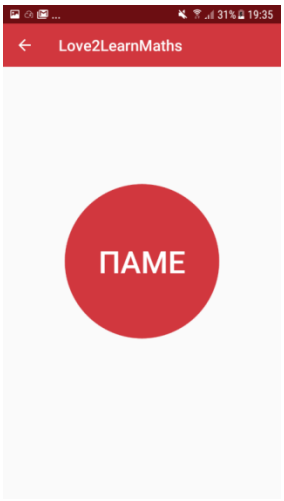


3.3.7. Exercises

If someone selects the exercises, the following screen will appear, which, as soon as he / she clicks, GO, multiple choice questions will start to appear, which are in accordance with the section chosen by the student.

Figure 41

Love2LearnMaths GO button



3.3.7.1. Exercise Examples

In each chapter there is a different number of questions and they appear to the student each time in random order. As long as the student answers, time runs. As soon as the student answers one question, the next one automatically appears.

Figure 42

Love2LearnMaths exercise example

Depending on the answer given by the student, the corresponding message appears at the bottom of the screen. In case they have answered correctly, the message Correct is displayed. In case they have answered incorrectly, the message False is displayed along with the indication of the correct answer.

Figure 43

Correct answer example

Figure 44

False answer example

As soon as the time is up or the questions are over, the results screen is displayed to the user.

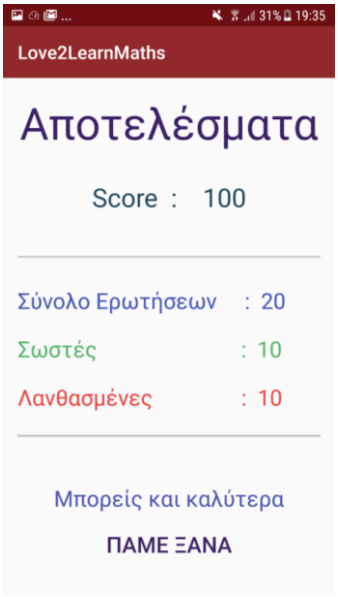
3.3.8. Results

This screen shows to the students the set of questions they have answered, how many are answered correctly and how many are answered incorrectly. Based on the number of correct answers, a Score is calculated which is displayed to the students. If the score is higher than the previous one that the students have achieved in this section, the score that is stored on the Score Card changes, otherwise remains the same. This means that the app displays the highest score and motivates students to beat it.

Also, based on the score, a message is displayed to the students as shown in the screen below. In case of incorrect answers mild remarks are used to avoid students' disappointment and encourage the users to continue practicing.

Figure 45

Love2LearnMaths Results Screen



The messages that may appear are the following:

- You need improvement
- You can do better
- Keep trying
- Good for you

When students press the go button again they go back to the screen: Choose Lesson.

3.3.9. Theory

If the student chooses the theory, the corresponding sections that exist in the theory of the specific chapter are displayed and depending on which student will click, the corresponding text is also displayed. Figure 46 and figure 47 display the theory menu of algebras first chapter and an Example of the first section of Algebra's theory, which is Prime and Compound numbers.

Figure 46

Theory menu of algebras first chapter

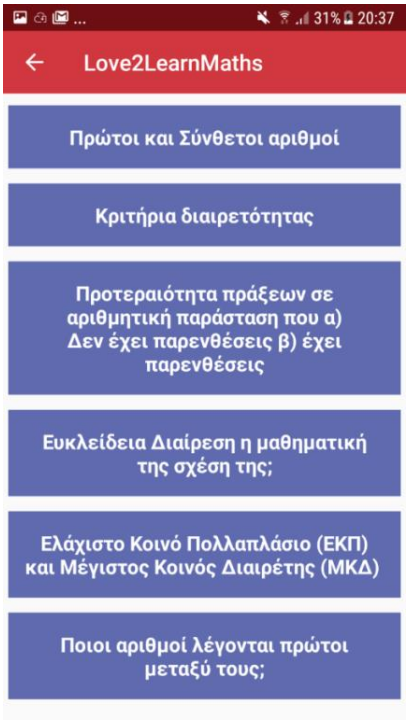
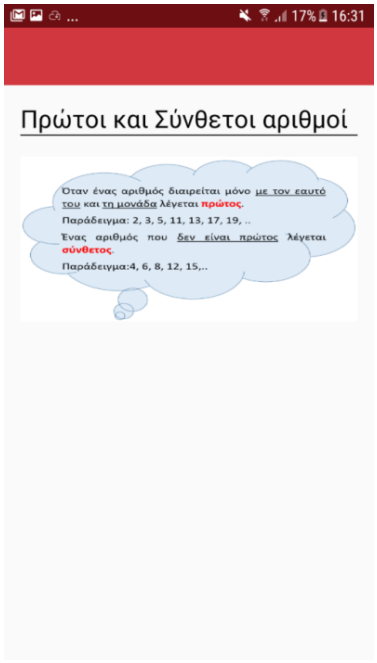


Figure 47

Example of the first section of Algebra's theory: Prime and Compound numbers



4. RESEARCH METHODOLOGY

In this research a collection of procedures, technics, tools and documentation were applied to accomplish certain tasks which are relevant to our stydy. In this chapter the analysis of all the methods which were employed during the study is attempted. Information such as the location of the study, research design, sampling and sample size, types of data, data collection method and its management are provided. Explanations are also provided on how instruments were validated.

The chapter is divided into the following topics:

- The justification of the research
- Research Problem, Research Questions and Research Objectives
- The phases of the research and the procedures
- The instruments to collect information and
- The participants of the phases of the research.

4.1. Justification of the research

After having examined the above literature and thoroughly considered the below presented factors:

1. The mass use of smartphones in the students' community as stated in section 2.3.2. by Laricchia (2023).

2. The positive effects of M-Learning in Special Education as stated in section 2.3.4 by Kamaruzaman et al. (2017), by Novack et al. (2018), by Pitchford et al. (2018) and many others.

3. The characteristics and needs of people with learning difficulties as stated in sections 2.1.1. by Siregar et al. (2023), by Yunus & Ahmad (2022), by Snowling et al. (2020), by Haberstroh & Schulte-Körne (2019) and finally,

4. The situation in Greece where not many investigations about M-Learning in Special Education have been carried out, because mobile devices are not fully integrated into the learning procedure, as referred to section 2.3.3., because of the strict legislation involving the use of mobile devices at school and as stated to section 2.3.2. by Nikolopoulou (2021). With consideration to all the above we decided to design an Android application that intends to assist pupils with learning difficulties with their educational process. The application was designed to be tested in integration department classes by teachers and students. Finally, students' and teachers' experience regarding the app's use in class was determined that it should be evaluated.

Of course, before attempting all these, teachers' readiness and attitudes towards the use of mobile devices in the educational process, raised as an important issue to be examined. That is why in the first phase of our survey, we attempted to detect teachers' perceptions on this area. Besides, according to İlçi (2014) M-Learning readiness and acceptance of students and teachers are emerging as important areas of research to be carried out.

So, this research's main goal is to evaluate the efficacy of a new mobile application that has been designed in the context of the whole study. To achieve this goal, we used both quantitative and qualitative tools. This approach provides the best opportunities for answering the important research questions of this study, the answers of which rely upon a variety of forms of data. Cohen, et al. (2008) claim that two of the most commonly employed data collection methods are questionnaires and interviews, each of them providing an alternative tool for the collection of empirical data.

4.2. Research Problem, Research Questions and Research Objectives

It is inevitable that students with learning difficulties face huge problems in participating in the educational system. Especially for students who according to Greek law study in the Integration Departments of typical schools, has not been provided much intervention to help them to smoothly be included in the general class. Those students, as described in section 2.1.2. “About The Greek educational structures for pupils with learning difficulties”, attend the same courses and are examined exactly at the same examination topics as the other students without learning difficulties. Therefore, we decided to provide some help to those students. In Greece the region of Western Macedonia, where many students with learning difficulties study in the integration departments of typical schools, where there have not been carried out previous surveys on this area, it is important that we direct our attention towards trying to facilitate those pupils’ learning process and facilitate in this way their inclusion to the regular class.

The research problem that this PhD program is expected to investigate is the next:

Can we improve the learning in mathematics of students with learning difficulties using a mobile application?

For the purposes of the study, is estimated as necessary to find out the readiness and the attitudes of special education teachers in the area of our research.

After that we proceeded to the design and the use of our app in classroom and finally we moved forward to the evaluation of the application.

All the above mentioned steps highlight the following research questions:

1. Are special education teachers familiar with the use of ICTs?
2. What are their attitudes and perceptions about the existing applications and about a new android application for mobile devices?

3. Does the app include the appropriate educational content in order to help students in learning?
4. Is the app well designed, characterized by functionality and reliability?

The project's main focus is to evaluate the functionality of a new educational Android application that could help students with learning difficulties who study in the Integration departments of two Greek schools in the field of mathematics. The application is also going to be designed in the context of this research.

The main objectives of the research are:

- To analyze the readiness, attitudes and perceptions of teachers.
- To evaluate this application's educational effects after having been implemented in the students with educational needs.

Table 11

Research objectives, research tasks and research instruments

GENERAL RESEARCH OBJECTIVES	SPECIFIC RESEARCH OBJECTIVES	RESEARCH TASKS	INSTRUMENT
To analyze the readiness, attitudes and perceptions of teachers	To analyze the relation between teachers' digital competence and the use of ICTs in school.	Design, validation, implementation and analysis of an initial questionnaire for teachers.	Initial questionnaire for teachers.
	To analyze the relation between attitudes-perceptions of teachers on the existing ICTs and their attitudes-perceptions about a new android application for mobile phones.		
To evaluate the quality of our Android application.	To evaluate whether the app has appropriate and complete educational content.	• Design of a new technological Android application, which intends to assist and improve the skills of students with learning difficulties in the sector of mathematics. • Design, validation, implementation and analysis of teachers' and students' questionnaires for the evaluation of the app. • Design, validation, implementation and analysis of teachers' interviews for the evaluation of the app.	• Questionnaires for specialists in the area of informatics and mathematics. • Questionnaires for students' who have tried the app. • Interviews for the three special education teachers who have used the app in their integrated departments.
	To evaluate the design of the app.		
	To evaluate the app's functionality.		
	To evaluate the app's performance and reliability.		

The Table 10 included above presents the main research objectives, along with the specific research objectives, the research tasks and the corresponding instruments of our research. Undoubtedly one of the most important tasks of our research is the design of a new technological Android application, which intends to assist and improve the skills of students with learning difficulties in the sector of mathematics.

After all the above steps have been followed, further improvement of the application according to the results of the evaluation could be attempted. This could also become the main object of another study.

Of course, in order to create an innovative and useful app concerning people with special educational needs (SEN) a matter of great importance is that we should analyze those peoples' particular needs and preferences.

However, a wider future goal could be that the implementation of such a mobile application could benefit a wider learning community apart from the Gymnasiums' pupils with SEN in our area (Gymnasium is a structure of secondary education in Greece, where students from twelve to fifteen years old attend classes) and could also possibly include supportive tools for additional lessons such as physics and Greek language.

4.3. Research Method

This research is an evaluative one because its main focus is to evaluate the functionality of a new educational Android application that could help students with learning difficulties in the field of mathematics.

Considering its design this study is a mixed-type research using both quantitative and qualitative techniques to collect data (Creswell, 2021). Therefore, in this research both Quantitative and Qualitative instruments and techniques are used. In the Quantitative part structured questionnaires were used to explore teachers' perceptions on ICTs and apps, while in the Qualitative part semi-structured interviews and questionnaires were used to find out the results derived from the application's use.

4.4. Phases of the research and procedures

Our research includes three stages. In the first stage, we identify the attitudes and perceptions of special education teachers about ICTs applications as well as their readiness to use such a tool in the classroom. This stage is carried out via structured questionnaires. After the data analysis of the first phase's questionnaires and after the study of the appropriate learning theories, we are directed to the second stage of our survey.

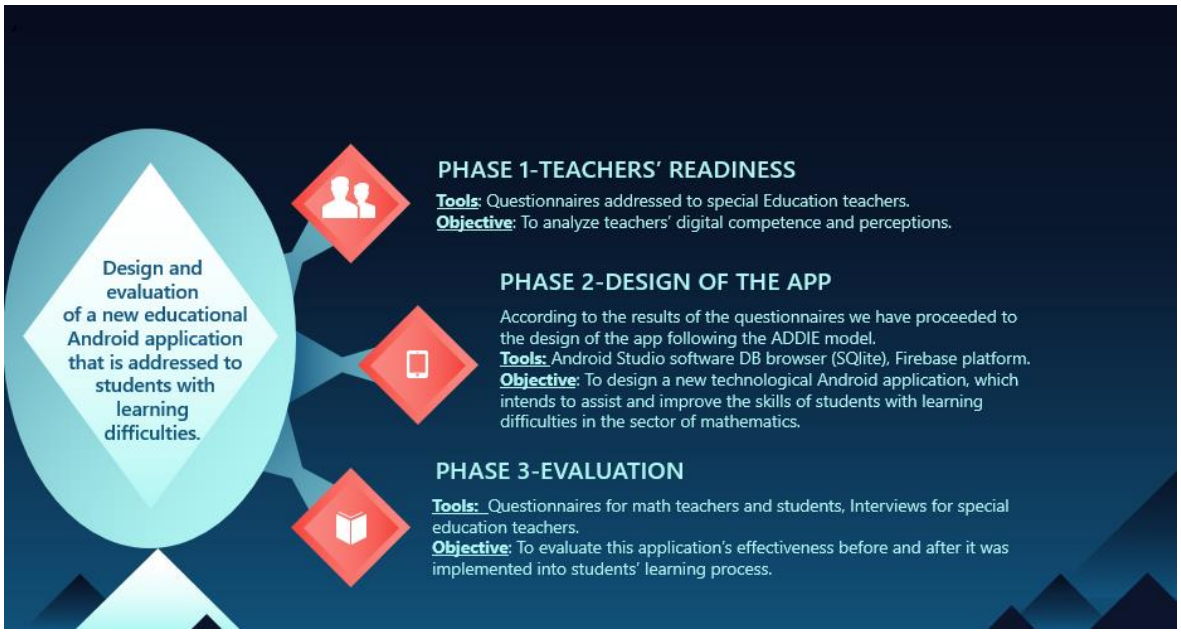
The second stage includes the design and the use of a new educational android application which intends to help gymnasium students with learning difficulties (who attend integration department classes) acquire extra skills in mathematics. This app is designed using Android Studio platform, which employs the JAVA programming language and the Extensible Markup Language (XML).

After a two-month trial period of the application we are proceeding into the overall evaluation of the use. This is the third stage of our research, which involves:
1) Questionnaires for specialists in the area of informatics and mathematics.
2) Interviews for the three special education teachers who have used the app in their integrated departments,
3) Questionnaires addressed to the students who have tried the app in their integration classes.

The above stages are described in detail within the next chapters. The picture below presents all these phases along with the tools that are going to be used in each phase, along with the objectives of each one.

Figure 48

The tools that are used in each phase of the research



Two of the most commonly employed data collection methods are questionnaires and interviews, each of them providing an alternative tool for the collection of empirical data. As a means of data collection, questionnaire was chosen for the quantitative section, which addresses the research question related to the students' needs.

Questionnaire is a commonly used data collection instrument that is easy to be distributed, without requiring the presence of the researcher and is easy in analyzing its results. Its disadvantage is that it takes time to establish and to check the data of its pilot mission and then its eventual modification and final mission.

The processing of the questionnaire and the data analysis were made using the software of Statistical Package for Social Sciences (SPSS) 24.0 for Windows. The analysis of the data was based on descriptive and inferential statistics. For the statistical analysis of the data, the non-parametric Tests Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test were used to detect statistically significant differences in the responses of the overall sample, depending on some of their characteristics. In addition, the Spearman Correlation Coefficient rs was used to

detect correlations between quantitative variables. To determine statistically significant differences and correlations, level a = 0,05 was selected.

The qualitative section includes interviews. We conducted interviews with the same sample of population of the research to explore the mobile application's effectiveness. In cases where we aimed at deepening, interviews are most appropriate. Both the interviewer and the interviewee have the possibility of intervention in the procedure in order to give in depth answers about personal beliefs or feelings. The personal contact among interviewer and interviewee usually ensure more information both quantitatively and qualitatively derived (Cohen, Manion & Morrison, 2008).

4.5. Instruments to collect information

For the purposes of our study, we used both Questionnaires and Interviews to collect the needed information. Those instruments are described in detail in the following sections.

4.5.1. Questionnaires about teachers' readiness

McLeod (2023) states that a questionnaire is a research tool that includes questions asked to the respondents in order to collect information. We can say that questionnaires could be similar to written interviews.

The questionnaire is a research tool for the researcher with which the collection of appropriate information is anticipated by the respondent. At the same time, the questionnaire consists of research questions concerning a study and reflects the purpose of obtaining the necessary information for the research.

The first stage of our survey refers to data collection via a questionnaire to assure the teachers' digital competence and perceptions about the use of ICTs and M-Learning in education. This form includes a series of structured questions, in which the respondent is asked to answer in a specific order.

A questionnaire is a very important task for any sampling research. According to Wilson (2014) the advantages of using a questionnaire are as follows:

- Give the researcher accurate information,
- With questionnaires a researcher gathers both qualitative and quantitative data,
- Questionnaires are low-cost and reliable methods of collecting data,
- As long as the questionnaire has been thoughtfully designed, tested, and distributed it may provide the researcher with accurate and valid data.

Cohen et al. (2008) declare that the researcher cannot persuade the respondents to give answers through a questionnaire, but they can motivate them. The questionnaire questions must be comprehensible, and concise, not to guide the participants and it must have a clear frame of reference. What is more, a questionnaire should be well organized and should contain the necessary instructions and suggestions.

Furthermore, the questionnaire may be supplemented without the presence of the investigator. A questionnaire may contain both closed-ended and open-ended questions. In closed-type questions, the respondent is asked to choose between specific answers, while in the open-type the respondent answers the question by filling in the blank space provided to register their answer. Closed-ended questions are easier to be answered because all is needed is selecting the appropriate answer without a lot of thinking (Connor Desai et al., 2019). Furthermore, Farrell (2016) states that closed-ended questions are often good for surveys because users don't have to type so much. Additionally, the researcher can easily statistically analyze answers given to closed-ended questions.

According to the above-mentioned statements, the type of questions that were chosen to frame our survey, are closed-type questions.

Last but not least, our questionnaire is accompanied by a letter explaining clearly the objectives of the investigation and the significant contribution of the respondents to the fulfillment of its purpose.

4.5.1.1. Description of the Research Tool

Having in mind Cohen's et al. (2008) research, the following factors were taken into account in the process of the questionnaire creation in order to lead us to a successful research:

- The formulation of clear and complete questions.
- The avoidance of ambiguous questions without cohesion.

- The respondents' ability and potential reluctance to answer.
- The formulation of short questions.
- The avoidance of negative content questions.
- The omission of biased questions and terms.
- The ability of the questions to be encoded and analyzed.

For the formulation of our Questionnaire some of the questions referring to the use of ICTs in the teaching process were similar with those of the research of Kartsiotou and Roussos (2011). For the purposes of our research we have designed the rest of the questions referring to the perceptions of teachers about a new android application for mobile phones and tablets. Finally, we checked the validity of the questionnaire by a pilot sending, as described below.

The first part of the questionnaire includes demographic Information about the respondent. The second part refers to the respondents' familiarity and knowledge concerning Information and Communication Technology Systems. The third part includes questions about the use of Information and Communication Technologies (ICTs) in class and the fourth part deals with the attitudes and perceptions of teachers related a) to existing ICTs and b) to a new android application for mobile phones. All the questions of the questionnaire divided into these research dimensions, are displayed below in Table 11.

Table 12

The questions about teachers' readiness, divided into the research dimensions

RESEARCH OBJECTIVES	*DIMENSIONS TO RESEARCH (INFORMATION TO COLLECT WITH THESE INSTRUMENTS)*	*QUESTIONNAIRE FOR TEACHERS (ITEMS)*
Analyze the relation between teachers' digital competence and the use of ICTs in school	Digital competence	1. At what level would you classify your knowledge of ICTs? 2. Are you capable of adapting to the use of a new ICT's software? 3. Do you consider that you are good at using electronic devices such as Tablets and Mobiles?
	Use of ICT	4. Do you use ICTs in class? 5. Do you use Software to motivate students' interest in class, such as: videos, presentations etc.? 6. Do you use ICTs in class, such as: Educational Software for the teaching of subjects (e.g. Language, Mathematics)? 7. Do you use Software for the evaluation of students' knowledge in class?
Analyze the relation between attitudes-perceptions of teachers on the existing ICTs and their attitudes-perceptions about a new android application for mobile phones	Attitudes-perceptions of teachers on the existing ICTs	8. Students with special educational needs could benefit from the use of ICTs in class. 9. ICTs is an appropriate tool to the teacher to manage the class. 10. The use of ICTs is a funny and attractive way of learning that speeds up the learning process. 11. The use of ICTs in courses helps students with different learning styles and difficulties learn easier and better. 12. The use of ICTs motivates students to participate more actively in the learning process and cooperate with each other. 13. The use of ICTs facilitates students' self-studying at home. 14. The use of ICTs in the courses increases the authority of the teacher.
	Attitudes-perceptions of teachers about a new android application for mobile phones	15. M-Learning could help students with learning disabilities achieve better educational performance. 16. Students with learning disabilities could benefit from the creation of a new educational Android application. 17. A new mobile app could facilitate students' self-studying at home. 18. Teachers could easily accept and use a new mobile educational app in the learning process. 19. Students could very easily accept and use a new mobile educational app in the learning process.

The final questionnaire consists of 19 questions, in which the answers are given through a Five-Grade Likert Scale, which is a table containing questions and five possible answers (Not at all, A little, Moderately, Sufficiently, A lot). The advantages of this form are that the space is used constructively and efficiently, the questionnaire is completed faster and the respondents have the opportunity to compare their answers.

4.5.1.2. Validity check - Pilot Research

The validity of the questionnaire was checked by a pilot sending a task essential for good research according to Hazzi & Maldaon (2015). As McLeod (2023) declares it is important to conduct a pilot study for many reasons:

- For checking that the terminology used in the questionnaire is understandable
- To make sure that emotional questions are not included because people become defensive and could give wrong answers.
- To make sure that the questionnaire can be completed within a certain period. It must not be too long.

Therefore, before the questionnaire was finalized, a small pilot study had been carried out to check the validity of our research tool. The pilot questionnaire has as its primary purpose the assessment of the effectiveness of the "tool" we designed. At the trial stage, the degree of understanding, acceptance, and interpretation of the questionnaire was measured. In the pilot questionnaire, we tried to clarify if the terms used are easily understood, if the set of questions does not cause possible confounding tendencies, if the questionnaire has the appropriate scope, etc.

In pilot sending the questionnaire has been submitted to a limited number of individuals to answer. The results of the pilot study showed that we should proceed to the modification of some expressions to make the questions more comprehensive and that we should completely omit a certain question as its content was considered unnecessary and redundant. The above described required corrections were made

and the questionnaire was properly formed so that it would be ready to be distributed.

4.5.1.3. Cronbach's Alpha (a) reliability check

In every investigation, the reliability of the research tool in the specific case of the questionnaire plays an essential role. The notion of "reliability" is referred to whether a questionnaire lacks errors of measurement in the exported results and includes the internal relevance of the questions between them. One way to check the reliability of a questionnaire is to calculate the alpha (a) factor of Cronbach. This index takes values from -1 to 1. George & Mallery (as cited in Gliem & Gliem, 2003) claim that indicators getting values from 0,7 and above are acceptable. When the value is close to 0,9, we consider that the questionnaire is extra reliable. On the other hand, values upper than 0,95 are not desirable as they state that the various elements of a questionnaire are similar to each other and they are repetitive and therefore do not offer additional information.

Then before we started the questionnaire's statistical processing and analysis of the results, we calculated the internal consistency reliability of all the concepts and variables of the questionnaire by checking the correlation coefficient (a) of Cronbach, which was found to be a=0.902, as shown in Table 12, suggesting that internal consistency reliability coherence is excellent.

Table 13

Cronbach's a=0,902 for teachers' readiness questionnaires

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,902	,906	19

Another factor which is important to take into consideration while studying the internal consistency reliability of the questions that compose an integrated questionnaire is the correlation between each sentence-variable with the total sum of the remaining sentences-variables. This is presented by the Corrected Item-Total

Correlation column of the Item-Total Statistics table that results from the internal consistency reliability analysis of Cronbach (a) index calculated by the SPSS tool. This table is exhibited in Appendix B with the name “Table 1. Item-Total Statistics”. Since all values are greater than +0.3 but less than 0.7, a limit that has been empirically set, we have yet another indication that the internal consistency reliability of the questions is worthwhile. What is more, the last column of the particular table (Column Cronbach's Alpha if Item Deleted) demonstrates that the deletion of any question does not mean a further increase in the Cronbach's Alpha index.

4.5.2. Teachers’ and Students’ questionnaires for the evaluation of the app

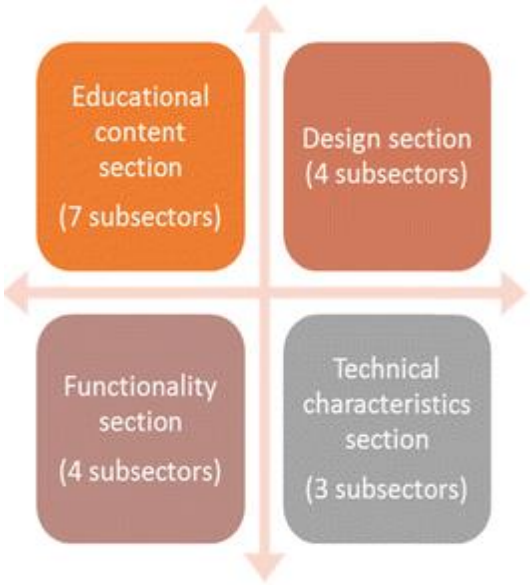
The Graded Criteria Scale for the Evaluation of Educational Mobile Applications for Preschool Children (REVEAC - Rubric for the Evaluation of Educational Apps for preschool Children) by Papadakis et al. (2017) was used as an evaluation tool, which helped us to formulate the questions of both the questionnaires and the interviews as well. This tool may refer to preschool children, but it has been suitably adapted to meet the purposes of our research. Essentially, this scale takes into account all aspects of a children's application. The rubric is divided into four main areas: educational content, design, functionality and technical characteristics.

Each main area of the Rubric consists of some relevant subsectors (sub-axes). The rubric’s sub-axes were as follows according to its creators and are presented in the figure 49 below:

- The educational content section consists of seven subsectors
- The design section consists of four subsectors
- Four subsectors are included in the functionality section
- The technical characteristics section consists of three subsectors.

Figure 49

The sub axes of the rubric (Papadakis et al., 2017, p. 3155)



We also decided to evaluate the same four main areas: educational content, design, functionality and technical characteristics and having in mind the subsectors of each area, we omitted some of them and we finally formulated the questions of our research.

The questions addressed to the students were fewer, simple and easily understood. Students' questionnaire consists of 16 closed-ended questions and 4 open-ended questions, which are:

1. How do you feel when you use the app?
2. Did you like the app and find it helpful?
3. What possible improvements would you suggest to improve the app's effectiveness?
4. Would you continue using the app after the trial period?

The same open-ended questions were addressed to the 3 special education mathematician teachers who were interviewed. Interviews were consisted of 22 closed-ended questions and 4 open-ended ones similar to the students'.

1. How do the students feel when they use the app?
2. Did you like the app and find it helpful?

3. What possible improvements would you suggest to improve the app's effectiveness?
4. Would you continue using the app in your classes after the trial period?

The questionnaire addressed to both teachers of Mathematics and Informatics were the same as the 22 closed-ended questions of the interviews. We chose as evaluators of the app both mathematics' and computer science teachers, because according to Greek Ministerial decision 85980/D2/04-07-2020, the course of mathematics can be taught by computer scientists as well as by mathematicians.

The questions of children and teachers' Questionnaires were formulated through a five Likert scale, rating system. According to Jamieson (2022) Rensis Likert, an American social scientist designed the Likert scale in 1932 in order to be used for measuring the perceptions, attitudes and opinions of people according to their answers to questionnaires.

According to Jamieson (2022) the size of a Likert scale may vary. Most researchers prefer and use a five-point scale. A larger scale (e.g., seven-point) even if offers a larger scope of choices to respondents to select, it still has been noted that people usually avoid to select answers at the start or the end of large rating scales, because they do not want to appear having extreme opinions. On the other hand, scales with only three categories may not exhibit sufficient differentiation.

The table 13 below presents all the questions of the teachers' and students' questionnaires divided into the four main sectors (Educational content, Design, Functionality and Technical Characteristics) according to Papadakis et al. (2017).

Table 14

Teachers' and students' questions for the evaluation of the app divided into sectors

RESEARCH OBJECTIVES	*DIMENSIONS TO RESEARCH (INFORMATION TO COLLECT WITH THESE INSTRUMENTS)*	*QUESTIONNAIRE FOR STUDENTS (ITEMS)*	*QUESTIONNAIRE FOR TEACHERS (ITEMS) QUESTIONS FOR INTERVIEWS(ITEMS)*
Educational content To create an app with the most appropriate and complete educational content	knowledge package appropriateness, learning provision, motivation/engagement, feedback provision.	1. Does the system improve your learning interest? 2. Does it offer a good presentation of mathematics material? 3. Do the graphics strengthen your attention? 4. Feedback enhances content (built-in rewards are used) 5. Do the elements of the program match with your prior knowledge? 6. Could you increase your learning abilities in Maths by using the app?	1. Does the system provide guidance in learning? 2. Does the system aim at attracting attention and provide information about the objectives of the course? 3. Does the system improve learning interest? 4. Does the system motivate the student and emphasize internal motivation when possible? 5. Does it offer a good presentation of mathematics material? 6. Feedback enhances content (built-in rewards are used). 7. Is the course content sufficient? 8. Does the course content correspond to the curriculum? 9. Is the program accompanied by strategies for extending learning? 10. Can you evaluate the child based on their performance in the program exercises? 11. Could children using the program increase their learning abilities in Maths?
Design To create an app with the most appropriate and modern design	graphics, sound, layout/scenery app/menu design.	7. Does feedback employ meaningful graphic and sound capabilities? 8. Are the available navigation menus simple and understandable?	12. Is the system characterized by elegance and minimalism in the provided information to avoid user confusion? 13. Does feedback employ meaningful graphic and sound capabilities? 14. Are the available navigation menus simple and understandable? 15. Does the application provide alternative navigation routes between its screens?
Functionality To create an app fully and appropriately functional	Child friendliness autonomy instructions	9. Is the text of the navigation options (menus, buttons etc.) simple and understandable to you? 10. Are the instructions for using the application clear? 11. Does the application provide the appropriate comments? 12. Are the comments provided at the right time? 13. Is the application friendly to you?	16. Is the text of the navigation options (menus, buttons etc.) simple and understandable? 17. Are the instructions for using the application clear? 18. Does the application provide the appropriate comments? 19. Is the application child friendly?

Technical characteristics To create an app with the most appropriate performance and reliability	performance reliability	14. Does the application use simple and natural dialogs? 15. Does the application supports shutdown at any time you want? 16. Is the application efficient and reliable?	20. Is it possible to select specific functions? 21. Does the application use simple and natural dialogs? 22. Is the application efficient and reliable?
Open-ended questions only for students and teachers who tested the app in class Feelings	Opinions or feelings about the app after using it	1. How do you feel when you use the app? 2. Did you like the app and find it helpful?	1. How do the students feel when they use the app? 2. Did you like the app and find it helpful?
Suggestions	Suggestions	3. What possible improvements would you suggest to improve the app's effectiveness? 4. Would you continue using the app after the trial period?	3. What possible improvements would you suggest to improve the app's effectiveness? 4. Would you continue using the app in your classes after the trial period?

As in the first step of our work, a preliminary part of research conducted before a complete survey to test the effectiveness of the research methodology.

According to Roopa & Rani (2012) the pilot survey is intended to determine: If the questions are properly presented, if the questions have been placed in the best order, if the questions are understood by all the respondents, if additional or specifying questions are needed, or if some of them need to be eliminated and last, if the instructions given to the correspondents are adequate.

What is more, the Internal Consistency Reliability is used to judge the reliability of the tool by estimating how consistent the results are for different items of the same construct. A way to check the internal consistency reliability of a questionnaire is to calculate the alpha (a) factor of Cronbach (Cronbach's Alfa).

4.5.2.1. Cronbach's Alpha (a) reliability check

As in the first stage of our survey, before attempting the statistical processing and analysis of teachers' questionnaires, the internal consistency reliability of all the concepts and variables of the questionnaire was checked and the correlation

coefficient (a) of Cronbach was calculated. The Cronbach's Alpha (a) factor was calculated and it was found to be: a=0.873, as shown in Table 14, meaning that internal consistency reliability is very good.

Table 15

Cronbach's a=0,873 for teachers' evaluation questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,873	,882	22

Again, in the case of students' questionnaires, the internal consistency reliability of all the concepts and variables of the questionnaire was checked and the correlation coefficient (a) of Cronbach was calculated. The Cronbach's a index was calculated to be a=0.901, as shown in Table 15, suggesting that internal consistency reliability is excellent.

Table 16

Cronbach's a=0,901 for students' evaluation questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,901	,899	16

4.5.3. Teachers' interviews for the evaluation of the app

We conducted the interviews with the three special education math teachers who had tested the app in their integration classes. According to Subramanya et al. (2023) researchers can search deeper in to a subject using interviews and can also allow the interviewees to ask some clarifying questions on this subject. McLeod (2023) on the other hand, states that written interviews are much alike questionnaires.

The interviews' questions are the same as the ones included in the questionnaires addressed to teachers' of math and informatics and are both presented in table 13 of section 4.5.2.

The interviews are semi structured and include both closed-ended and open-ended questions. Closed-ended questions are easier to be answered because all is needed is selecting the appropriate answer without a lot of thinking (Connor Desai et al., 2019). On the other hand open-ended questions have many advantages as challenging the interviewees to give a huge diversity of answers enriching the results (Krosnick, 2018).

Before the app's implementation in the integration classes, we had met the teachers and thoroughly explained to them how the app operates. We explained its purpose, the learning theory upon which the app is designed and the content of the app. Then we made many tests throughout the functionality and operation of the application. The teachers followed the instructions and completed all the test's questions many times. This fact we consider that helped them to acquire complete knowledge of the apps functions, so that they could assist students at a later time to accomplish the same knowledge and become capable users of it.

Finally, after the trial period (which was shorter than it was initially planned, due to the restrictions of COVID-19), we interviewed the teachers separately from each other asking the same questions that were included in the questionnaire addressed to both the mathematicians and teachers of Informatics of the general education classes. We only added four open questions which were not included in the aforementioned questionnaire.

The open questions belong in the sector "Opinions or feelings about the app after using it" and are the bellow mentioned:

1. "How do the students feel when they use the app?"
2. "Did you like the app and find it helpful?"
3. "What possible improvements would you suggest to improve the app's effectiveness?'

4. “Would you continue using the app in your classes after the trial period?”

The teachers as referred above were interviewed separately and each interview was conducted face to face with the researcher. The researcher asked each question and the interviewee gave the relevant answer. Both questions and answers were recorded, in order to be registered and analyzed.

4.6. Participants

In this chapter are described the sample sizes for both the phases of our investigation. The first phase, which studies the teachers' digital readiness and the third stage, which intend to evaluate the experience of using our Android application.

After creating the app, we communicated with 7 mathematics and IT teachers and asked them to evaluate their experiences after using the app. Firstly, we installed the app on their mobile phones and asked them to use it repeatedly so that they get familiar with its features and characteristics and be able to evaluate it later on.

At the same time, we approached 3 special education mathematicians and asked them to use this application with their students in integration department or in parallel support classes. The application was tested during the school year 2021-2022 only for a period of 2 months and no longer as it was originally planned, because schools in Greece were closed for a long period due to the pandemic covid 19.

After this period, the questionnaires were distributed a) to the 7 teachers who had tested the application at their own time and place and b) to the 16 students who had tested the application at school. In addition, interviews were conducted with the 3 special education mathematicians who had tested the application with their students in their classrooms.

4.6.1. Participants who answered questionnaires about teacher's readiness

After the pilot survey that was conducted to ensure questionnaire's validity, the questionnaire about teacher's readiness ended up having nineteen questions and was shared to be answered. The final survey was conducted on April-May 2020. The sample population is finally defined as the 48 special education teachers of both

primary and secondary education of the region of Western Macedonia in Greece who returned the questionnaire completed after a waiting period of three weeks. We sent most of the questionnaires and received them back through e-mail and we sent some others through post office. We delivered some of them hand by hand.

The questionnaires were anonymous and completed by the participants in the absence of the researcher. The demographic characteristics of the sample are described in Table 16 below.

Table 17

Demographic characteristics of the sample of teacher's readiness questionnaire

Variables	Categories	Frequency (N)	Percent (%)
Gender	Male	13	27,1
	Female	35	72,9
Age	22-30	3	6,3
	31-40	28	58,3
	41-50	12	25,0
	51 and more	5	10,4
Academic Level	Pedagogical Academy	0	0
	Technological Institute	3	6,3
	University	9	18,8
	Master	32	66,7
	Phd	4	8,3
Years of Experience	Not at all (1st year)	1	2,1
	A little (2-5)	12	25,0
	Moderately (6-10)	20	41,7
	Sufficiently (11-15)	7	14,6
	A lot (more than 15 years)	8	16,7

4.6.2. Participants for App's evaluation -Educators who tested the app

The sample population, who was asked to answer questionnaires about the evaluation of the app, is finally defined as 7 mathematicians and IT teachers who taught to Greek gymnasium secondary schools during 2021-2022 school year. According to 85980/D2/2020 Ministerial Decision 2737 B/2020, both specialties of teachers can teach mathematics in Greek Gymnasiums.

The sample consists of 5 males and 2 females. Concerning age, 1 teacher belongs to the age group of 22-30 years (14,3 %), 5 of them (71.4 %) belong to the group of 41-50 years old, while 1 teacher (14.3 %) belongs to the group of 51 age and over.

With respect to the educators' academic level, 2 of them (28.6 %) are graduates of technological education institutes, 2 of them are university graduates, while 3 of them (42.9 %) have a master's degree.

Regarding the years of total experience in education, 2 teachers (28.6 %) have been working for 2-5 years, 2 teachers for 6-10 years, while 3 of them (42.9 %) for more than 15 years. Consequently, five out of seven teachers have much experience in education.

Concerning teachers' previous experience in Android devices, 1 teacher (14.3 %) stated that they have not at all, 1 (14.3 %) teacher that they have a little, 4 teachers (57.1 %) that they have sufficient android experience and 1 of them (14.3 %) that they have a lot. Thus, six out of seven teachers have some previous experience in Android applications.

The demographic characteristics of the sample are summarized in Table 17 below.

Table 18

Demographic characteristics of the sample of teachers' evaluation questionnaire

Variables	Categories	Frequency (N)	Percent (%)
Gender	Male	5	71,4
	Female	2	28,6
Age	22-30	1	14,3
	41-50	5	71,4
	51 and more	1	14,3
Academic Level	Technological Institute	2	28,6
	University	2	28,6
	Master	3	42,9
Years of total Experience	A little (2-5)	2	28,6
	Moderately (6-10)	2	28,6
	A lot (more than 15)	3	42,9
Years of Experience with Android applications	Not at all	1	14,3
	A little	1	14,3
	Sufficiently	4	57,1
	A lot	1	14,3

4.6.3. Participants for App's evaluation- Students with learning difficulties who used the app

The sample population of the students' questionnaires is defined as 16 students who studied at the integration departments or parallel support of two Greek secondary schools during 2021-2022 school year. The sample consists of 13 males and 3 females. Concerning students' learning difficulties, 3 of them (18,8 %) have dyslexia, while another group of three (18,8 %) are diagnosed with dysgraphia. 2 students (12.5 %) have ADHD (Attention Deficit Hyperactivity Disorder), while another group of two (12.5 %) have dyscalculia. 5 students (31,3 %) have a diagnosis of generalized Learning difficulties at language and at mathematics and one student (6,3 %) faces complex cognitive and emotional difficulties. All the above data is displayed in table 18.

Table 19

Demographic Characteristics of the students' sample

Variables	Categories	Frequency (N)	Percent (%)
Gender	Male	13	71,4
	Female	3	28,6
Learning Difficulties	Dyslexia	3	18,8
	Dysgraphia	3	18,8
	ADHD	2	12,5
	Dyscalculia	2	12,5
	Generalized Learning Difficulties in language and in mathematics	5	31,3
	Complex Cognitive and emotional Difficulties	1	6,3

4.6.4. Participants for App's evaluation- Special Education Teachers who used the app

The sample consists of one male and two female special education math teachers who were asked to help us evaluate the experience of using the app by conducting interviews.

All of them (100 %) had previous experience with Android applications, they had all (100 %) a master's degree in Special Education, which is a necessary prerequisite to become a special education teacher. What is more, they all (100 %) had 3 to 6 years of total experience as teachers. Two of them (66,6 %), the male and one of the female teachers were teaching at the integration departments of two gymnasiums. On the other hand, the other female (33,3 %) provided parallel support to two students of the Students' Sample, the ones who were diagnosed with ADHD.

5. RESULTS-DATA ANALYSIS

This chapter presents the results of the two phases of our survey. On the one hand, the analysis of the questionnaires referred to the inquiry into teachers' readiness and digital competence is displayed. On the other hand, the results of the questionnaires and interviews regarding the evaluation of the use of the application arriving from both students and teachers are presented.

5.1. Teachers' readiness questionnaires analysis

In the chapter below, we present the analysis and the results of the questionnaires of the first phase of our study. For the analysis we used Descriptive Statistics and Inferential statistics (Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test).

5.1.1. Descriptive Statistics

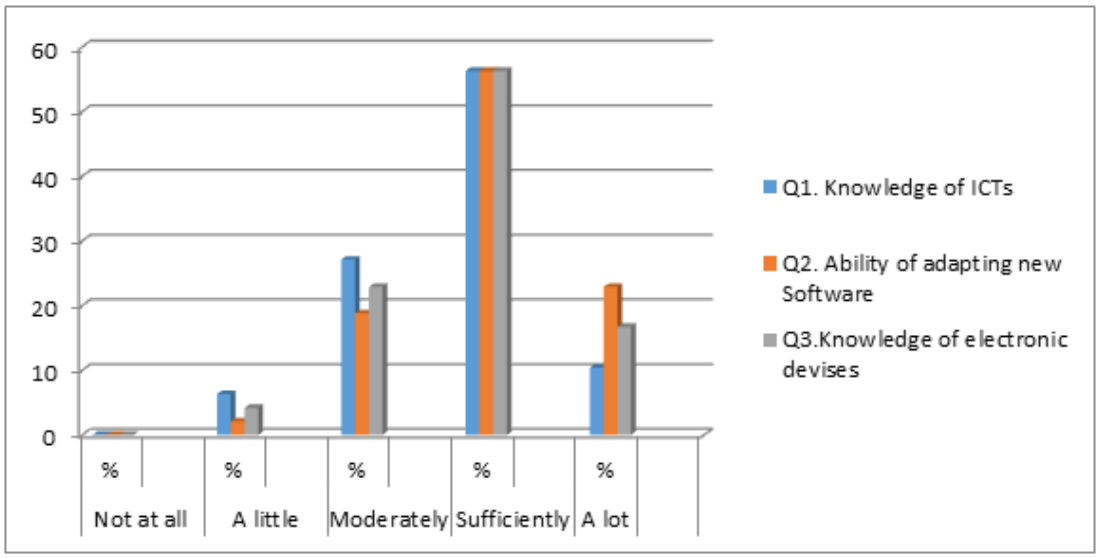
Descriptive statistics deals with the summarized and effective presentation of the data of a statistical survey. The data was initially chosen to be analyzed with Descriptive Statistics in order to extract for each question the number and percentage of people who chose each of the suggested answers. As already mentioned, suggestions receive responses on a Likert scale from 1=Not at all to 5=A lot.

The second part of the questionnaire (Questions 1-3), which follows demographics, concerns ICT Knowledge of the Special Education teachers that compose the sample of the research. The first question is "At what level would you classify your knowledge of ICTs?", the second question is "Are you capable of adapting to the use of a new ICT's software?", while the third is "Do you consider that you are good at using electronic devices such as Tablets and Mobiles?".

Figure 50 that follows shows the percent (%) of the answers. Clearly, there is minimal the percentage of teachers who answered *Not at all* and there is very little percentage of teachers who answered *A little* to questions about ICT Knowledge, while around 70 % of respondents answered *Sufficiently* or *A lot*. The mean value for each of these 3 questions is 3.71, 4.00 and 3.85 respectively based on the statistical analysis of SPSS, which shows that the answers converge much above the average answer, which is Moderately and has a value of 3. All the above prove that the knowledge of most of the teachers about ICTs is sufficient, a necessary prerequisite for accepting M-Learning in education.

Figure 50

Percent of answers about ICT Knowledge



The third part of the questionnaire (Questions 4-7) concerns the grade of the Use and utilization of Information and Communication Technologies (ICTs) in class. It consists of the following questions:

4. Do you use ICTs in class?

5. Do you use Software to motivate students' interest in class, such as: videos, presentations etc.?

6. Do you use ICTs in class, such as: Educational Software for the teaching of subjects (e.g. Language, Mathematics)?

7. Do you use Software for the evaluation of students' knowledge in class?

The value of mean which is 3,29 for Question 4, 3,46 for Question 5, 3,02 for question 6 and 2,48 for Question 7. The percentages of the answers given are presented in figure 51.

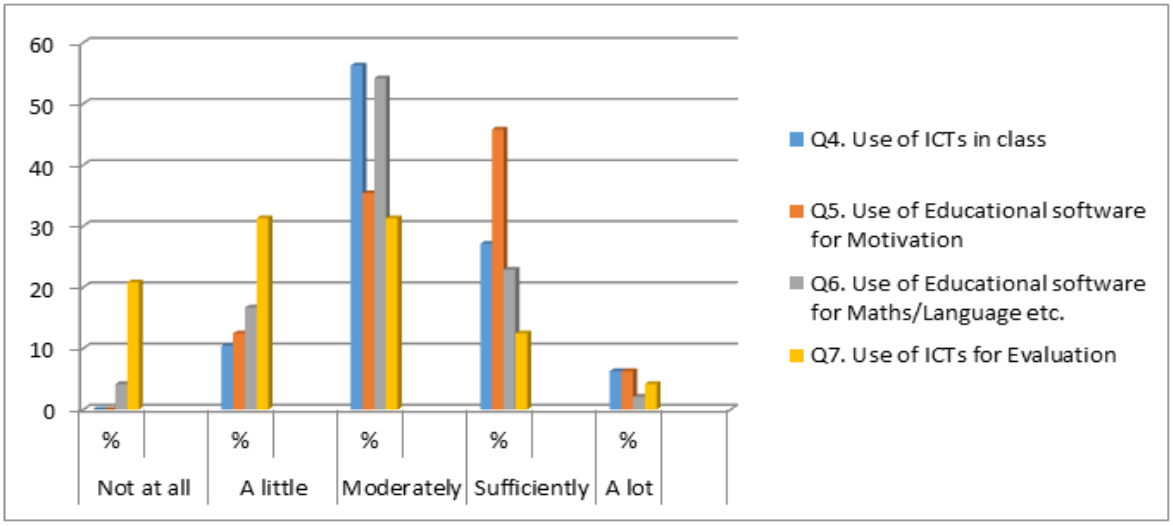
Obviously, all respondents use ICTs in class to some degree. Specifically, about 56 % use ICTs Moderately, while 27 % sufficiently. It is worth noting here that 46 % use ICTs as an Educational software for Motivation. Sufficiently and about 75 %

of teachers use Educational software for Maths/Language etc. more than Moderatelly.

Things are a little different regarding the Use of ICTs for Evaluation, as 21 % of the respondents answered that they do not use it at all, while 31 % use them a little. 48 % however use it more than moderately. It therefore becomes clear that all teachers are familiar with the use of ICTs.

Figure 51

Distribution of answers about use and utilization of ICTs in class



The fourth part of the questionnaire deals with the Attitudes-perceptions of teachers related to ICTs and Educational practices. The investigation of the perceptions of teachers is very important because their attitudes may affect their practices and, consequently, student learning process. This part is divided into two Subcategories. Subcategory D.1, deals with the attitudes and perceptions of teachers on the existing ICTs and it consists of Questions-Statements 8 to 14.

The value of mean for question 8 stating that students with special educational needs could benefit from the use of ICTs in class, is 4,35 and the rates of teachers answers are really high, as shown in figure 52, which proves the indisputable contribution of ICTs to education of pupils with SEN.

Concerning question - statement No. 9, “ICTs is an appropriate tool to the teacher to manage the class”, the mean value is 3,79 which is considered to be a high value, as it placed above Moderately. Only two responders (4,2 %) answered that they agree a little with this statement, while the 58,3 % of them answered that they agree sufficiently and 13 % answered that they agree a lot.

Statement No. 10, “The use of ICTs is a funny and attractive way of learning that speeds up the learning process” has a really high mean value of 4,19 while more than 87 % of the educators stated that they agree Sufficiently or A lot.

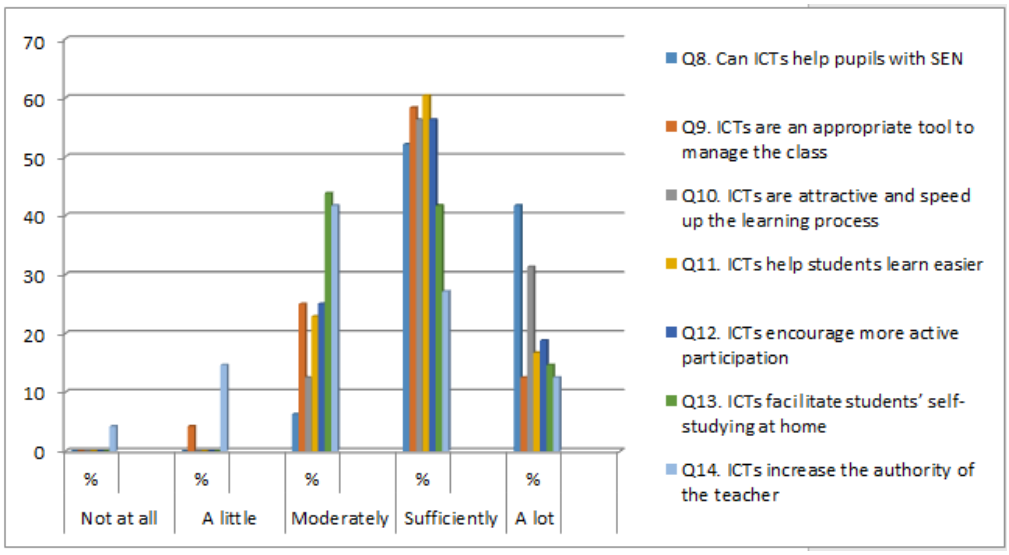
Question 11 and Question 12 seem to bring similar conclusions as they both have the same mean value which is 3,94. What is more, the majority of the responders answered that they agree Sufficiently in both cases as shown below by figure 52. This is another significant indicator that proves the importance of ICTs in the learning process, as ICTs help students learn easier and encourage students’ active participation in class.

In the same way, Statement 13, “The use of ICTs facilitates students’ self-studying at home” received similar treatment by the responders, as its mean value is 3,71 and their rate of agreement ranges from Moderately to A lot.

The lower mean value of the fourth part of the questionnaire (3,29) is being met at Question No. 14. In this case we have two responders who disagree with the statement that the use of ICTs in the courses increases the authority of the teacher and 7 of them who agree a little. Even so, approximately 42 % of the responders claimed that they agree Moderately, 27 % of them agree Sufficiently and 13 % agree A lot. Figure 52 below presents the percentages of teachers’ attitudes and perceptions on the existing ICTs.

Figure 52

Distribution of answers about Attitudes-perceptions of teachers on the existing ICTs



The second Subcategory of the fourth part of our research tool refers to the Attitudes-perceptions of teachers about a new android application for mobile phones and tablets and consists of the final Questions 15 to 19. Figure 53 that is presented below shows Frequencies of answers about the attitudes and the perceptions of teachers about a new android application for mobile phones and tablets.

Question 15 is "M-Learning could help students with learning disabilities achieve better educational performance", with mean value of 4,00. We have no "Not at All" or "A Little" agreements to this statement. On the contrary, 58,3 % of the responders agreed Sufficiently and 20,8 of them agreed A lot.

The significant majority of the responders agree a lot with statement 16 that students with learning disabilities could benefit from the creation of a new educational Android application, as shown in the table 6 below. What is more, its mean value is again really high, 4,33.

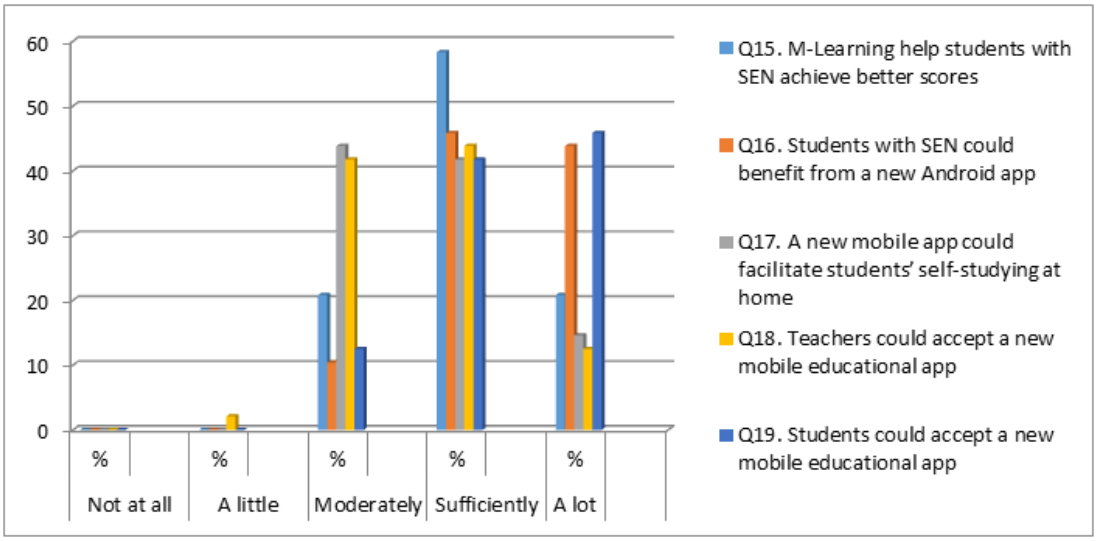
There are also no "Not at All" or "A Little" agreements to statement 17 that a new mobile app could facilitate students' self-studying at home. Its mean value is 3,71 and the 42 % and 15 % of the teachers responded that they agree Sufficiently and A lot respectively.

Question No. 18 states that teachers could easily accept and use a new mobile educational app in the learning process. The mean value of the particular question is 3,67 which is the smaller mean value for this part of the questionnaire, but it is still above moderately. In fact, 44 % of the educators mentioned that they agree sufficiently with this statement and 13 % of them, agree a lot.

In Question 19, which is "Students could very easily accept and use a new mobile educational app in the learning process", the value of the mean is 4,33 and the 88 % of the responders agree A lot or Sufficiently.

Figure 53

Percent of answers about Attitudes-perceptions of teachers about a new android application for mobile phones and tablets



5.1.2. Inferential statistics

To test the relationship between some characteristics of teachers and ICT knowledge, the use and utilization of ICT in the classroom and their views on ICT in education were used the non-parametric Tests Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test. Those tests were used to detect statistically significant differences in the responses of the overall sample, depending on some of their characteristics. In addition, the Spearman Correlation Coefficient rs was used to

detect correlations between quantitative variables. To determine statistically significant differences and correlations, level a = 0,05 was selected.

Mann-Whitney U test

When the dependent variable is either ordinal or continuous we use the Mann-Whitney U test to compare differences between two independent groups but not normally distributed. All the above criteria make the Mann-Whitney U test suitable to understand whether the teachers' answers, differ based on their gender. Gender, which has two groups: "male" and "female" is going to play the role of the independent variable while the dependent ones would be all the questions.

Table 3 in the Appendix B, presents the ranks that occur after the Mann-Whitney test is being implemented, while Table 19 below shows the questions that indicate an important statistical difference in the significant level of 5 % between the groups male and female of the independent variable Gender.

As it is confirmed by the results of the test, in the case of the use of ICTs in class, p-value = 0,003 < 0,05. In fact, the mean rank for male is 33,46 while the mean rank for the female is 21,17 which means that male use significantly more the ICTs in class.

We end up with the same results concerning the Use of Educational software for Motivation (p-value = 0,016 < 0,05). In this case the male mean rank is 31,92 while the female 21,74.

A significant statistical difference between the answers of the groups male and female seems to exist regarding the statement M-Learning help students with SEN achieve better scores, as p-value = 0,046 < 0,05. Again in this case, male group appears to agree more strongly with this statement (rank of male mean=30,35 in contrast with the female mean ran which is 22,33).

Table 20

Mann-Whitney Test-Test Statistics[a]

	Use of ICTs in class	Use of Educational software for Motivation	M-Learning help students with SEN achieve better scores
Mann-Whitney U	111,000	131,000	151,500
Wilcoxon W	741,000	761,000	781,500
Z	-3,020	-2,418	-1,992
Asymp. Sig. (2-tailed)	,003	,016	,046

a. Grouping Variable: Gender

Kruskal-Wallis test

After the implementation of the Mann-Whitney U test, the Kruskal-Wallis test (sometimes also called the "one-way ANOVA on ranks") was implemented. This is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is considered the nonparametric alternative to the one-way ANOVA, and an extension of the Mann-Whitney U test as it allows the comparison of more than two independent groups.

So the execution of the execution of the Kruskal-Wallis test was made to find out whether the distribution of the answers of the responders is the same across the different categories of the grouping variables Age, Academic Level, Years of Experience and Knowledge of ICTs.

The results of the test in the Grouping Variable Age, indicate that the distribution of the teachers' answers is being affected by Age only in one certain statement which says that students could very easily accept and use a new mobile educational app in the learning process.

Concerning the Academic Level of the respondents, the implementation of the Kruskal-Wallis test revealed that the responses are affected in only two cases. In the statement "The use of ICTs facilitates students' self-studying at home" as well as in the statement "A new mobile app could facilitate students' self-studying at home".

The execution of the test using as grouping variable the years of experience of the teachers, showed that the distribution of the statement “Do you use Software to motivate students' interest in class, such as: videos, presentations etc.?” and the statement “Students with special educational needs could benefit from the use of ICTs in class.” is not the same across the categories of the variable “years of experience”.

What is more, the results of the test using the Grouping Variable “Knowledge of ICTs” indicate that the distribution of the teachers’ answers is being affected by their knowledge in multiple cases.

5.2. Evaluation of the app

In this section, we present the analysis and the results of the questionnaires and interviews addressed to both teachers and students of the third phase of our study.

5.2.1. Teachers' questionnaires analysis

For the analysis of the questionnaires we used Descriptive Statistics and Inferential Statistics (Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test).

5.2.1.1. Descriptive Statistics

As described below by the table 20, the first main sector of the teachers' questionnaire is "Educational content" and it consists of 11 questions. As shown by the answers given in the first main sector "Educational content" of the teachers' questionnaire:

- To first question "Does the system aim to provide guidance in learning", five teachers (71,4 %) answer "Sufficiently", while two of them (28,6 %) answer "A lot".

We observe that all the teachers agree that the app provides either sufficiently or a lot guidance in learning.

- To second question "Does the system aim at attracting attention and information about the objectives of the course", three teachers (42,9 %) answer "Sufficiently", while four of them (57,1 %) answer "A lot".

We see that all the teachers agree either sufficiently or a lot that the app attracts attention and provides information about the objectives of the course.

- To third question “Does the system aim at improving learning interest”, three teachers (42,9 %) answer “Sufficiently”, while four of them (57,1 %) answer “A lot”.

Again all the teachers answering either sufficiently or a lot agree that the system improves learning interest.

- To fourth question “Does the system motivate the student and emphasize internal motivation when possible”, three teachers (42,9 %) answer “Moderately”, while four of them (57,1 %) answer “Sufficiently”.

Teachers answer either moderately or sufficiently that the app motivates students and emphasizes internal motivation.

- To fifth question “Does it offer a good presentation of mathematics material”, one teacher (14,3 %) answers “Moderately”, three teachers (42,9 %) answer “Sufficiently”, while three of them (42,9 %) answer “A lot”.

About the presentation of mathematics material teachers’ answers are distributed in three points: moderately, sufficiently and a lot, meaning that all teachers consider that the presentation of math is at least moderately good, while most of them state that is either sufficiently, or a lot good.

- To sixth question-statement «Feedback enhances content (built-in rewards are used)”, one teacher (14,3 %) answers “Moderately”, three teachers (42,9 %) answer “Sufficiently”, while three of them (42,9 %) answer “A lot”.

Teachers’ responses to the statement Feedback enhances content are distributed in three points: moderately, sufficiently and a lot, meaning that all teachers consider that Feedback enhances content moderately, while most of them state that it enhances content either sufficiently, or a lot.

- To seventh question “Is the course content sufficient”, four teachers (57,1 %) answer “Sufficiently”, while three of them (42,9 %) answer “A lot”.

We observe that teachers' responses to question: Is the course content sufficient, are distributed among sufficiently and a lot, which means that they agree that the course content is sufficient.

- To eighth question "Does the course content correspond to the curriculum", two teachers (28,6 %) answer "Moderately", while five of them (71,4 %) answer "A lot".

The vast majority of teachers believe that the course content corresponds to the curriculum a lot.

- To ninth question "Is the program accompanied by strategies for extending learning", three teachers (42,9 %) answer "Moderately", while four of them (57,1 %) answer "Sufficiently".

The majority of teachers believe that the program is accompanied by strategies for extending learning sufficiently, while some of them state that the program is moderately accompanied by strategies for extending learning.

- To tenth question "Can you evaluate the child based on his / her performance in the programs' exercises", four teachers (57,1 %) answer "Sufficiently", while three of them (42,9 %) answer "A lot".

We see that most of the teachers state that they can evaluate the students based on their performance in the programs' exercises sufficiently, while fewer state that they can evaluate the students a lot.

- To eleventh question "Could children using the program increase their learning abilities in Maths", four teachers (57,1 %) answer "Sufficiently", while three of them (42,9 %) answer "A lot".

We observe that teachers believe that children can sufficiently or a lot increase learning abilities in Math using the program.

Table 21

Distribution of teachers' answers in the sector "Educational content"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q1. Does the system aim to provide guidance in learning?	0	0	0	0	0	0	5	71,4	2	28,6
Q2. Does the system aim at attracting attention and information about the objectives of the course?	0	0	0	0	0	0	3	42,9	4	57,1
Q3. Does the system aim at improving learning interest?	0	0	0	0	0	0	3	42,9	4	57,1
Q4. Does the system motivate the student and emphasize internal motivation when possible?	0	0	0	0	3	42,9	4	57,1	0	0
Q5. Does it offer a good presentation of mathematics material?	0	0	0	0	1	14,3	3	42,9	3	42,9
Q6. Feedback enhances content (built-in rewards are used).	0	0	0	0	1	14,3	3	42,9	3	42,9
Q7. Is the course content sufficient?	0	0	0	0	0	0	4	57,1	3	42,9
Q8. Does the course content correspond to the curriculum?	0	0	0	0	0	0	2	28,6	5	71,4
Q9. Is the program accompanied by strategies for extending learning?	0	0	0	0	3	42,9	4	57,1	0	0
Q10. Can you evaluate the child based on his / her performance in the program exercises?	0	0	0	0	0	0	4	57,1	3	42,9
Q11. Could children using the program increase their learning abilities in Maths?	0	0	0	0	0	0	4	57,1	3	42,9

Figure 54 below, presents the answers of the teachers of the second main sector of the teachers' questionnaire "Design" and it consists of four questions. The answers to the questions are described below:

- Question 12 “Is the system characterized by elegance and minimalism in the provided information to avoid user confusion” is answered by two teachers (28,6 %) “Sufficiently” and by five teachers (71,4 %) “A lot”.

The vast majority of the teachers state that the system is characterized at a lot degree by elegance and minimalism in the provided information to avoid user confusion, while only few state at a sufficient degree.

- Question 13 “Does feedback employ meaningful graphic and sound capabilities” is answered by four teachers (57,1 %) “Moderately,” by two teachers (28,6 %) “Sufficiently” and by one teacher (14,3 %) “A lot”.

To question if feedback employs meaningful graphic and sound capabilities teachers agree that it employs at a moderate, a sufficient or at a lot extent.

- Question 14 “Are the available navigation menus simple and understandable” is answered by two teachers (28,6 %) “Sufficiently” and by five teachers (71,4 %) “A lot”.

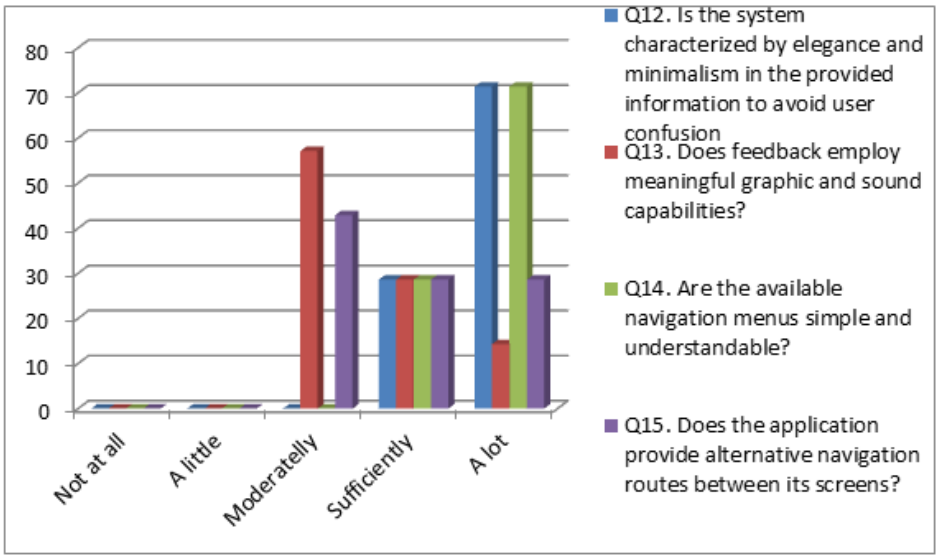
To question if the available navigation menus are simple and understandable the vast majority of teachers believe that they are a lot simple and understandable, while fewer believe that they are sufficiently simple and understandable.

- Question 15 “Does the application provide alternative navigation routes between its screens” is answered by three teachers (42,9 %) “Moderately,” by two teachers (28,6 %) “Sufficiently” and by two other teachers (28,6 %) “A lot”.

To question if the application provides alternative navigation routes between its screens, most of the teachers answer moderately, while the rest of them answer either sufficiently or a lot. This means that all basically agree that the application provides alternative navigation routes between its screens.

Figure 54

Distribution of teachers' answers in the sector "Design"



The below figure 55, presents the distribution of the answers of the third main sector of the teachers' questionnaire "Functionality" and it consists of four questions. The questions were answered as described below:

- To sixteenth question "Is the text of the navigation options (menus, buttons etc.) simple and understandable", one teacher (14,3 %) answers "Moderately", one teacher (14,3 %) answers "Sufficiently", while five of them (71,4 %) answer "A lot".

The answers mean that all the teachers in general agree that the text of the navigation options (menus, buttons etc.) is simple and understandable. The vast majority answers that the text of the navigation options (menus, buttons etc.) is to a large extent simple and understandable.

- To seventeenth question "Are the instructions for using the application clear", one teacher (14,3 %) answers "Moderately", four teachers (57,1 %) answer "Sufficiently", while two of them (28,6 %) answer "A lot".

To question that asks if the instructions for using the application are clear teachers generally agree that they are clear.

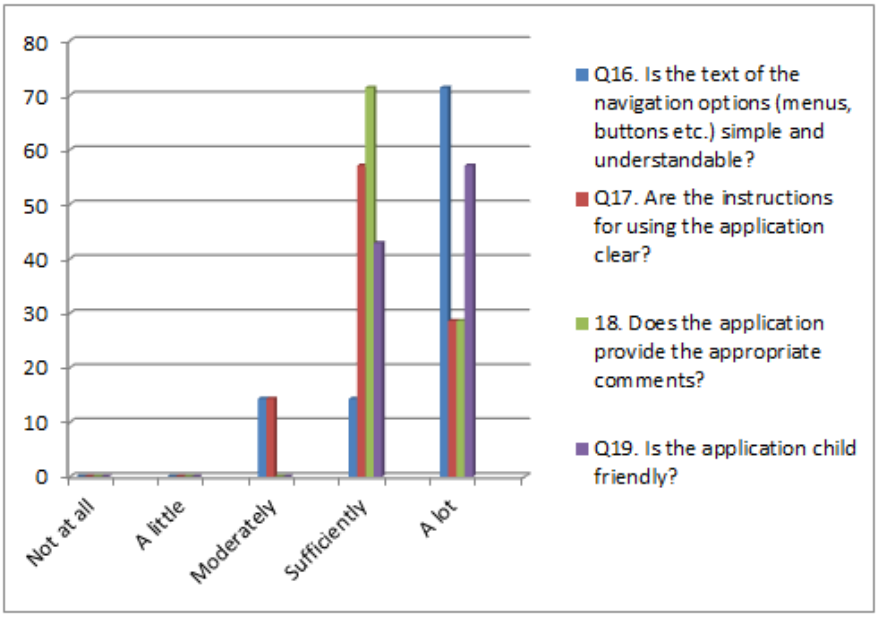
- To eighteenth question “Does the application provide the appropriate comments”, five teachers (71,4 %) answer “Sufficiently”, while two of them (28,6 %) answer “A lot”.

Teachers agree that the application provides the appropriate comments.

- To nineteenth question “Is the application child friendly”, three teachers (42,9 %) answer “Sufficiently”, while four of them (57,1 %) answer “A lot”.

There is a significant agreement that the application is child friendly with the vast majority of teachers answering that it is a lot child friendly.

Figure 55
Distribution of teachers’ answers in the sector “Functionality”



The fourth main sector of the teachers’ questionnaire “Technical Characteristics” consists of three questions. The questions were answered as described below in the figure 56:

- Question 20 “Is it possible to select specific functions” is answered by one teacher (14,3 %) “Moderately,” by five teachers (71,4 %) “Sufficiently” and by one other teachers (14,3 %) “A lot”.

Teachers basically agree that it is possible to select specific functions when using the app.

- Question 21 “Does the application use simple and natural dialogs” is answered by one teacher (14,3 %) “Sufficiently” and by six teachers (85,7 %) “A lot”.

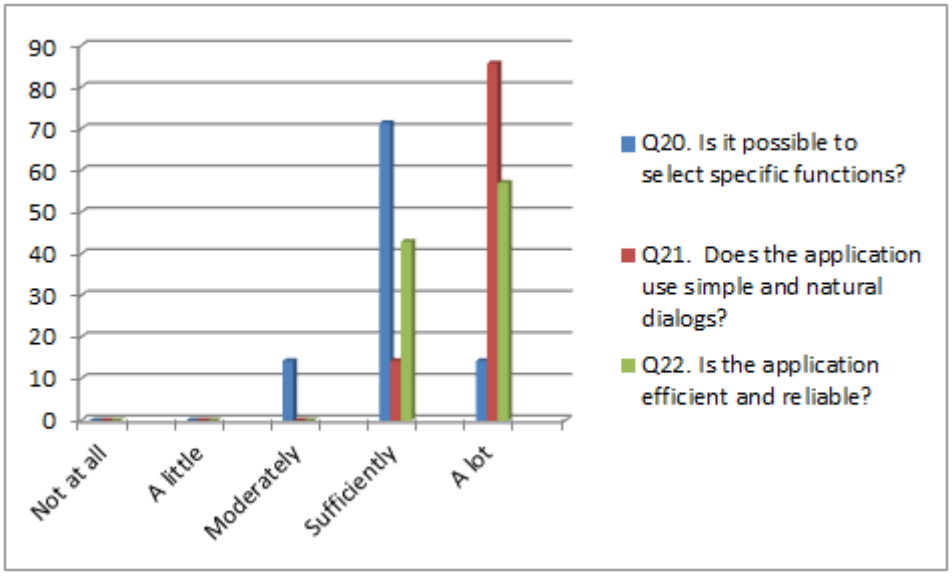
There is agreement that the application uses simple and natural dialogs.

- Question 22 “Is the application efficient and reliable” is answered by three teachers (42,9 %) “Sufficiently” and by four teachers (57,1 %) “A lot”.

Teachers declare that the application is efficient and reliable.

Figure 56

Distribution of teachers’ answers in the sector “Technical Characteristics”



5.2.1.2. Inferential statistics

To test the relationship between some characteristics of teachers the non-parametric Tests Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test was implemented. Those tests, as described in chapter 4.1.2, were used to detect statistically significant differences in the responses of the sample, depending on some of their characteristics.

Mann-Whitney U test

The Mann-Whitney U test, as stated in section 4.2., is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. All the above criteria make the Mann-Whitney U test suitable to understand whether the teachers' answers, differ based on their gender. Gender, which has two groups: "male" and "female" is going to play the role of the independent variable while the dependent ones would be all the questions of the questionnaire.

The implementation of Mann Whitney U test showed that there were not any statistically significant differences between the responses of the individuals of the two different groups male and female of the independent variable Gender. This means that the answers of teachers did not differ based on their gender.

Kruskal-Wallis test

After the implementation of the Mann-Whitney U test, the Kruskal-Wallis test (sometimes also called the "one-way ANOVA on ranks") was implemented. This is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable as referred in section 4.2.

So the execution of the Kruskal-Wallis test was made to find out whether the distribution of the answers of the responders is the same across the different categories of the grouping variables Age, Academic Level, Years of Experience and Previous experience with Android applications.

The results of the test in the Grouping Variable Age, indicate that Age affects the distribution of the teachers' answers only in one certain question: "Does the application provide the appropriate comments?" The answers are different across the categories of Age. Teachers' answers are differently distributed referring to the question if the system aims to provide guidance in learning among the categories of

Years of total experience as a teacher. (The one (14,3 %) oldest teacher answered sufficiently, while the tendency of the other age groups was a lot).

Concerning the Years of experience of the respondents, the implementation of the Kruskal-Wallis test revealed that the responses are affected in only one case. The distribution of the teachers' answers to the question: "Does the system aim to provide guidance in learning?" is different among categories of Years of total experience as a teacher. (Two people (28,6 %) with the least experience answered a lot and all the rest (71,4 %) with more experience answered sufficiently).

5.2.2. Students' questionnaire analysis

For the analysis we used Descriptive Statistics and Inferential statistics (Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test).

5.2.2.1. Descriptive Statistics

Figure 57 below displays the distribution of students' answers in the first main sector of the students' questionnaire "Educational content" and it consists of 6 questions.

- To first Question "Does the system provide guidance in learning" two students (12,5 %) answer "moderately", five students (31,3 %) answer "Sufficiently", while nine of them (56,3 %) answer "A lot".

We conclude that students agree that the system provides guidance in learning.

- To second Question "Does it offer a good presentation of mathematics material" two students (12,5 %) answer "moderately", five students (31,3 %) answer "Sufficiently", while nine of them (56,3 %) answer "A lot".

It is obvious that students believe that the system offers a good presentation of mathematics' course.

- To third Question "Do the graphics strengthen your attention" six students (37,5 %) answer "moderately", nine students (56,3 %) answer "Sufficiently", while one of them (6,3 %) answers "A lot".

Students think that the graphics strengthen their attention.

- To fourth Question "Feedback enhances content (built-in rewards are used)" three students (18,8 %) answer "moderately", six students (37,5 %) answer "Sufficiently", while seven of them (43,8 %) answer "A lot".

The students agree that feedback enhances content.

- To fifth Question "Do the elements of the program match your prior knowledge", two students (12,5 %) answer "moderately", four students (25,0 %) answer «Sufficiently", while ten of them (56,3 %) answer "A lot".

Students agree that the elements of the program match their prior knowledge.

- To sixth question which is: Could you increase your learning abilities in Maths by using the program, one student (6,3 %)answers "moderately", six students (36,7 %) answer «Sufficiently", while nine of them (56,3 %) answer "A lot".

Figure 57

Distribution of students' answers in the sector "Educational content"

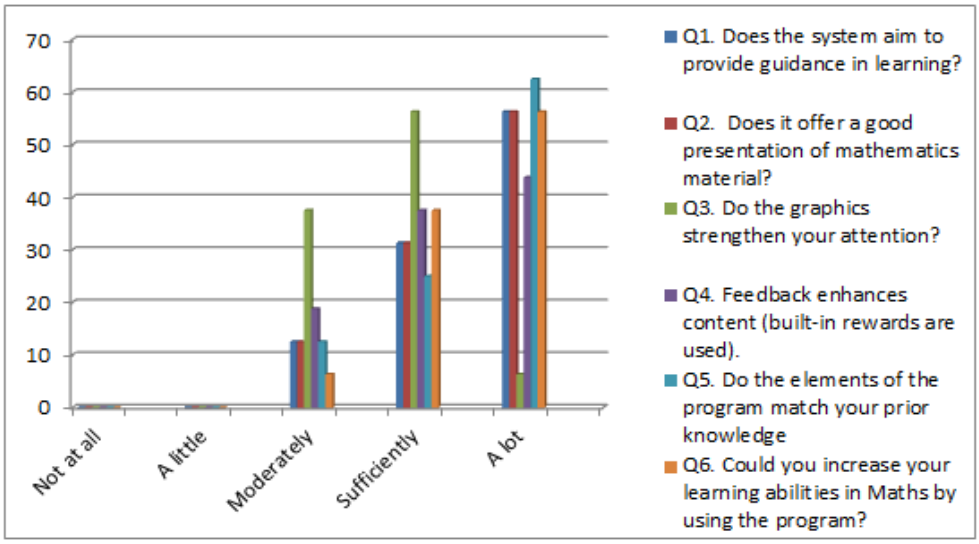


Figure 58 below presents the answers of students in the second main sector of the students' questionnaire "Design" and it consists of two questions. The questions were answered as described below:

- Question 7 "Does feedback employ meaningful graphic and sound capabilities" is answered by six students (37,5 %) "Moderately", by nine students (56,3 %) "Sufficiently" and by one student (6,3 %) "A lot".

Again students agree that feedback employs meaningful graphic and sound capabilities.

- Question 8 "Are the available navigation menus simple and understandable" is answered by one student (37,5 %) "Moderately", by nine students (56,3 %) "Sufficiently" and by six students (6,3 %) "A lot".

Students found the available navigation menus simple and understandable.

Figure 58

Distribution of students' answers in the sector "Design"

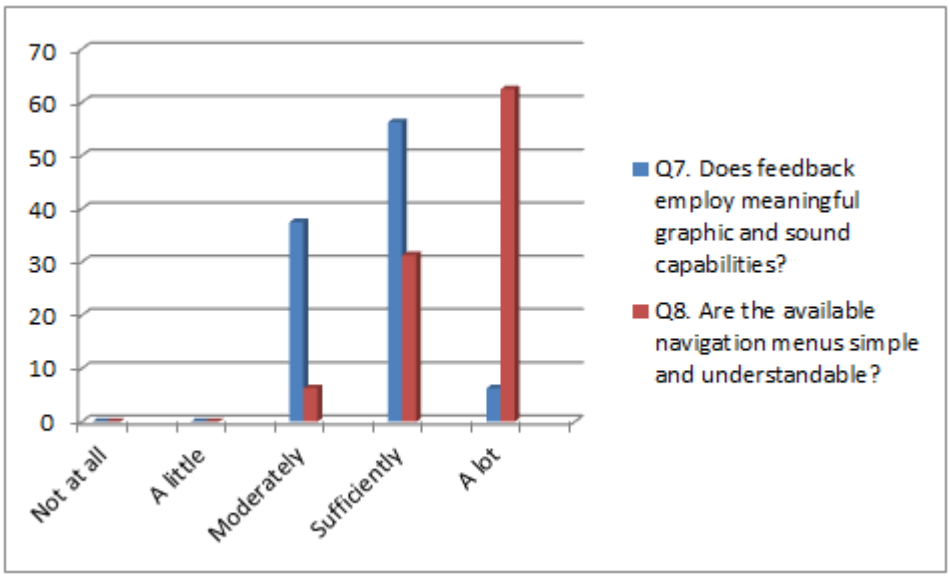


Figure 59 below presents the percentages of students' answers in the third main sector of the students' questionnaire "Functionality" and it consists of 5 questions.

- To ninth Question “Is the text of the navigation options (menus, buttons etc.) simple and understandable to you” one student (6,3 %) answers “Moderately”, four students (25,0 %) answer “Sufficiently”, while eleven of them (68,8 %) answer “A lot”.

As we understand, students regardless of their diagnosis find the text of the navigation options simple and understandable.

- To tenth Question “Are the instructions for using the application clear” nine students (56,3 %) answer “Sufficiently”, while seven of them (43,8 %) answer “A lot”.

Again students find the use instructions of the app clear, with no difficulty in understanding.

- To eleventh Question “Does the application provide the appropriate comments” three students (18,8 %) answer “moderately”, nine students (56,3 %) answer “Sufficiently”, while four of them (25,0 %) answer “A lot”.

Students also agree to a great extent that the application provides the appropriate comments.

- To twelfth Question “Are the comments provided at the right time” two students (12,5 %) answer “moderately”, eleven students (68,8 %) answer “Sufficiently”, while three of them (18,8 %) answer “A lot”.

As for the time of the comments providing students’ majority state that the time is right, with a minority of them to agree to a minor degree.

- To thirteenth Question “Is the application friendly to you” two students (12,5 %) answer “Sufficiently”, while fourteen of them (87,5 %) answer “A lot”.

Undoubtedly the application is friendly to students considering their answers to the relevant question.

Figure 59

Distribution of students' answers in the sector "Functionality"

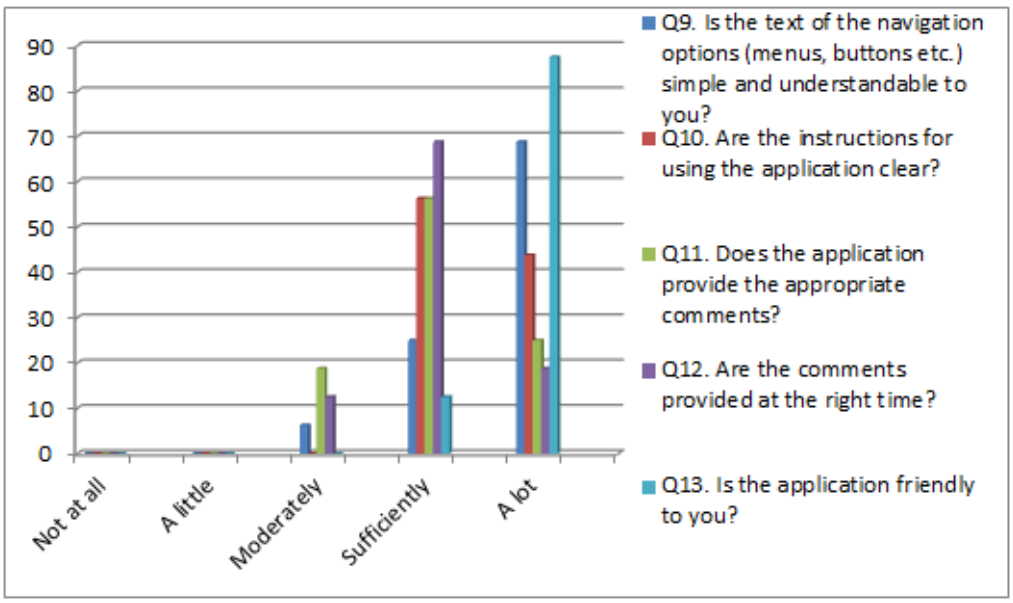


Figure 60 below displays the answers of the fourth main sector of the students' questionnaire "Technical Characteristics" and it consists of three questions. The questions were answered as described below:

- Question 14 "Does the application use simple and natural dialogs" is answered by two students (12,5 %) "Moderately", by four students (25,0 %) "Sufficiently" and by ten students (62,5 %) "A lot".

Students agree that the application uses simple and natural dialogs.

- Question 15 "Does the application supports shutdown at any time you want" is answered by two students (12,5 %) "Moderately", by thirteen students (81,3 %) "Sufficiently" and by one student (6,3 %) "A lot".

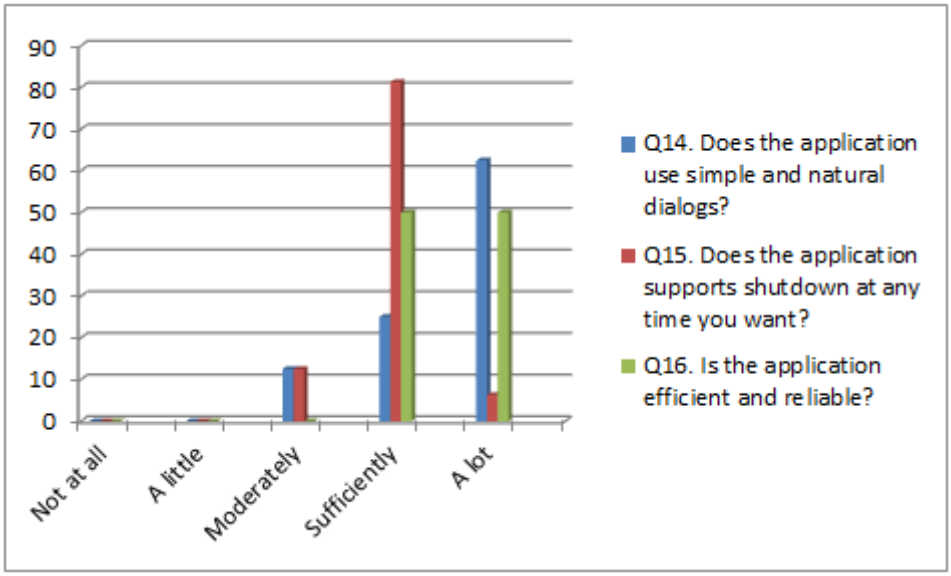
The application supports shutdown at any time a user wants, according to students' answers.

- Question 16 "Is the application efficient and reliable" is answered by eight students (50,0 %) "Sufficiently" and by eight other students (50,0 %) "A lot".

Students positively agree on the whole that the application is efficient and reliable.

Figure 60

Distribution of students' answers in the sector "Technical Characteristics"



Students' open ended questions:

- To first question of sector "Feelings": "How do you feel when you use the app?", 11 students (68,8 %) answered that they feel happy and excited, while 5 students (39,2 %), answered that they like the app and feel anxious to use it. This means that students enjoy using the app and feel positively about it.
- To second question of sector "Feelings: "Did you like the app and find it helpful?" All students (100 %) answered that they like the app and that it is very helpful.
- To third question of sector "Suggestions": "What possible improvements would you suggest to strengthen the app's effectiveness?", four students (25,0 %) suggested that the app should include more graphics such as animations to be more interesting and motivate them. Eight students (50,0 %)wanted a larger variety of music and songs of their preference, while other four students (25,0 %) noted that they should be given more time to answer each question. Ten students (62,5 %) suggested that the app included some difficult questions. Eleven of them (68,8 %) made a comment that the whole project was very interesting and they enjoy it a lot.

- To fourth question of sector “Suggestions”: “Would you continue using the app after the trial period?”, all of the students (100 %) answered that the wanted to use it for a longer period.

5.2.2.2. Inferential statistics

To test the relationship between some characteristics of students we used again, as we did concerning the teachers’ questionnaire, the non-parametric Tests Mann-Witnney U test and Kruskal-Wallis one-way ANOVA test.

The implementation of Mann Whitney U test showed that did not emerge any statistically significant differences between the responses of the students of the two different groups male and female of the independent variable Gender. This means that the answers of students did not differ based on their gender.

Then we executed the Kruskal-Wallis test to find out whether the distribution of the answers of the responders is the same across the different categories of the grouping variables, such as Learning Difficulties.

The results of the test in the Grouping Variable Learning Difficulties indicate that the distribution of the students’ answers is not affected by the different types of their Learning Difficulties. There were not observed any statistically significant differences between the responses to the questions of the students diagnosed with different Learning Difficulties. Thus, the answers of students did not differ based on the type of their learning difficulty.

5.2.3. Special education teachers’ Interviews analysis

To analyze the interviews we conducted with the three special education teachers we categorized their answers, which are presented in their real form in the Appendix D2, and then we used descriptive statistics, as presented below. The first main sector of the interviews’ questions “**Educational content**” includes 11 questions.

To question 1: “Does the system provides guidance in learning?” three teachers believe that the app provides guidance in learning. Characteristically we quote a teachers’ answer:

> “I think that the app offers a great a teaching aid to me and my students also think that the app offers them a great assistance in learning math”.

To question 2: “Does the system attract attention and offers information about the objectives of the course?” all the teachers think that the system attracts students’ attention. An indicative response is presented below:

> “I think that the app attracts students’ attention and helps them to stay focused, which is rather difficult for them, if we consider their condition”.

To question 3: “Does the system improve learning interest?” all the teachers answer positively that their students’ learning interest has been improved. One characteristic answer is:

> “My students are enthusiastic about using the app. Their learning interest has significantly been improved”.

To question 4: “Does the system motivate the student and emphasize on internal motivation when possible?” the three teachers agree again that the app motivates the students internally and externally. Two indicative responses are quoted below:

> Teacher one: “I think that students are internally motivated to use the app and answer to the questions. Graphics help a lot in this area”.

> Teacher two: “The app gave my students the motivation internal and external to practice in their lessons”.

To question 5: “Does it offer a good presentation of mathematics material?” the three teachers state that the presentation of maths offered by the app is very well organized. One characteristic answer is:

> “The presentation of the course’s material is very well-organized in small parts of theory followed by the relevant multiple choice questions”.

To question 6: “Feedback enhances content (built-in rewards are used)?” all the teachers state that the provided feedback enriches the course content and the system employs built-in rewards. We quote one of their responses:

> “Verbal and audible rewards are used after every right answer. After a wrong answer the system verbally encourages students to continue. Thus, the course content is enriched and reinforced”.

To question 7: “Is the course content sufficient?” all the teachers agree again that the course content is sufficient according to the curriculum. An indicative response is presented below:

> “Yes, there are all the necessary chapters for both the subjects: Algebra and Geometry that are included in the class’s curriculum. There is also a sufficient amount of questions regarding each chapter”.

To question 8: “Does the course content correspond to the curriculum?” all the three teachers unequivocally state that the course content corresponds directly to the curriculum. A response indicative of teachers’ agreement is quoted below:

> “Yes, because it includes all the chapters and exercises that are referred to it”.

To question 9: “Is the program accompanied by strategies for extending learning?” one teacher, states that the program is not accompanied by strategies for extending learning. On the other hand, the two other teachers agree that the program is accompanied by strategies for extending learning because it encourages students and extends their learning through repetition. Below we quote a response of the teachers who agreed and answered positively:

> “Yes, because students are enthusiastic about it and try and retry to solve the questions. They eventually learn through repetition”.

To question 10: “Can you evaluate the child based on his / her performance in the program exercises?” the three teachers agree that they can evaluate the students after the system has evaluated them. The below answer represents teachers’ agreement:

> "After the system evaluated them, I also can evaluate them for their progress in solving the program's exercises".

To question 11: "Could a child using the program increase his learning abilities in Maths?" all the teachers positively agree that the students could increase their learning abilities in Maths. One says that they need more time practicing with the app, while the other two say that the students have already made progress. An answer indicative of teachers' agreement is:

> "Yes. Although they haven't finished all the math curriculum's chapters during the app's trial period, they have made excellent progress. I think the progress is mainly due to motivation the app offers to them".

The second main sector of the interviews' questions **"Design"** includes 4 questions.

To question 12: "Is the system characterized by elegance and minimalism in the provided information to avoid user confusion?" the three teachers declare that the system is elegant and minimal in the provided information, so users are not confused. One of their responses is presented below:

> "Yes, it is elegant and minimal in the provided information, so students are not confused by too much unnecessary information".

To question 13: "Does feedback employ meaningful graphic and sound capabilities?" all the teachers state that feedback employs meaningful graphic and sound capabilities. One featured answer is listed below:

> "Yes, feedback employs meaningful graphic and sound capabilities, so students according to sound and graphics know if they are right or wrong doing the exercises".

To question 14: "Are the available navigation menus simple and understandable?" there is again an agreement between all the teachers that the available navigation menus are simple and understandable. One of their responses is presented below:

> "Students after the first navigation through the whole menu of the app were able to go through it without teachers help".

To question 15: "Does the application provide alternative navigation routes between its screens?" the three teachers also agree that the application provides alternative navigation routes between its screens. One featured answer is listed below:

> "Yes, every user can choose either Algebra or Geometry and can also choose between theory and exercises".

The third main sector of the interviews' questions **"Functionality"** includes 4 questions.

To question 16: "Is the text of the navigation options (menus, buttons etc.) simple and understandable?" it is clearly stated by all the teachers that the text of the navigation options is simple and understandable.

To question 17: "Are the instructions for using the application clear?" there is an absolute agreement of the teachers that the instructions for using the application are clear.

To question 18: "Does the application provide the appropriate comments?" the three teachers declare that the application provides the appropriate comments. One featured answer is listed below:

> "Yes, it does. It is designed to provide the appropriate comments".

To question 19: "Is the application child friendly?" all the teachers state that the application is very child friendly. One of their responses is presented below:

> "It is definitely child friendly, because children became very enthusiastic about it".

The fourth main sector of the interviews' questions is **"Technical Characteristics"** and includes 3 questions.

To question 20: “Is it possible to select specific functions?” there is an agreement of the three teachers, that it is possible for a user to select any function of the app. An indicative answer is the next one:

> “Yes, anyone can select any function following the order they want”.

To question 21: “Does the application use simple and natural dialogs?” the application uses simple and natural dialogs, according to teachers’ answers. One of their responses is presented below:

> “Yes, students can easily understand them”.

To question 22: “Is the application efficient and reliable?” all the teachers answer that the application is efficient and reliable. An indicative answer is the next one:

> “Yes, the application is efficient and reliable. It worked steadily without any problems.”

Special education teachers’ interviews included four **open-ended questions** as well as students’ questionnaires, which are both presented in table 21.

The first main sector of the interviews’ open-ended questions **“Feelings”** includes 2 questions.

To question 1: “How do the students feel when they use the app?” all the teachers answer that that students feel positively towards the use of the app. The responses are listed below:

> Teacher one: “They feel excited. They were really tired with traditional learning and teaching”.
>
> Teacher two: “They were enthusiastic. They asked me to extend the period of using it”.
>
> Teacher three: “They were curious at first. They eventually became eager, anxious and willing to use it”.

To question 2: “Did you like the app and find it helpful?” all the teachers state that found the app very helpful. An indicative answer is provided below:

> “Yes, it is very helpful for me. It provided me and my students with an alternative teaching and learning method”.

The second main sector of the interviews’ open-ended questions **“Suggestions”** includes 2 questions.

To question 3: “What possible improvements would you suggest to improve the app’s effectiveness?” we quote below their distinctive suggestions in random order:

> Teacher one “I should suggest that you must design better graphics in order to make the app more attractive to users – students. It would also be interesting if you installed the application to tablets, because their screen is larger and easier to use”.
>
> Teacher two: “You should add more lessons in the application, for example Language or Physics. I also suggest the distribution of the application through the Google Play Store and its distribution to schools”.
>
> Teacher three: “Perhaps you should adapt the content to the students’ special needs e.g. Dyslexia, Dysgraphia, ADHD, Dyscalculia, Generalized Learning Difficulties, Complex Cognitive and emotional Difficulties. I think that my diagnosed with ADHD students need simpler content and exercises. They also would like more and funnier graphics”.

To question 4: “Would you continue using the app in your classes after the trial period?” all the teachers positively state that they would use the app after the trial period. Their responses are quoted below:

> Teacher one: “I certainly would continue using the app in my classes after the trial period, because children’s’ behavior has been positively improved and also their math knowledge in certain chapters has been remarkably developed”.
> Teacher two: “I certainly would continue using the app in my classes after the trial period because it is a great help for me teaching to students with those learning

difficulties. Students have been improved, too in their behavior and level of knowledge".

Teacher three: "I certainly would continue using the app in my classes after the trial period. My students liked it and this is an excellent way for me to manage the class".

Table 22 below presents the answers of teachers and students to open-ended questions' and the areas in which there is an agreement between students' and teachers' answers.

In the question asking about students' feelings toward the app both teachers and students agree that students have positive feelings. What is more, both students of integration departments and/or parallel support and teachers liked the app and found it helpful.

In the question asking about suggestions for app's improvement or further use both students and teachers ask for more graphics and for simpler content. Furthermore, both students and teachers want to use the app for a longer period of time.

Teachers found the app very helpful in managing the class and in avoiding students' distraction. App's use is considered as an alternative teaching and learning method. Teachers noticed an improvement in students' behavior and level of knowledge.

Table 23

Open-ended questions' answers of teachers and students and agreement areas

Open-ended Questions	Integration Department Students' answers	Special Education Teachers' answers	Areas of Agreement
FEELINGS **1. Students' question: How do you feel when you use the app?** **1. Teachers' question: How do the students feel when they use the app?**	5 students (39,2 %) like the app and feel anxious to use it. 11 students (68,8 %) feel happy and excited.	All the teachers (100 %) state that students feel positively towards the use of the app: "excited, enthusiastic, eager, anxious and willing to use it".	Teachers and students agree that students have positive feelings.

2. Did you like the app and find it helpful?	All students (100 %) like the app and find it very helpful.	All the teachers (100 %) found the app very helpful. Help for managing the class (33,3 %) and avoiding students' distraction (33,3 %). An alternative teaching and learning method (33,3 %).	Both students and teachers liked the app and found it helpful.
SUGGESTIONS **3. What possible improvements would you suggest to strengthen the app's effectiveness?**	4 students (25,0 %) ask for more graphics such as animations to be more interesting and motivating. 8 students (50,0 %) ask for a variety of music and songs. 4 students (25,0 %) ask for more time to answer each question. 4 students (25,0 %) ask not to include difficult questions. 7 students (68,8 %) find the whole project very interesting and enjoyable.	Employment of funnier & impressive graphics (33,3 %). App's installation to tablets (33,3 %). App's extension with the addition of more lessons (33,3 %). Distribution of the application through the Google Play Store Distribution to schools (33,3 %). Adaptation of the content to the students' special needs (33,3 %). Simpler content and exercises (33,3 %).	Both students and teachers ask for more graphics and for simpler content.
4. <u>Students' question:</u> Would you continue using the app after the trial period? **4. <u>Teachers' question:</u> Would you continue using the app in your classes after the trial period?**	Students (100 %) wanted to use the app for a longer period than it was planned.	Teachers would use the app after the trial period (100 %). Help in managing the class (100 %). Improvement of students' behavior and level of knowledge (66,6 %).	Both students and teachers want to use the app for a longer period.

6. DISCUSSION & CONCLUSIONS

The present study concludes having its final chapter divided into five sub-sections:

- Discussion.
- Conclusions.
- Research limitations.
- Future research goals.

The subsections of discussion, conclusions and conclusions in relation to research objectives cover a summary of the answers to the research questions and the inferences resulting from the data analysis. In the subsections of research limitations and future goals, on the one hand, the obstacles encountered during the procedures of this work and on the other hand, the proposals for further studies are presented.

6.1. Discussion

The analysis of the responses of the questionnaires of the first phase of our research lead us to the below thoughts. From the second part of the questionnaire which concerns ICT Knowledge of the Special Education teachers that compose the sample of the research, it is obvious that the knowledge of most of the teachers about ICTs is sufficient, a necessary prerequisite for accepting M-Learning in education.

From the third part that concerns the grade of the Use and utilization of ICTs in class it is being clear that all of the respondents use ICTs in class to some degree. Specifically, about 56 % use ICTs Moderately, while 27 % Sufficiently. It is worth noting here that 46 % use ICTs as an Educational software for Motivation. Sufficiently and about 75 % of teachers use Educational software for Maths/Language etc. more than Moderately. Therefore, it becomes clear that all teachers are familiar with the use of ICTs.

The analysis of the fourth part of the questionnaire which deals with the Attitudes-perceptions of teachers related to ICTs, proves the importance of ICTs in the learning process and the indisputable contribution of ICTs to education of pupils with SEN. It is worth mentioned here that 94 % of the educators agree Sufficiently or A lot with the Statement “Students with special educational needs could benefit from the use of ICTs in class” and that more than 87 % of them stated that they agree Sufficiently or A lot with the Statement “The use of ICTs is a funny and attractive way of learning that speeds up the learning process”. What is more, most teachers agree that the use of ICTs facilitates students’ self-studying at home, while it is an appropriate tool for teachers to manage the class. This kind of findings of the research are similar to the findings of Roussos (2007, p. 588) as a relatively positive attitude toward using computers, declaring that “the picture emerging from this finding seems encouraging, since it could well reflect a reduction of the degree of computer stereotypes within younger people who have been sufficiently exposed to computers”.

The significant majority of teachers think that M-Learning could help students with learning disabilities achieve better educational performance. They also believe that students with learning disabilities could benefit from the creation of a new educational Android application and that this new mobile app could also facilitate students' self-studying at home. On their behalf teachers declare that they could very easily accept and use a new mobile educational app in the learning process. The findings of the research are similar to the findings of Yusri et al. (2015) who declare that teachers in Indonesia had positive perception of M-Learning and were looking forward to be engaged in M-Learning.

A sufficient number of teachers believe that students could very easily accept and use a new mobile educational app in the learning process. The findings of the research are similar to the findings of Kim et al. (2013) who argue that students have positive views toward the use of mobile devices.

We conducted the first phase of our research in order to find the levels of acceptance and readiness of special education teachers to use a new android app in their lessons, following the advice of İlçi (2014) who states M-Learning readiness and acceptance of students and teachers are emerging as important areas of research, as referred in section 2.3.2 and described by Table 4, that indicates the importance of M-Learning readiness and acceptance of teachers and their positive attitudes towards mobile devices. Such positive attitudes of teachers towards the use of mobile phones for educational purposes are stated in the research of: Mahat et al. (2012), Ekanayake and Wishart (2011), Chen (2017), Seralidou and Douligeris (2015), Kousloglou and Syrpi (2018), Nikolopoulou and Kousloglou (2020), Nikolopoulou et al. (2021), and Nikolopoulou (2021) who state that most of school teachers accept the use of mobile phones for educational purposes.

We can generally speaking state that mathematicians and informatics' teachers have a positive attitude towards the application "Love2LearnMaths". Similar attitudes towards mobile devices and apps in general had been announced by the Special Education teachers of the first phase of our research, as they are described in section 5.1. The same positive point of view towards the application

“Love2LearnMaths” can be also observed in the answers of the interviewees, who are the special education mathematicians.

Students of integration departments on the other hand, appear positively enthusiastic about the use of the application “Love2LearnMaths”. Such positive attitude of students towards mobile technologies is also stated by Flewitt et al. (2015) who stated that children easily become able to use mobile technologies, by Seralidou and Douligeris (2015) stating that most of the students rapidly accepted the use of smart phones, by Nikolopoulou & Kousloglou (2020) who state that high school students are inspired when mobile technology is used in schools and express positive emotions such as joy and excitement and by Nikolopoulou (2021) who states that secondary education students express positive views about the advantages of mobile education.

Many similar to our research’s positive results referring to the course of math have been announced by Audi and Gouia-Zarrad (2013), Drigas and Pappas (2015), Neumann and Neumann (2015), Kyriakides et al. (2016), Al-Mashaqbeh (2016) and Chen et al. (2017) as referred in section 2.3.5.

Considering the use of apps in teaching and learning of math there are also similar to our survey’s positive results noted by Carr (2012), Riconscente (2013), Zanchi et al. (2013), Drigas and Pappas (2015), Al-Mashaqbeh (2016), Piat et al. (2016), Pitchford et al. (2018), and Outhwaite et al. (2019) indicating the positive effect of math apps in education as referred in section 2.3.5.1.

We can see that special education teachers and students of integration departments find the educational content of “Love2LearnMaths”, excellent because it offers many positive capabilities, such as: attracts students’ attention and motivates them, makes students’ evaluation easier, increases students’ learning abilities in Math and many others.

Table 7 in section 2.3.4 briefly presents the results of the relevant research that also indicate that M-Learning in Special Education has a positive effect. Such similar to our research’s results are stated:

- By Kagohara et al. (2013) stating that students with Asperger's syndrome and ADHD using IPad and IPod presented 100 % development in using the word processor

- By Campigotto et al. (2013) stating that students with Dysgraphia-Dysorthographia using Tablets and Mobiles increased of their motivation and interest in learning, felt important and gained confidence

- By Skiada et al. (2014) stating that students with Dyslexia with Mobile phones and Tablets made progress, in reading and recognition of words

- By Rivera et al. (2016) stating that students with Mental Disabilities with Mobile devices made impressive progress in language skills

- By Kamaruzaman, et al. (2017) stating that students with Autism, using Smartphones PDAs and tablets acquired support for learning basic numbers, were attracted in practicing and doing exercises, attained their learning interest and achieved self-independence

- By Pitchford et al. (2018) stating that students with Special Educational Needs and Disabilities with Interactive apps on Touch-screen tablets increased their learning standards and Learning of Basic Mathematics

- By Novack et al. (2018) students with Autism Spectrum Disorder with mobile applications acquired receptive language skills and demonstrated relatively high rates of learning.

The design of “Love2LearnMaths” is faultless, as it is elegant and minimal, includes feedback with graphic and sound capabilities, has simple and understandable navigation menus and offers freedom in the choice of the navigation routes.

Functionality of “Love2LearnMaths” is also exemplary, because of its simple and understandable text and instructions, its provision for the appropriate comments at the right time and, most of all, because it is very child friendly.

Technical Characteristics of the application “Love2LearnMaths” are impressively good, because the app is characterized by all stakeholders easy to use, efficient and reliable.

Referring to the answers of both special education teachers and students to the open-ended questions, there is a mutual suggestion asking for more and impressive graphics. In our opinion we haven’t employed many graphics, to avoid students’ distraction from the content by being more attracted by graphics.

The other one mutual suggestion of all stakeholders asking for adding simpler and easier content and exercises is under our consideration for designing of the application’s a new edition which is included in our future plans. As a matter of fact we plan to modify the app’s content and exercises according to the above suggestion, because our main interest is to help more students with more severe difficulties in mathematics.

With consideration to teachers’ suggestion to install the application to tablets, we may do it as one of our future plans. We in the first place installed the app to mobile phones, because the vast majority of students own mobile phones. As for the teachers’ suggestion to employ many impressive graphics in app’s design, we haven’t employed such graphics to avoid students’ being more attracted by graphics rather than by the educational content of the app. However, we could possibly include some new graphics in our future work, when we are ready to present a new, modified edition of the app “Love2LearnMaths”.

With respect to the teachers’ suggestions to add more lessons to the application and distribute it to the Google Play Store and to schools, we are intended to both modify the app by adding more lessons to help integration departments’ students and distribute it to the Google Play Store and to schools.

Finally, according to the holistic results of the evaluation, the opinion of the teachers and students who participated in the evaluation process regarding accuracy, usefulness, usability, functionality, and effectiveness of the application appears to be positively excellent. Therefore, the design and development of an

application, which includes the above features, can provide the right tool for teachers and students by offering new flexible ways of teaching and learning, which provide immediate and great convenience to all stakeholders.

The results of the evaluation of the application, among others, showed an easy to use, stable and quite effective application. More specifically, the application uses a simple and natural dialogue with clear instructions and easy to understand, simple and complete navigation and menu options. The navigation options appear in a similar way between different screens and use interesting appearance and graphics. From a technical point of view, the application is stable, it provides alternatives navigation paths and supports shutdown at any time and also has satisfactory documentation. However, graphics and notifications should to improve, as stakeholders point out. Finally, the app is efficient in options and functions, easy to use and also inspiring enthusiasm in the user during its use.

As a general result we can say that the teachers that participated in the evaluation process would like to use the app after the trial period, because it helped them in managing the class and most importantly, they had noticed an improvement of students' behavior and level of knowledge. Teachers believe that learning through the use of the application is more interesting and they also like the idea of using it in order to enhance the interest and abilities of their students. Thus, we think that the objectives of our study as described by table 10 in section 4.2 were fulfilled.

6.2. Conclusions

The first phase of the study aimed at finding out teachers' readiness to accept and use M-Learning in class. The part of the questionnaire which concerns ICT Knowledge was answered positively meaning that the knowledge of most of the teachers in ICTs is sufficient, a necessary prerequisite for accepting M-Learning in education.

It also became clear that all teachers are familiar with the use of ICTs and recognize the indisputable contribution of ICTs to education of pupils with SEN. Teachers think that M-Learning could help students with learning disabilities achieve better educational performance. Students could benefit from the use of a new educational Android application and in the case of self-studying at home using this mobile app. Moreover, teachers could very easily accept and use a new mobile educational app in the learning process.

All the above findings confirmed that special education teachers were ready to accept and use ICTs to education of pupils with SEN in the form of a mobile application. Therefore, the application was designed to be implemented in to integration departments.

Conserning the app's evaluation we proceeded into an overall holistic analysis of the answers to questionnaires and interviews, as both the questioned and the interviewed were asked to some extent to answer to similar questions, as mentioned before. The analysis of the responses of both students and teachers to the questionnaires and to the interviews of special education teachers in the third phase of our research lead us to the below conclusions:

From the second part of the questionnaire or questions of interviews, which concerns the Educational content of the app all the 7 teachers agree that the app provides either sufficiently or a lot guidance in learning. This statement is reinforced by students' and special education teachers' answers also who agree that the system provides guidance in learning.

Also there is strong agreement of teachers that the system attracts students' attention and gives information about the course's objectives, while students believe that the graphics strengthen their attention.

The system improves learning interest according to general education teachers, while special education teachers agree that their students' learning interest has been improved because the app employs interesting sounds and graphics and students were positively interested in learning maths, enthusiastic about using the app and their learning interest has significantly been improved. (There was no such question for students to answer).

All the teachers either questioned or interviewed agree again that the app motivates the students internally and externally. (There was no such question for students to answer).

Teachers state that the provided feedback enriches the course content and the system employs built-in rewards and students agree that feedback enhances content.

All teachers agree again that the course content is sufficient according to school curriculum. (There was no such question for students to answer).

The teachers unequivocally state that the course content corresponds directly to the curriculum, while students agree that the elements of the program match their prior knowledge.

The majority of teachers believe that the program is accompanied by strategies for extending learning, while only one of the interviewed teachers (33,33 %) states that the program is not accompanied by strategies for extending learning. (There was no such question for students to answer).

Teachers state that they can evaluate the students based on their performance in the programs' exercises and the interviewed declare that students have already made a remarkable progress in their performance at maths. (There was no such question for students to answer).

Again all the teachers positively agree that the students could increase their learning abilities in Maths. One says that they need more time practicing with the app, while the other two say that the students have already made progress.

To sum up, in the sector Educational content the app:

- provides guidance in learning,
- attracts students' attention and gives information about the objectives of the course,
- improves learning interest,
- motivates the students internally and externally,
- offers a good presentation of mathematics' course,
- provides feedback that enriches the course content and employs built-in rewards,
- provides sufficient course content, corresponding to the curriculum,
- provides elements that match students' prior knowledge,
- is moderately accompanied by strategies for extending learning,
- makes students' evaluation easier and
- increases students' learning abilities in Math.

In the sector Design teachers declare that the system is elegant and minimal in the provided information, so users are not confused.

Teachers and students agree that feedback employs meaningful graphic and sound capabilities.

The available navigation menus are simple and understandable according to the answers of students and teachers.

Teachers agree that the application provides alternative navigation routes between its screens and there is no mandatory choice in the sequence of exercises or theory and can also choose between theory and exercises.

In brief the application in the sector Design:

- is elegant and minimal in the provided information to avoid users' confusion,
- includes feedback that employs meaningful graphic and sound capabilities,
- provides navigation menus that are simple and understandable and
- provides alternative navigation routes on its screens for someone to follow.

In the sector Functionality teachers and students, regardless of their diagnosis, find the text of the navigation options simple and understandable.

Teachers and students find the use instructions of the app clear, with no difficulty in understanding.

The application provides the appropriate comments according to teachers' and students' answers.

As for the time at which the comments are provided students state that the comments are provided at the right time.

Teachers and students find the application is very child friendly. In few words the application in the sector Functionality:

- includes simple and understandable text of the navigation options,
- contains use instructions clear, with no difficulty in understanding,
- provides the appropriate comments,
- provides the comments at the right time and

- is very child friendly.

In the sector of Technical Characteristics teachers agree that it is possible for a user to select any function of the app.

Teachers and students agree that the application uses simple and natural dialogs.

Teachers and students positively agree on the whole that the application is efficient and reliable.

The application supports shutdown at any time a user wants, according to students' answers.

To summarize in the sector of Technical Characteristics, the app:

- offers the user the opportunity user to select any of its functions,
- uses simple and natural dialogs,
- is efficient and reliable and
- supports shutdown at any time a user wants.

Referring to the open questions which were addressed to the interviewed special education teachers and the students who had tried the app in their classes, the answers were presented by table 21 in section 5.2.3.

As we can observe in the answers to the open questions there is absolute agreement in both teachers' and students' views at the points presented below:

- Both students and teachers who tried the app agree that the students have positive feelings about it.
- Both students and teachers liked the app and found it helpful.
- Both students and teachers asked for more graphics.
- They both ask for simpler content and easier exercises.

We are going to explain our conclusions in relation to the research objectives, so we are going to try to answer to all our research questions. The research problem that this PhD program is expected to investigate as referred in section 4.2 is:

Can we improve the learning in mathematics of students with learning difficulties by using a mobile application?

For the purposes of the study, it was critical that we should clarify the readiness and the attitudes of special education teachers in the area of our research. After that we designed and implemented our app in school classes and finally we evaluated it.

All the above mentioned steps highlight the following research questions:

1. Are special education teachers familiar with the use of ICTs? The questionnaire's analysis showed that special education teachers were familiar with the use of ICTs at a great extent.

2. What are their attitudes and perceptions about the existing applications and about a new android application for mobile devices? From teachers' answers became obvious that teachers have positive attitudes and perceptions about both the the existing applications and a new android application for mobile devices.

3. Does the app include the appropriate educational content in order to help students in learning? It was proven by both questionnaires' and interviews' answers that the app included the appropriate educational content.

4. Is the app well designed, characterized by functionality and usability? The app was according to the answers very well designed and characterized by functionality and usability.

The project's main focus is to evaluate the functionality of a new educational Android application that could help students with learning difficulties who study in the Integration departments of two Greek schools in the field of mathematics.

Table 10 in section 4.2., Presents the General and Specific Research objectives of our study as referred below:

1st General Research Objective: To analyze the readiness, attitudes and perceptions of teachers. This objective includes two Specific Research Objectives as analyzed below:

1st Specific Research Objective: To analyze the relation between teachers' digital competence and the use of ICTs in school.

According to section 5.1., "Teachers' readiness investigation analysis", the knowledge of most of the teachers about ICTs is sufficient, which is necessary for accepting M-Learning in education because all respondents use ICTs in class to some degree either as an Educational software for Motivation, or as an Educational software for Maths or Language. Additionally, few of them use it for students' evaluation. Consequently, all the respondents are familiar with the use of ICTs and thus, are digitally competent. We assume that teachers' digital competence affects the use of ICTs in school. Competent teachers use ICTs in class. Thus, the study's first specific objective has been fulfilled and teachers are ready to accept and use in class our application. Moreover, the first research question has been answered.

2nd Specific Research Objective: To analyze the relation between attitudes-perceptions of teachers on the existing ICTs and their attitudes-perceptions about a new android application for mobile phones.

Referring to teachers' perceptions of the existing ICTs teachers believe that students with special educational needs could benefit from the use of ICTs in class. On teachers' behalf, existing ICTs is an appropriate tool for managing the class. Referring to students, the use of ICTs helps students learn easier, encourages them in participating actively in class and facilitates their self-studying at home. This is another significant indicator that proves the importance of existing ICTs in the learning process and teachers' indisputable positive attitudes involving the contribution of existing ICTs to education of pupils with SEN.

With respect to attitudes-perceptions of teachers toward a new android application for mobile phones and tablets, the significant majority of the responders agreed that students with learning disabilities could benefit from the creation of a new educational Android application, because a new mobile app could facilitate students' self-studying at home and improve students' educational performance. On teachers' behalf they could easily accept and use a new mobile educational app in the learning process in their classes. Moreover, the respondents positively think that their students could very easily accept and use a new mobile educational app in the learning process, as well.

All the above findings prove teachers' positive attitudes and perceptions toward both the existing ICTs and a new android application for mobile phones and tablets that is going to be designed and used in their classes. Subsequently, the study's second specific objective has been fulfilled, as teachers think positively either about the existing ICTs, or about a new android application that is going to be created. Additionally, the second research question has been answered.

2nd General Research Objective: To evaluate our application's educational effects after having been implemented in the students with educational needs. This objective includes four Specific Research Objectives as analyzed below:

1st Specific Research Objective: To evaluate whether the app has appropriate and complete educational content.

As described in sections 5.2.1., 5.2.2. & 5.2.3., special education teachers and students of integration departments find the educational content of application "Love2LearnMaths", excellent because it offers many positive capabilities, attracts students' attention and motivates them, makes students' evaluation easier, increases students' learning abilities in Math and many others. Thus, the 3rd specific research objective has been fulfilled and the third research question has been answered.

4th Specific Research Objective: To evaluate the design of the app.

From the answers of the respondents in sections 5.2.1., 5.2.2. & 5.2.3., we assume that the design of “Love2LearnMaths” is faultless, as it is elegant and minimal, includes feedback with graphic and sound capabilities, has simple and understandable navigation menus and offers freedom in the choice of the navigation routes. Thus, the 4th specific research objective has been fulfilled.

5th Specific Research Objective: To evaluate the app’s functionality.

In sections 5.2.1., 5.2.2. & 5.2.3., the respondents state that the functionality of “Love2LearnMaths”, is exellent, because of its simple and understandable text and instructions, its provision for the appropriate comments at the right time and most of all, because it is very child friendly. The 5th research objective has been fulfilled

6th Specific Research Objective: To evaluate the app’s performance and reliability.

In sections 5.2.1., 5.2.2. & 5.2.3., the respondents state that Technical Characteristics of the application “Love2LearnMaths” are impressively good, because the app is characterized by all stakeholders easy to use, efficient and reliable. The app’s performance and reliability has been evaluated as required by 6th Specific Research Objective.

Teachers believe that learning through the use of the application is more interesting and they also like the idea of using it in order to enhance the interest and abilities of their students, as they had noticed an improvement of students’ behavior and level of knowledge. Thus, we think that the objectives of our study as described by table 10 in section 4.2 were fulfilled and the research questions have been answered.

6.3. Research limitations

As in every research there were presented some limitations to the carrying out of our study.

First and most important there were barriers to the use of technology in secondary education gymnasiums in which our research was conducted. It is a common phenomenon in Greek schools that limited access to technological tools and resources are well known and happen frequently. Such limited access is internet access, which makes the operation of our application impossible, because mobile phones that include it in any case need internet access for students and teachers in order to be able of using the app in their classes.

Another serious obstacle was the pandemic Covid-19 and the many problems it caused to schools' regular operation. Due to Covid-19 restrictions the app's trial period was notably shortened to two months instead of six as initially scheduled. We could say that the results may have been at some extent different if the trial period was longer. This is a problem in which finding a solution is required.

Another difficulty that we had to deal with due to Covid-19 is that our access to school was limited; therefore, there wasn't enough time to give the appropriate instructions about the application's operation and functions to both teachers and students.

Covid-19 is also charged with the fact that we were prohibited from meeting the students, thus students' answers to the study's questionnaire were given with the supervision and the necessary instructions of their teachers, after the short trial period. Another limitation that prohibited us from meeting the students and instead of interviewing them, as planned, distributing their questionnaires via their teachers, is the strict Greek law about students' with learning difficulties sensitive personal data, to which we had limited access. Difficulty there was also presented in accessing the educators for the interviews. However, we overcame this difficulty by meeting the 3 teachers outside of the school environment.

Additionally, because of the small sample of both the educational population and students' population, the results of our research as encouraging as they may be, they cannot in the slightest be generalized. This could be a reason for further future research.

Another serious limitation of this study may be their different learning styles of students resulting from their different learning difficulties. As stated by Uğur et al. (2011) each person and student has their own method of identifying and processing the information they receive and difference in learning style. Considering this fact of personalized and adaptive learning, our approach with the application "Love2LearnMaths" may is not sufficient for all students' learning difficulties. This indication will be under our thorough consideration for our future plans to improve our application aiming at students' best interest.

6.4. Future Research Goals

The positive results that became apparent after the analysis of the questionnaires and interviews data that were given by all stakeholders, encouraged us to carry on with researching some other aspects that came about of this research. Thus, we came up with many plans that we intend to fulfill for the students' best interest.

For the near future, on the one hand we decided to attempt the re-evaluation of the app by more students and teachers. Through a more extensive statistical analysis on a larger sample of the educational population of many students and teachers we shall be able to extract better evaluative results that could possibly be generalized by representing the views of a larger part of the population.

On the other hand, upgrading some of the apps' features based on the feedback that we have received from teachers and students has already been planned. Some of the app's intended modifications are:

- App's extension with the addition of more lessons. In this case we think that students of integration or inclusion departments would greatly benefit.

- Design of an App's new edition that could be installation to tablets, so as for readers or students to be able to enjoy a larger screen and text, if they prefer so.

- Employment of funnier and more impressive graphics and music. This modification wasn't included in our initial plans. It would be interesting to be implemented though, so as to be verified if students' distraction or attention is being affected at some extent by graphics, as we expect. Of course, this would be determined by a new research that we are going to implement.

- Change the app's settings, so as to allow students more time to answer each question. This modification is simple and can be easily accomplished by suitably adjusting the time in the app's settings.

- Creation of another new edition that will include a more synoptic outline of the theory content and simple or easy questions or exercises. In this way we hope that there will be an adaptation of the content to a wider student population with more severe learning difficulties.

- Distribution of the application through the Google Play Store and to Greek schools, as well.

At last we consider of creating a new series of mobile applications that can be used by certain categories of learning difficulties. We intend to specialize the content of the app, so as each specialized content to meet their corresponding educational needs of students. This is the ultimate goal that we are hoping to accomplish for the best benefit of a wider SEN community.

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APPENDICES

APPENDIX A1. Questionnaire about teachers' digital competence

My name is Retzepi Nikoleta and I am a PhD student in the Department of Educational Technology of the University of Murcia, Spain. Am I conducting a research entitled "A Mobile Application for Students with Learning Difficulties: Design and Evaluation".

To design the software in the first phase of my research I will need the answers that will result from your experience and your views from your Service in the field of Special Education as Special Education and Parallel Support teachers in the specialized educational program for the integration of children with disabilities and special educational needs.

The questionnaire is anonymous and any information of your responses will be fully confidential and will be used exclusively for the needs of the implementation of my research, which aims at a further improvement on the educational needs of the students I have mentioned before. The answers to the questions are extremely important for the handling of my investigation and I would therefore, be extremely happy if you answered all questions effortlessly, honestly and spontaneously.

Thank you in advance for your valuable contribution. I am available for any clarifications or questions you might have.

Nikoleta Retzepi
nikolretz@hotmail.com

Please fill in the "X" symbol or underline the answer that represents your opinion.

A. General information

- GENDER: ❒ Man ❒ Woman
- AGE: ❒ 22-30 Year's old ❒ 31-40 Years ❒ 41-50 Years ❒ Above 51
- ACADEMIC LEVEL: (fill in the highest level)
  - ❒ Graduate of Pedagogical Academy
  - ❒ Graduate of Technological Education Institute
  - ❒ Graduate of University
  - ❒ You have a Master's Degree
  - ❒ You are a PhD Holder
- Years of total experience as a teacher
  - ❒ Not at all (1st year)
  - ❒ A little (2-5 years)
  - ❒ Moderately (6-10 years)
  - ❒ Sufficiently (11-15 years)
  - ❒ A lot (more than 15 years)

B. ICT knowledge (Questions 1-3)

1. At what level would you classify your knowledge of ICTs?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

2. Are you capable of adapting to the use of a new ICT's software?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

3. Do you consider that you are good at using electronic devices such as Tablets and Mobiles?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

C. Use and utilization of Information and Communication Technologies (ICTs) in class (Questions 4-7)

4. Do you use ICTs in class?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

5. Do you use Software to motivate students' interest in class, such as: videos, presentations etc.?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

6. Do you use ICTs in class, such as: Educational Software for the teaching of subjects (e.g. Language, Mathematics)?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

7. Do you use Software for the evaluation of students' knowledge in class?
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

D. Attitudes-perceptions of teachers related to ICTs and Educational practices

D.1. Attitudes-perceptions of teachers on the existing ICTs (Questions-Statements 8-14)

8. Students with special educational needs could benefit from the use of ICTs in class.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

9. ICTs is an appropriate tool to the teacher to manage the class.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

10. The use of ICTs is a funny and attractive way of learning that speeds up the learning process.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

11. The use of ICTs in courses helps students with different learning styles and difficulties learn easier and better.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

12. The use of ICTs motivates students to participate more actively in the learning process and cooperate with each other.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

13. The use of ICTs facilitates students' self-studying at home.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

14. The use of ICTs in the courses increases the authority of the teacher.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

D.2. Attitudes-perceptions of teachers about a new android application for mobile phones and tablets (Questions-Statements 15-19)

15. M-Learning could help students with learning disabilities achieve better educational performance.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

16. Students with learning disabilities could benefit from the creation of a new educational Android application.
❒ Not at all

❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

17. A new mobile app could facilitate students' self-studying at home.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

18. Teachers could easily accept and use a new mobile educational app in the learning process.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

19. Students could very easily accept and use a new mobile educational app in the learning process.
❒ Not at all
❒ A little
❒ Moderately
❒ Sufficiently
❒ A lot

Thank you very much for your response.

APPENDIX A2. Statistical analysis of the Questionnaire about teachers' digital competence

Table1. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Knowledge of ICTs	67,35	65,638	,608	,872	,895
Ability of adapting new Software	67,06	66,273	,578	,789	,896
Knowledge of electronic devises	67,21	65,658	,606	,867	,895
Use of ICTs in class	67,77	66,691	,516	,678	,898
Use of Educational software for Motivation	67,60	67,606	,401	,716	,901
Use of Educational software for Maths/Language etc.	68,04	66,339	,492	,680	,899
Use of ICTs for Evaluation	68,58	62,163	,590	,764	,897
Can ICTs help pupils with SEN	66,71	68,509	,466	,611	,899
ICTs are an appropriate tool to manage the class	67,27	65,308	,667	,732	,894
ICTs are attractive and speed up the learning process	66,88	66,537	,627	,626	,895
ICTs help students learn easier	67,13	66,197	,671	,745	,894
ICTs encourage more active participation	67,13	66,707	,585	,683	,896
ICTs facilitate students' self-studying at home	67,35	66,063	,598	,830	,896
ICTs increase the authority of the teacher	67,77	63,500	,559	,676	,898
M-Learning help students with SEN achieve better scores	67,06	67,039	,566	,833	,897
Students with SEN could benefit from a new Android app	66,73	67,180	,542	,700	,897
A new mobile app could facilitate students' self-studying at home	67,35	65,425	,656	,887	,894
Teachers could accept a new mobile educational app	67,40	68,797	,348	,385	,902
Students could accept a new mobile educational app	66,73	68,670	,378	,522	,901

Table 2. Mean and Standard Deviation

	N	Mean	Std. Deviation	Minimum	Maximum
Knowledge of ICTs	48	3,71	,743	2	5
Ability of adapting new Software	48	4,00	,715	2	5
Knowledge of electronic devises	48	3,85	,743	2	5
Use of ICTs in class	48	3,29	,743	2	5
Use of Educational software for Motivation	48	3,46	,798	2	5
Use of Educational software for Maths/Language etc.	48	3,02	,812	1	5
Use of ICTs for Evaluation	48	2,48	1,091	1	5
Can ICTs help pupils with SEN	48	4,35	,601	3	5
ICTs are an appropriate tool to manage the class	48	3,79	,713	2	5
ICTs are attractive and speed up the learning process	48	4,19	,641	3	5
ICTs help students learn easier	48	3,94	,633	3	5
ICTs encourage more active participation	48	3,94	,665	3	5
ICTs facilitate students' self-studying at home	48	3,71	,713	3	5
ICTs increase the authority of the teacher	48	3,29	1,010	1	5
M-Learning help students with SEN achieve better scores	48	4,00	,652	3	5
Students with SEN could benefit from a new Android app	48	4,33	,663	3	5
Teachers could accept a new mobile educational app	48	3,67	,724	2	5
Students could accept a new mobile educational app	48	4,33	,694	3	5
A new mobile app could facilitate students' self-studying at home	48	3,71	,713	3	5

Table 3. Mann-Whitney Test-Ranks

	Gender	N	Mean Rank	Sum of Ranks
Knowledge of ICTs	Male	13	25,69	334,00
	Female	35	24,06	842,00
	Total	48		
Ability of adapting new	Male	13	24,23	315,00

Software	Female	35	24,60	861,00
	Total	48		
Knowledge of electronic devises	Male	13	24,69	321,00
	Female	35	24,43	855,00
	Total	48		
Use of ICTs in class	Male	13	33,46	435,00
	Female	35	21,17	741,00
	Total	48		
Use of Educational software for Motivation	Male	13	31,92	415,00
	Female	35	21,74	761,00
	Total	48		
Use of Educational software for Maths/Language etc.	Male	13	27,04	351,50
	Female	35	23,56	824,50
	Total	48		
Use of ICTs for Evaluation	Male	13	26,69	347,00
	Female	35	23,69	829,00
	Total	48		
Can ICTs help pupils with SEN	Male	13	23,58	306,50
	Female	35	24,84	869,50
	Total	48		
ICTs are an appropriate tool to manage the class	Male	13	27,27	354,50
	Female	35	23,47	821,50
	Total	48		
ICTs are attractive and speed up the learning process	Male	13	24,27	315,50
	Female	35	24,59	860,50
	Total	48		
ICTs help students learn easier	Male	13	27,08	352,00
	Female	35	23,54	824,00
	Total	48		
ICTs encourage more active participation	Male	13	21,27	276,50
	Female	35	25,70	899,50
	Total	48		
ICTs facilitate students' self-studying at home	Male	13	27,77	361,00
	Female	35	23,29	815,00
	Total	48		
ICTs increase the authority of the teacher	Male	13	25,35	329,50
	Female	35	24,19	846,50
	Total	48		
M-Learning help students with SEN achieve better scores	Male	13	30,35	394,50
	Female	35	22,33	781,50
	Total	48		

Students with SEN could benefit from a new Android app	Male	13	28,69	373,00
	Female	35	22,94	803,00
	Total	48		
A new mobile app could facilitate students' self-studying at home	Male	13	27,27	354,50
	Female	35	23,47	821,50
	Total	48		
Teachers could accept a new mobile educational app	Male	13	25,65	333,50
	Female	35	24,07	842,50
	Total	48		
Students could accept a new mobile educational app	Male	13	23,19	301,50
	Female	35	24,99	874,50
	Total	48		

Table 4. Kruskal Wallis Test- Grouping Variable: Age

	Age	N	Mean Rank
Knowledge of ICTs	22-30	3	30,00
	31-40	28	23,00
	41-50	12	26,33
	51 and more	5	25,20
	Total	48	
Ability of adapting new Software	22-30	3	30,33
	31-40	28	22,71
	41-50	12	28,83
	51 and more	5	20,60
	Total	48	
Knowledge of electronic devises	22-30	3	27,00
	31-40	28	22,88
	41-50	12	28,33
	51 and more	5	22,90
	Total	48	
Use of ICTs in class	22-30	3	19,00
	31-40	28	22,71
	41-50	12	26,67
	51 and more	5	32,60
	Total	48	
Use of Educational software for Motivation	22-30	3	11,17
	31-40	28	23,59
	41-50	12	29,04
	51 and more	5	26,70

	Total	48	
Use of Educational software for Maths/Language etc.	22-30	3	17,83
	31-40	28	24,91
	41-50	12	28,75
	51 and more	5	16,00
	Total	48	
Use of ICTs for Evaluation	22-30	3	18,83
	31-40	28	23,39
	41-50	12	31,00
	51 and more	5	18,50
	Total	48	
Can ICTs help pupils with SEN	22-30	3	31,00
	31-40	28	24,64
	41-50	12	24,21
	51 and more	5	20,50
	Total	48	
ICTs are an appropriate tool to manage the class	22-30	3	28,50
	31-40	28	24,86
	41-50	12	21,00
	51 and more	5	28,50
	Total	48	
ICTs are attractive and speed up the learning process	22-30	3	27,00
	31-40	28	25,30
	41-50	12	22,13
	51 and more	5	24,20
	Total	48	
ICTs help students learn easier	22-30	3	26,00
	31-40	28	25,63
	41-50	12	22,54
	51 and more	5	22,00
	Total	48	
ICTs encourage more active participation	22-30	3	26,00
	31-40	28	24,34
	41-50	12	24,00
	51 and more	5	25,70
	Total	48	
ICTs facilitate students' self-studying at home	22-30	3	11,00
	31-40	28	22,70
	41-50	12	29,75
	51 and more	5	30,10
	Total	48	

ICTs increase the authority of the teacher	22-30	3	33,67
	31-40	28	23,61
	41-50	12	22,83
	51 and more	5	28,00
	Total	48	
M-Learning help students with SEN achieve better scores	22-30	3	24,50
	31-40	28	24,50
	41-50	12	21,33
	51 and more	5	32,10
	Total	48	
Teachers could accept a new mobile educational app	22-30	3	11,50
	31-40	28	25,98
	41-50	12	24,58
	51 and more	5	23,80
	Total	48	
Students could accept a new mobile educational app	22-30	3	23,50
	31-40	28	28,04
	41-50	12	15,67
	51 and more	5	26,50
	Total	48	
Students with SEN could benefit from a new Android app	22-30	3	19,17
	31-40	28	24,75
	41-50	12	21,42
	51 and more	5	33,70
	Total	48	
A new mobile app could facilitate students' self-studying at home	22-30	3	17,83
	31-40	28	23,91
	41-50	12	23,50
	51 and more	5	34,20
	Total	48	

Table 5. Kruskal Wallis Test- Grouping Variable: Academic Level

	Academic Level	N	Mean Rank
Knowledge of ICTs	Technological Institute	3	14,00
	University	9	17,56
	Master	32	26,38
	Phd	4	33,00
	Total	48	
Ability of adapting new	Technological Institute	3	18,33

Software	University	9	18,11
	Master	32	25,75
	Phd	4	33,50
	Total	48	
Knowledge of electronic devises	Technological Institute	3	14,33
	University	9	19,78
	Master	32	25,97
	Phd	4	31,00
	Total	48	
Use of ICTs in class	Technological Institute	3	20,33
	University	9	24,33
	Master	32	24,38
	Phd	4	29,00
	Total	48	
Use of Educational software for Motivation	Technological Institute	3	17,67
	University	9	27,22
	Master	32	24,31
	Phd	4	25,00
	Total	48	
Use of Educational software for Maths/Language etc.	Technological Institute	3	8,83
	University	9	26,39
	Master	32	24,94
	Phd	4	28,50
	Total	48	
Use of ICTs for Evaluation	Technological Institute	3	18,17
	University	9	26,83
	Master	32	24,38
	Phd	4	25,00
	Total	48	
Can ICTs help pupils with SEN	Technological Institute	3	23,50
	University	9	21,94
	Master	32	24,27
	Phd	4	32,88
	Total	48	
ICTs are an appropriate tool to manage the class	Technological Institute	3	21,83
	University	9	20,28
	Master	32	25,00
	Phd	4	32,00
	Total	48	
ICTs are attractive and	Technological Institute	3	20,00

speed up the learning process	University	9	18,67
	Master	32	25,81
	Phd	4	30,50
	Total	48	
ICTs help students learn easier	Technological Institute	3	19,33
	University	9	21,56
	Master	32	23,89
	Phd	4	39,88
	Total	48	
ICTs encourage more active participation	Technological Institute	3	13,00
	University	9	21,50
	Master	32	25,67
	Phd	4	30,50
	Total	48	
ICTs facilitate students' self-studying at home	Technological Institute	3	17,83
	University	9	17,06
	Master	32	25,50
	Phd	4	38,25
	Total	48	
ICTs increase the authority of the teacher	Technological Institute	3	15,00
	University	9	20,28
	Master	32	24,84
	Phd	4	38,38
	Total	48	
M-Learning help students with SEN achieve better scores	Technological Institute	3	24,50
	University	9	26,61
	Master	32	22,13
	Phd	4	38,75
	Total	48	
Students with SEN could benefit from a new Android app	Technological Institute	3	19,17
	University	9	26,94
	Master	32	22,63
	Phd	4	38,00
	Total	48	
Teachers could accept a new mobile educational app	Technological Institute	3	18,33
	University	9	21,72
	Master	32	24,30
	Phd	4	37,00
	Total	48	
Students could accept a new	Technological Institute	3	19,17

mobile educational app	University	9	20,61
	Master	32	25,13
	Phd	4	32,25
	Total	48	
A new mobile app could facilitate students' self-studying at home	Technological Institute	3	17,83
	University	9	19,33
	Master	32	24,44
	Phd	4	41,63
	Total	48	

Table 6. Kruskal Wallis Test- Grouping Variable: Years of Experience

	Years of Experience	N	Mean Rank
Knowledge of ICTs	Not at all	1	30,00
	A little	12	25,67
	Moderately	20	21,80
	Sufficiently	7	32,29
	A lot	8	22,00
	Total	48	
Ability of adapting new Software	Not at all	1	24,00
	A little	12	22,25
	Moderately	20	24,20
	Sufficiently	7	32,14
	A lot	8	22,00
	Total	48	
Knowledge of electronic devises	Not at all	1	27,00
	A little	12	23,04
	Moderately	20	23,60
	Sufficiently	7	32,00
	A lot	8	22,06
	Total	48	
Use of ICTs in class	Not at all	1	47,00
	A little	12	21,00
	Moderately	20	21,60
	Sufficiently	7	31,57
	A lot	8	28,00
	Total	48	
Use of Educational software for Motivation	Not at all	1	47,00
	A little	12	20,54
	Moderately	20	20,55

	Sufficiently	7	33,50
	A lot	8	29,63
	Total	48	
Use of Educational software for Maths/Language etc.	Not at all	1	23,50
	A little	12	23,75
	Moderately	20	25,40
	Sufficiently	7	32,29
	A lot	8	16,69
	Total	48	
Use of ICTs for Evaluation	Not at all	1	43,50
	A little	12	20,04
	Moderately	20	23,93
	Sufficiently	7	34,14
	A lot	8	21,81
	Total	48	
Can ICTs help pupils with SEN	Not at all	1	38,50
	A little	12	27,25
	Moderately	20	22,48
	Sufficiently	7	33,29
	A lot	8	16,00
	Total	48	
ICTs are an appropriate tool to manage the class	Not at all	1	45,50
	A little	12	25,50
	Moderately	20	22,35
	Sufficiently	7	28,07
	A lot	8	22,63
	Total	48	
ICTs are attractive and speed up the learning process	Not at all	1	41,00
	A little	12	22,88
	Moderately	20	26,75
	Sufficiently	7	26,00
	A lot	8	17,94
	Total	48	
ICTs help students learn easier	Not at all	1	44,50
	A little	12	24,08
	Moderately	20	25,70
	Sufficiently	7	25,79
	A lot	8	18,50
	Total	48	
ICTs encourage more active	Not at all	1	26,00

participation	A little	12	27,38
	Moderately	20	23,75
	Sufficiently	7	25,57
	A lot	8	20,94
	Total	48	
ICTs facilitate students' self-studying at home	Not at all	1	11,00
	A little	12	22,38
	Moderately	20	25,33
	Sufficiently	7	23,64
	A lot	8	28,06
	Total	48	
ICTs increase the authority of the teacher	Not at all	1	36,00
	A little	12	26,96
	Moderately	20	23,38
	Sufficiently	7	17,36
	A lot	8	28,44
	Total	48	
M-Learning help students with SEN achieve better scores	Not at all	1	43,50
	A little	12	22,92
	Moderately	20	22,60
	Sufficiently	7	29,93
	A lot	8	24,50
	Total	48	
Students with SEN could benefit from a new Android app	Not at all	1	16,50
	A little	12	23,21
	Moderately	20	23,35
	Sufficiently	7	26,86
	A lot	8	28,25
	Total	48	
Teachers could accept a new mobile educational app	Not at all	1	45,50
	A little	12	21,42
	Moderately	20	23,10
	Sufficiently	7	31,00
	A lot	8	24,31
	Total	48	
Students could accept a new mobile educational app	Not at all	1	37,50
	A little	12	27,00
	Moderately	20	24,00
	Sufficiently	7	26,64
	A lot	8	18,50
	Total	48	

A new mobile app could facilitate students' self-studying at home	Not at all	1	11,00
	A little	12	25,21
	Moderately	20	23,28
	Sufficiently	7	23,64
	A lot	8	28,94
	Total	48	

Table 7. Kruskal Wallis Test- Grouping Variable: Knowledge of ICTs

	Knowledge of ICTs	N	Mean Rank
Ability of adapting new Software	A little	3	4,33
	Moderately	13	17,08
	Sufficiently	27	26,89
	A lot	5	43,00
	Total	48	
Knowledge of electronic devises	A little	3	3,67
	Moderately	13	13,85
	Sufficiently	27	28,24
	A lot	5	44,50
	Total	48	
Use of ICTs in class	A little	3	13,67
	Moderately	13	21,15
	Sufficiently	27	24,78
	A lot	5	38,20
	Total	48	
Use of Educational software for Motivation	A little	3	11,17
	Moderately	13	20,73
	Sufficiently	27	26,17
	A lot	5	33,30
	Total	48	
Use of Educational software for Maths/Language etc.	A little	3	16,17
	Moderately	13	20,85
	Sufficiently	27	25,72
	A lot	5	32,40
	Total	48	
Use of ICTs for Evaluation	A little	3	5,50
	Moderately	13	18,62
	Sufficiently	27	27,52
	A lot	5	34,90
	Total	48	
Can ICTs help pupils with	A little	3	16,00

SEN	Moderately	13	17,73
	Sufficiently	27	29,13
	A lot	5	22,20
	Total	48	
ICTs are an appropriate tool to manage the class	A little	3	15,17
	Moderately	13	18,19
	Sufficiently	27	26,57
	A lot	5	35,30
	Total	48	
ICTs are attractive and speed up the learning process	A little	3	9,00
	Moderately	13	25,19
	Sufficiently	27	25,17
	A lot	5	28,40
	Total	48	
ICTs help students learn easier	A little	3	19,33
	Moderately	13	18,19
	Sufficiently	27	26,46
	A lot	5	33,40
	Total	48	
ICTs encourage more active participation	A little	3	13,00
	Moderately	13	22,77
	Sufficiently	27	25,72
	A lot	5	29,30
	Total	48	
ICTs facilitate students' self-studying at home	A little	3	11,00
	Moderately	13	21,50
	Sufficiently	27	26,41
	A lot	5	30,10
	Total	48	
ICTs increase the authority of the teacher	A little	3	9,00
	Moderately	13	21,65
	Sufficiently	27	26,39
	A lot	5	31,00
	Total	48	
M-Learning help students with SEN achieve better scores	A little	3	18,17
	Moderately	13	24,50
	Sufficiently	27	23,80
	A lot	5	32,10
	Total	48	
Students with SEN could	A little	3	7,50

benefit from a new Android app	Moderately	13	27,04
	Sufficiently	27	23,96
	A lot	5	31,00
	Total	48	
Teachers could accept a new mobile educational app	A little	3	18,33
	Moderately	13	25,92
	Sufficiently	27	24,89
	A lot	5	22,40
	Total	48	
Students could accept a new mobile educational app	A little	3	19,17
	Moderately	13	20,35
	Sufficiently	27	25,94
	A lot	5	30,70
	Total	48	
A new mobile app could facilitate students' self-studying at home	A little	3	11,00
	Moderately	13	24,65
	Sufficiently	27	23,89
	A lot	5	35,50
	Total	48	

Table 8. Frequencies and Percent of answers about ICT Knowledge

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q1. Knowledge of ICTs	0	0	3	6,3	13	27,1	27	56,3	5	10,4
Q2. Ability of adapting new Software	0	0	1	2,1	9	18,8	27	56,3	11	22,9
Q3.Knowledge of electronic devises	0	0	2	4,2	11	22,9	27	56,3	8	16,7

Table 9. Frequencies and Percent of answers about use and utilization of ICTs in class

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q4. Use of ICTs in class	0	0	5	10,4	27	56,3	13	27,1	3	6,3

Q5. Use of Educational software for Motivation	0	0	6	12,5	17	35,4	22	45,8	3	6,3
Q6. Use of Educational software for Maths/Language etc.	2	4,2	8	16,7	26	54,2	11	22,9	1	2,1
Q7. Use of ICTs for Evaluation	10	20,8	15	31,3	15	31,3	6	12,5	2	4,2

Table 10. Frequencies and Percent of answers about Attitudes-perceptions of teachers on the existing ICTs

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q8. Can ICTs help pupils with SEN	0	0	0	0	3	6,3	25	52,1	20	41,7
Q9. ICTs are an appropriate tool to manage the class	0	0	2	4,2	12	25,0	28	58,3	6	12,5
Q10. ICTs are attractive and speed up the learning process	0	0	0	0	6	12,5	27	56,3	15	31,3
Q11. ICTs help students learn easier	0	0	0	0	11	22,9	29	60,4	8	16,7
Q12. ICTs encourage more active participation	0	0	0	0	12	25,0	27	56,3	9	18,8
Q13. ICTs facilitate students' self-studying at home	0	0	0	0	21	43,8	20	41,7	7	14,6
Q14. ICTs increase the authority of the teacher	2	4,2	7	14,6	20	41,7	13	27,1	6	12,5

Table 11. Frequencies and Percent of answers about Attitudes-perceptions of teachers about a new android application for mobile phones and tablets

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q15. M-Learning help students with SEN achieve better scores	0	0	0	0	10	20,8	28	58,3	10	20,8
Q16. Students with SEN could benefit from a new Android app	0	0	0	0	5	10,4	22	45,8	21	43,8
Q17. A new mobile app could facilitate students' self-studying at home	0	0	0	0	21	43,8	20	41,7	7	14,6
Q18. Teachers could accept a new mobile educational app	0	0	1	2,1	20	41,7	21	43,8	6	12,5
Q19. Students could accept a new mobile educational app	0	0	0	0	6	12,5	20	41,7	22	45,8

APPENDIX B1. Evaluation Questionnaire addressed to Special Education teachers

My name is Retzepi Nikoleta and I am a PhD student in the Department of Educational Technology at the University of Murcia, Spain. I am conducting research entitled "A Mobile Application for Students with Learning Difficulties: Design and Evaluation".

In the previous phase of my research, I designed a software with math exercises aimed at students with learning disabilities. To complete the present phase of my research, I invite you to evaluate together this software, which you have met and tested by answering the questionnaire below.

The questionnaire is anonymous and any information of your answers will be completely confidential and will be used exclusively for the needs of implementing my research, which aims to further improve the learning needs of the students I mentioned above. The answers to the questions in the questionnaire are extremely important to the completion of my research and therefore I would be most grateful if you would answer all the questions effortlessly, honestly and spontaneously.

Thank you in advance for your valuable input. I am at your disposal for any clarification or question.

Nikoleta Retzepi
nikolretz@hotmail.com

Please underline the answer or statement that represents you, or fill in the box of the answer or statement that represents you with the symbol "X"

A. General Information

• Gender:
❒ Male
❒ Female

• Age
❒ 22-30 years old
❒ 31-40 years old
❒ 41-50 years old
❒ above 51 years old

• Previous experience with Android applications
❒ Not at all
❒ A little
❒ Moderate
❒ Enough

❒ A lot

• Academic Level (Note the highest):
❒ Graduate of Pedagogical Academy
❒ Graduate of Technological Education Institute
❒ Graduate of University
❒ Master's degree holder
❒ Holder of Ph.D

• Years of total experience as a teacher
❒ Not at all (1st year)
❒ A little (2-5)
❒ Moderately (6-10)
❒ Sufficiently (11-15)
❒ A lot (more than 15 years)

B. Educational Purposes-Motivation

1. Does the system aim to provide guidance in learning?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

2. Does the system aim at attracting attention and information about the objectives of the course?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

3. Does the system aim at improving learning interest?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

4. Does the system motivate the student and emphasize internal motivation when possible?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

5. Does it offer a good presentation of mathematics material?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

6. Feedback enhances content (built-in rewards are used)

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

7. Is the course content sufficient?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

8. Does the course content correspond to the curriculum?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

9. Is the program accompanied by strategies for extending learning?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

10. Can you evaluate the child based on his/her performance in the program exercises?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

11. Could children using the program increase their learning abilities in Mathematics?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

C. Design

12. Is the system characterized by elegance and minimalism in the provided information to avoid user confusion?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

13. Does feedback employ meaningful graphic and sound capabilities?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

14. Are the available navigation menus simple and understandable?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

15. Does the application provide alternative navigation routes between its screens?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

D. Functionality

16. Is the text of the navigation options (menus, buttons etc.) simple and understandable?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

17. Are the instructions for using the application clear?

- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

18. Does the application provide the appropriate comments?
    - ❒ Not at all
    - ❒ A little
    - ❒ Moderately
    - ❒ Sufficiently
    - ❒ A lot

19. Is the application child friendly?
    - ❒ Not at all
    - ❒ A little
    - ❒ Moderately
    - ❒ Sufficiently
    - ❒ A lot

E. Technical Characteristics

20. Is it possible to select specific functions?
    - ❒ Not at all
    - ❒ A little
    - ❒ Moderately
    - ❒ Sufficiently
    - ❒ A lot

21. Does the application use simple and natural dialogs?
    - ❒ Not at all
    - ❒ A little
    - ❒ Moderately
    - ❒ Sufficiently
    - ❒ A lot

22. Is the application efficient and reliable?
    - ❒ Not at all
    - ❒ A little
    - ❒ Moderately
    - ❒ Sufficiently
    - ❒ A lot

Thank you very much for your response.

APPENDIX B2. Analysis of Evaluation Questionnaire addressed to Special Education teachers

Table 12. Distribution of teachers' answers in the sector "Design"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q12. Is the system characterized by elegance and minimalism in the provided information to avoid user confusion	0	0	0	0	0	0	2	28,6	5	71,4
Q13. Does feedback employ meaningful graphic and sound capabilities?	0	0	0	0	4	57,1	2	28,6	1	14,3
Q14. Are the available navigation menus simple and understandable?	0	0	0	0	0	0	2	28,6	5	71,4
Q15. Does the application provide alternative navigation routes between its screens?	0	0	0	0	3	42,9	2	28,6	2	28,6

Table 13. Distribution of teachers' answers in the sector "Functionality"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q16. Is the text of the navigation options (menus, buttons etc.) simple and understandable?	0	0	0	0	1	14,3	1	14,3	5	71,4
Q17. Are the instructions for using the application clear?	0	0	0	0	1	14,3	4	57,1	2	28,6
18. Does the application provide the appropriate comments?	0	0	0	0	0	0	5	71,4	2	28,6
Q19. Is the application child friendly?	0	0	0	0	0	0	3	42,9	4	57,1

Table 14. Distribution of teachers' answers in the sector "Technical Characteristics"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q20. Is it possible to select specific functions?	0	0	0	0	1	14,3	5	71,4	1	14,3
Q21. Does the application use simple and natural dialogs?	0	0	0	0	0	0	1	14,3	6	85,7
Q22. Is the application efficient and reliable?	0	0	0	0	0	0	3	42,9	4	57,1

Table 15.Mann-Whitney Test-Ranks

	Gender	N	Mean Rank	Sum of Ranks
Does the system aim to provide guidance in learning?	male	5	3,70	18,50
	female	2	4,75	9,50
	Total	7		
Does the system aim at attracting attention and information about the objectives of the course?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		
Does the system aim at improving learning interest?	male	5	4,10	20,50
	female	2	3,75	7,50
	Total	7		
Does the system motivate the student and emphasize internal motivation when possible?	male	5	4,10	20,50
	female	2	3,75	7,50
	Total	7		
Does it offer a good presentation of mathematics material?	male	5	3,20	16,00
	female	2	6,00	12,00
	Total	7		
Feedback enhances content (built-in rewards are used)	male	5	3,20	16,00
	female	2	6,00	12,00
	Total	7		
Is the course content sufficient?	male	5	3,20	16,00
	female	2	6,00	12,00
	Total	7		
Does the course content correspond to the curriculum?	male	5	3,60	18,00
	female	2	5,00	10,00
	Total	7		
Is the program accompanied by strategies for extending learning?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		

Can you evaluate the child based on his / her performance in the program exercises?	male	5	4,60	23,00
	female	2	2,50	5,00
	Total	7		
Could children using the program increase their learning abilities in Maths?	male	5	3,90	19,50
	female	2	4,25	8,50
	Total	7		
Is the system characterized by elegance and minimalism in the provided information to avoid user confusion?	male	5	3,60	18,00
	female	2	5,00	10,00
	Total	7		
Does feedback employ meaningful graphic and sound capabilities?	male	5	3,10	15,50
	female	2	6,25	12,50
	Total	7		
Are the available navigation menus simple and understandable?	male	5	4,30	21,50
	female	2	3,25	6,50
	Total	7		
Does the application provide alternative navigation routes between its screens?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		
Is the text of the navigation options (menus, buttons etc.) simple and understandable?	male	5	4,20	21,00
	female	2	3,50	7,00
	Total	7		
Are the instructions for using the application clear?	male	5	3,00	15,00
	female	2	6,50	13,00
	Total	7		
Does the application provide the appropriate comments?	male	5	3,00	15,00
	female	2	6,50	13,00
	Total	7		
Is the application child friendly?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		
Is it possible to select specific functions?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		
Does the application use simple and natural dialogs?	male	5	3,80	19,00
	female	2	4,50	9,00
	Total	7		
Is the application efficient and reliable?	male	5	3,40	17,00
	female	2	5,50	11,00
	Total	7		

APPENDIX C1. Evaluation Questionnaire addressed to students with learning difficulties

My name is Retzepi Nikoleta and I am a PhD student in the Department of Educational Technology at the University of Murcia, Spain. I am conducting research entitled "A Mobile Application for Students with Learning Difficulties: Design and Evaluation".

In the previous phase of my research, I designed a software with math exercises aimed at students with learning disabilities. To complete the present phase of my research, I invite you to evaluate together this software, which you have met and tested by answering the questionnaire below.

The questionnaire is anonymous and any information of your answers will be completely confidential and will be used exclusively for the needs of implementing my research, which aims to further improve the learning needs of the students I mentioned above. The answers to the questions in the questionnaire are extremely important to the completion of my research and therefore I would be most grateful if you would answer all the questions effortlessly, honestly and spontaneously.

Thank you in advance for your valuable input. I am at your disposal for any clarification or question.

Nikoleta Retzepi
nikolretz@hotmail.com

Please underline the answer or statement that represents you, or fill in the box of the answer or statement that represents you with the symbol "X"

A. General Information

• Gender:
- ❒ Boy
- ❒ Girl

- Type of learning disability: (complete or fill in accordingly to your status)
  ……
  ……
  ……...

B. Educational Purposes-Motivation

1. Does the system aim at improving your learning interest?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

2. Does it offer a good presentation of mathematics material?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

3. Do the graphics strengthen your attention?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

4. Feedback enhances content (built-in rewards are used).
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

5. Do the elements of the program match with your prior knowledge?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

6. Could you increase your learning abilities in math by using the app?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

C. Design

7. Does feedback employ meaningful graphic and sound capabilities?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

8. Are the available navigation menus simple and understandable?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

D. Functionality

9. Is the text of the navigation options (menus, buttons etc.) simple and understandable to you?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

10. Are the instructions for using the application clear?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

11. Does the application provide the appropriate comments?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

12. Are the comments provided at the right time?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

13. Is the application friendly to you?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

E. Technical Characteristics

14. Does the application use simple and natural dialogs?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

15. Does the application supports shutdown at any time you want?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

16. Is the application efficient and reliable?
- ❒ Not at all
- ❒ A little
- ❒ Moderately
- ❒ Sufficiently
- ❒ A lot

F. Open-Ended Questions

1. How do you feel when you use the app?

2. Did you like the app and find it helpful?

3. What possible improvements would you suggest to improve the app's effectiveness?

4. Would you continue using the app after the trial period?

Thank you very much for your response.

APPENDIX C2. Analysis of Evaluation Questionnaire addressed to students with learning difficulties

Table 16. Distribution of students' answers in the sector "Educational content"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q1. Does the system aim to provide guidance in learning?	0	0	0	0	2	12,5	5	31,3	9	56,3
Q2. Does it offer a good presentation of mathematics material?	0	0	0	0	2	12,5	5	31,3	9	56,3
Q3. Do the graphics strengthen your attention?	0	0	0	0	6	37,5	9	56,3	1	6,3
Q4. Feedback enhances content (built-in rewards are used).	0	0	0	0	3	18,8	6	37,5	7	43,8
Q5. Do the elements of the program match your prior knowledge	0	0	0	0	2	12,5	4	25,0	10	62,5
Q6. Could you increase your learning abilities in Maths by using the program?	0	0	0	0	1	6,3	6	37,5	9	56,3

Table 17. Distribution of students' answers in the sector "Design"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q7. Does feedback employ meaningful graphic and sound capabilities?	0	0	0	0	6	37,5	9	56,3	1	6,3
Q8. Are the available navigation menus simple and understandable?	0	0	0	0	1	6,3	5	31,3	10	62,5

Table 18. Distribution of students' answers in the sector "Functionality"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%

Q9. Is the text of the navigation options (menus, buttons etc.) simple and understandable to you?	0	0	0	0	1	6,3	4	25,0	11	68,8
Q10. Are the instructions for using the application clear?	0	0	0	0	0	0	9	56,3	7	43,8
Q11. Does the application provide the appropriate comments?	0	0	0	0	3	18,8	9	56,3	4	25,0
Q12. Are the comments provided at the right time?	0	0	0	0	2	12,5	11	68,8	3	18,8
Q13. Is the application friendly to you?	0	0	0	0	0	0	2	12,5	14	87,5

Table 19. Distribution of students' answers in the sector "Technical Characteristics"

	Not at all		A little		Moderately		Sufficiently		A lot	
	N	%	N	%	N	%	N	%	N	%
Q14. Does the application use simple and natural dialogs?	0	0	0	0	2	12,5	4	25,0	10	62,5
Q15. Does the application supports shutdown at any time you want?	0	0	0	0	2	12,5	13	81,3	1	6,3
Q16. Is the application efficient and reliable?	0	0	0	0	0	0	8	50,0	8	50,0

Table 20. Mann-Whitney Test-Ranks

	Gender	N	Mean Rank	Sum of Ranks
Does the system aim at improving your learning interest?	male	13	9,04	117,50
	female	3	6,17	18,50
	Total	16		
Does it offer a good presentation of mathematics material?	male	13	8,77	114,00
	female	3	7,33	22,00
	Total	16		
Do the graphics strengthen your attention?	male	13	8,69	113,00
	female	3	7,67	23,00
	Total	16		

Feedback enhances content (built-in rewards are used)	male	13	8,46	110,00
	female	3	8,67	26,00
	Total	16		
Do the elements of the program match your prior knowledge?	male	13	8,35	108,50
	female	3	9,17	27,50
	Total	16		
Could you increase your learning abilities in Maths by using the program?	male	13	8,85	115,00
	female	3	7,00	21,00
	Total	16		
Does feedback employ meaningful graphic and sound capabilities?	male	13	7,54	98,00
	female	3	12,67	38,00
	Total	16		
Are the available navigation menus simple and understandable?	male	13	8,96	116,50
	female	3	6,50	19,50
	Total	16		
Is the text of the navigation options (menus, buttons etc.) simple and understandable to you?	male	13	8,50	110,50
	female	3	8,50	25,50
	Total	16		
Are the instructions for using the application clear?	male	13	8,69	113,00
	female	3	7,67	23,00
	Total	16		
Does the application provide the appropriate comments?	male	13	8,62	112,00
	female	3	8,00	24,00
	Total	16		
Are the comments provided at the right time?	male	13	8,08	105,00
	female	3	10,33	31,00
	Total	16		
Is the application friendly to you?	male	13	8,88	115,50
	female	3	6,83	20,50
	Total	16		
Does the application use simple and natural dialogs?	male	13	8,88	115,50
	female	3	6,83	20,50
	Total	16		
Does the application supports shutdown at any time?	male	13	8,38	109,00
	female	3	9,00	27,00
	Total	16		
Is the application efficient and reliable?	male	13	9,42	122,50
	female	3	4,50	13,50
	Total	16		

APPENDIX D1. Evaluation Interview addressed to 3 Special Education teachers who tested the app

My name is Retzepi Nikoleta and I am a PhD student in the Department of Educational Technology at the University of Murcia, Spain. I am conducting research entitled "A Mobile Application for Students with Learning Difficulties: Design and Evaluation".

In the previous phase of my research, I designed a software with math exercises aimed at students with learning disabilities. To complete the present phase of my research, I invite you to evaluate together this software, which you have met and tested by answering the questionnaire below.

The questionnaire is anonymous and any information of your answers will be completely confidential and will be used exclusively for the needs of implementing my research, which aims to further improve the learning needs of the students I mentioned above. The answers to the questions in the questionnaire are extremely important to the completion of my research and therefore I would be most grateful if you would answer all the questions effortlessly, honestly and spontaneously.

Thank you in advance for your valuable input. I am at your disposal for any clarification or question.

Nikoleta Retzepi
nikolretz@hotmail.com

Please underline the answer or statement that represents you, or fill in the box of the answer or statement that represents you with the symbol "X"

A. General Information

• Gender:
❒ Male
❒ Female

• Age
❒ 22-30 years old
❒ 31-40 years old
❒ 41-50 years old
❒ above 51 years old

• Previous experience with Android applications
❒ Not at all
❒ A little
❒ Moderate
❒ Enough

❒ A lot

• Academic Level (Note the highest):
❒ Graduate of Pedagogical Academy
❒ Graduate of Technological Education Institute
❒ Graduate of University
❒ Master's degree holder
❒ Holder of Ph.D

• Years of total experience as a teacher
❒ Not at all (1st year)
❒ A little (2-5)
❒ Moderately (6-10)
❒ Sufficiently (11-15)
❒ A lot (more than 15 years)

B. Educational Purposes-Motivation

1. Does the system aim to provide guidance in learning?

2. Does the system aim at attracting attention and information about the objectives of the course?

3. Does the system aim at improving learning interest?

4. Does the system motivate the student and emphasize internal motivation when possible?

5. Does it offer a good presentation of mathematics material?

6. Feedback enhances content (built-in rewards are used)

7. Is the course content sufficient?

8. Does the course content correspond to the curriculum?

9. Is the program accompanied by strategies for extending learning?

10. Can you evaluate the child based on his/her performance in the program exercises?

11. Could children using the program increase their learning abilities in Mathematics?

C. Design

12. Is the system characterized by elegance and minimalism in the provided information to avoid user confusion?

13. Does feedback employ meaningful graphic and sound capabilities?

14. Are the available navigation menus simple and understandable?

15. Does the application provide alternative navigation routes between its screens?

D. Functionality

16. Is the text of the navigation options (menus, buttons etc.) simple and understandable?

17. Are the instructions for using the application clear?

18. Does the application provide the appropriate comments?

19. Is the application child friendly?

E. Technical Characteristics

20. Is it possible to select specific functions?

21. Does the application use simple and natural dialogs?

22. Is the application efficient and reliable?

F. Open-Ended Questions

1. How do the students feel when they use the app? 4. Would you continue using the app in your classes after the trial period?

2. Did you like the app and find it helpful?

3. What possible improvements would you suggest to improve the app's effectiveness?

4. Would you continue using the app in your classes after the trial period?

Thank you very much for your response.

APPENDIX D2. Answers of Evaluation Interview addressed to 3 Special Education teachers who tested the app

The first main sector of the interviews' questions **"Educational content"** includes 11 questions.

In question 1: "Does the system provides guidance in learning?"

- Teacher one (male): "It definitely does. It follows the curriculum which is very helpful for both teachers and students. Students need such kind of guidance".
- Teacher two (female): "It does. Students need such an interesting presentation of both Algebra and Geometry".
- Teacher three (female, parallel support): "I think that the app offers a great a teaching aid to me and my students also think that the app offers them a great assistance in learning math".

In question 2: "Does the system attract attention and offers information about the objectives of the course?"

- Teacher one (male): "It attracts attention about the objectives of the course, because its graphics and sound are very well presented and make students enthusiastic about them".
- Teacher two (female): "It really attracts students' attention". They expressed their enthusiasm when they tested the app for the first time. They were really focused to run through all the exercises".
- Teacher three (female, parallel support): "I think that the app attracts students' attention and helps them to stay focused, which is rather difficult for them, if we consider their condition".

In question 3: "Does the system improve learning interest?"

- Teacher one (male): "Yes, it certainly does. It employs interesting sounds and graphics for that purpose".
- Teacher two (female): "Students are tired of being taught via school books and paper notes. They are positively interested in learning maths through the app, so their learning interesting has been improved".

- Teacher three (female, parallel support): “My students are enthusiastic about using the app. Their learning interest has significantly been improved”.

In question 4: “Does the system motivate the student and emphasize on internal motivation when possible?”

- Teacher one (male): “The system motivates students. Students of my class are easily getting tired of typical teaching and learning. Using mobiles as a learning tool greatly motivates them and makes them to practice again and again”.
- Teacher two (female): “I think that students are internally motivated to use the app and answer to the questions. Graphics help a lot in this area”.
- Teacher three (female, parallel support): “The app gave my students the motivation internal and external to practice in their lessons”.

In question 5: “Does it offer a good presentation of mathematics material?”

- Teacher one (male): “I think that the presentation of the course is very good”.
- Teacher two (female): “It really does. The material of the course is presented very well”.
- Teacher three (female, parallel support): “The presentation of the course’s material is very well-organized in small parts of theory followed by the relevant multiple choice questions”.

In question 6: “Feedback enhances content (built-in rewards are used)?”

- Teacher one (male): “There are verbal rewards that encourage students to continue with answering to the exercises’ questions”.
- Teacher two (female): “After answering each question there is immediate feedback that regardless of whether the answer is right or wrong motivates the student to continue”.
- Teacher three (female, parallel support): “Verbal and audible rewards are used after every right answer. After a wrong answer the system verbally encourages students to continue. Thus, the course content is enriched and reinforced”.

In question 7: “Is the course content sufficient?”

- Teacher one (male): “Yes, there are all the necessary chapters for both the subjects: Algebra and Geometry that are included in the class’s curriculum. There is also a sufficient amount of questions regarding each chapter”.
- Teacher two (female): Yes, it is sufficient according to the curriculum”.
- Teacher three (female, parallel support): Yes, because it includes all the chapters and exercises that are referred to the course curriculum”.

In the question 8: “Does the course content correspond to the curriculum?”

- Teacher one (male): “Yes, it corresponds directly to the curriculum”.
- Teacher two (female): Yes, it corresponds satisfactorily to the curriculum
- Teacher three (female, parallel support): Yes, because it includes all the chapters and exercises that are referred to it.

In question 9: “Is the program accompanied by strategies for extending learning?”

- Teacher one (male): “I don’t think so. It’s an interesting program that takes into account students’ prior knowledge and that’s all’.
- Teacher two (female):” Yes, because it encourages students to continually use it for gaining better scores”.
- Teacher three (female, parallel support): “Yes, because students are enthusiastic about it and try and retry to solve the questions. They eventually learn through repetition”.

In question 10: “Can you evaluate the child based on his / her performance in the program exercises?”

- Teacher one (male): “Of course I can. The system evaluates the students and after enough practicing they gain better scores and grades”.
- Teacher two (female): “I think I can. As a matter of fact, students have already made a remarkable progress in their performance at maths”.
- Teacher three (female, parallel support): “After the system evaluated them, I also can evaluate them for their progress in solving the program’s exercises”.

In question 11: “Could a child using the program increase his learning abilities in Maths?”

- Teacher one (male): “Yes, they could. But they need much more time practicing with the app”.

- Teacher two (female): “Yes, some of them already have increased their learning abilities in the math chapters they have already been taught”.
- Teacher three (female, parallel support): “Yes. Although they haven’t finished all the math curriculum’s chapters during the app’s trial period, they have made excellent progress. I think the progress is mainly due to motivation the app offers to them”.

The second main sector of the interviews’ questions **“Design”** includes 4 questions.

In question 12: “Is the system characterized by elegance and minimalism in the provided information to avoid user confusion?”

- Teacher one (male): “Yes, it contains only the necessary information and assistance to users, so that they can’t be confused”.
- Teacher two (female): “Yes it is characterized by elegance and minimalism in the provided information, so users aren’t confused”.
- Teacher three (female, parallel support): “Yes, it is elegant and minimal in the provided information, so students are not confused by too much unnecessary information”.

In question 13: “Does feedback employ meaningful graphic and sound capabilities?”

- Teacher one (male): “Yes graphics and sound are provided in the right time and the students are enthusiastic when for example receive a praise sound or message”.
- Teacher two (female): “Yes, feedback employs meaningful graphic and sound capabilities, so students according to sound and graphics know if they are right or wrong doing the exercises”.
- Teacher three (female, parallel support): “Yes, sound and graphics inform students about their progress”.

In question 14: “Are the available navigation menus simple and understandable?”

- Teacher one (male): “The navigation menus are simple and easily understandable”.
- Teacher two (female): “Students after the first navigation through the whole menu of the app were able to go through it without teachers help”.

- Teacher three (female, parallel support): “The navigation menus are very simple and very understandable”.

In question 15: “Does the application provide alternative navigation routes between its screens?”

- Teacher one (male): “Yes, every user can choose either Algebra or Geometry and can also choose between theory and exercises”.
- Teacher two (female): “Yes, everyone can choose every option and every question that is included in the app’s menu”.
- Teacher three (female, parallel support): “Yes, there is no mandatory choice in the sequence of exercises or theory”.

The third main sector of the interviews’ questions **“Functionality”** includes 4 questions.

In question 16: “Is the text of the navigation options (menus, buttons etc.) simple and understandable?”

- Teacher one (male): “Yes, they are”.
- Teacher two (female): “Yes, they are very simple and understandable”.
- Teacher three (female, parallel support): “Yes, they are”.

In question 17: “Are the instructions for using the application clear?”

- Teacher one (male): “Yes, they are”.
- Teacher two (female): “Yes, they are very clear”.
- Teacher three (female, parallel support): “Yes, they are”.

In question 18: “Does the application provide the appropriate comments?”

- Teacher one (male): “Yes, it does”
- Teacher two (female): “Yes, it does. It is designed to provide the appropriate comments”.
- Teacher three (female, parallel support): “Yes it does and in the right time”.

In question 19: “Is the application child friendly?”

- Teacher one (male): “It is very child friendly”.
- Teacher two (female): “It is very child friendly according to the positive reaction of the students”.

- Teacher three (female, parallel support): “It is definitely child friendly, because children became very enthusiastic about it”.

The fourth main sector of the interviews’ questions **“Technical Characteristics”** includes 3 questions.

In question 20: “Is it possible to select specific functions?”

- Teacher one (male): “Yes, it is possible for the users to select any function of the app they want”.
- Teacher two (female): “Yes, anyone can select any function following the order they want”.
- Teacher three (female, parallel support): “Yes, it is possible to select any specific function”.

In question 21: “Does the application use simple and natural dialogs?”

- Teacher one (male): “Yes, it uses very simple and easy to understand dialogs”.
- Teacher two (female): “Yes, the app uses simple and natural words and vocabulary”.
- Teacher three (female, parallel support): “Yes, students can easily understand them”.

In question 22: “Is the application efficient and reliable?”

- Teacher one (male): “Yes, it is. It worked without errors and technical problems.”
- Teacher two (female): “Yes, it is. Its operation was excellent.”
- Teacher three (female, parallel support): “Yes, the application is efficient and reliable. It worked steadily without any problems.”

Answers to Open- ended questions

The first main sector of the interviews’ open-ended questions **“Feelings”** includes 2 questions.

1. “How do the students feel when they use the app?”
    - Teacher one (male): “They feel excited. They were really tired with traditional learning and teaching”.

- Teacher two (female): “They were enthusiastic. They asked me to extend the period of using it”.
- Teacher three (female, parallel support): “They were curious at first. They eventually became eager, anxious and willing to use it”

2. “Did you like the app and find it helpful?”
    - Teacher one (male): “Yes, it is very helpful for managing the class and avoiding students’ distraction”.
    - Teacher two (female): “Yes, it is very helpful especially for my students who are easily becoming tired by traditional teaching and they cannot stay concentrated on a subject for a long time”.
    - Teacher three (female, parallel support): “Yes, it is very helpful for me. It provided me and my students with an alternative teaching and learning method”.

The second main sector of the interviews’ open-ended questions **“Suggestions”** includes 2 questions.

3. “What possible improvements would you suggest to improve the app’s effectiveness?’
    - Teacher one (male): “I should suggest that you must design better graphics in order to make the app more attractive to users – students. It would also be interesting if you installed the application to tablets, because their screen is larger and easier to use”.
    - Teacher two (female): “You should add more lessons in the application, for example Language or Physics. I also suggest the distribution of the application through the Google Play Store and its distribution to schools”.
    - Teacher three (female, parallel support): “Perhaps you should adapt the content to the students’ special needs e.g. Dyslexia, Dysgraphia, ADHD, Dyscalculia, Generalized Learning Difficulties, Complex Cognitive and emotional Difficulties. I think that my diagnosed with ADHD students need simpler content and exercises. They also would like more and funnier graphics”.
4. “Would you continue using the app in your classes after the trial period?”

- Teacher one (male): “I certainly would continue using the app in my classes after the trial period, because children’s’ behavior has been positively improved and also their math knowledge in certain chapters has been remarkably developed”.
- Teacher two (female): “I certainly would continue using the app in my classes after the trial period because it is a great help for me teaching to students with those learning difficulties. Students have been improved, too in their behavior and level of knowledge”.
- Teacher three (female, parallel support): “I certainly would continue using the app in my classes after the trial period. My students liked it and this is an excellent way for me to manage the class”.