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«ASK4Apps: An Android Market for Educational Mobile Apps»

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Abstract

Nowadays, technology's penetration into the population is increasing dramatically day after day. As humanity is taking big steps forward towards breakthrough innovative technologies, the same time it is more affordable than ever for a person to purchase cutting edge technological devices. Specifically, smartphones and tablets are widely available in all price ranges that someone is willing to invest.

Along with smart mobile devices, their software started to develop rapidly too. Year after year, operating systems are growing stronger more efficient kai more flexible to meet the increasable needs of customers. Eventually developers started developing applications for mobile handheld devices of which popularity started growing.

Soon, Educational experts started experimenting with the use of mobile applications in order to add value to their courses depending on their needs. As technology was proving its value inside the educational field, the pool of applications that where targeting education, started to increase. At this point a new need started to arise. As it occurred in the past with learning objects, the need to be able to identify fast and efficient whether an application was matching the needs of teachers or students came up. Therefore separate groups of applications have been created in mobile applications markets trying to group mobile applications intended to be used in education. Although, still the ways of search and retrieval were having few differences from the way any other application was being retrieved.

The scope of this thesis is to present and propose a new metadata model that would be used to describe sufficiently mobile applications that have been characterized as educational. This metadata model will be used to implement a guided search on a custom Android applications market that would be called Ask4Apps. The purpose of the thesis is to add an extra arrow to the quiver of educational experts and students that are looking for ways to search, identify the value, and retrieve meaningful and useful educational applications.

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Chapter 1: Introduction

1.1 Problem Definition

Over the latest years the rapidly changing studying and working environment is demanding more accurate, flexible and productive solutions regarding techniques, processes and tools, that are used during studies and training. Either it comes on students of all ages and levels or on adult training (formal or informal) the outcome should be of an equal quality. In this direction, mobile technology has been used more and more over the last years, as it can provide both, student and teacher, the accuracy, flexibility and productivity needed in order to achieve their goals.

While mobile technologies are evolving, various mobiles devices are following this path. Closely related to this evolution, the production cost of high-spec mobile devices had reduced dramatically and so did the retail prices. Now a great presentence of people around the globe have access to devices such as smartphones and tablets in reasonable prices. This penetration of mobile devices into population, created a whole new market. The market of Mobile Applications. Individual developers could deploy now applications for all available platforms, iOS, Android and Windows Mobile. Mobile Applications are being distributed via central Mobile Application Markets, pre-installed in devices that provide access to user, to a large variety of applications for his/her device. Main mobile software manufacturers introduced their own markets such as iTunes Store, Windows App Store and Android Market which evolved later to Google Play.

Due to the huge number of applications coming out every day, developers overheard the need of users to have access markets that fit best their needs and interests. During last years, independent mobile application markets started to debut in Google Play, and Windows App store. While this technology outbreak was taking place, of course, Educational process could not be left unchanged. The needs and overall profiles of students changed in a great level and the teaching process had to meet those needs. Mobile Technologies, including mobile devices and applications, started to be used in every day education process formal or informal. But how easy is to determine the nature and efficiency of each application meant to be used, among the thousands of available applications in mobile markets? Especially when applications are archived under generic metadata tags, not designed for characterizing educational material.

Combining all the above, it can be noticed that a whole new challenge arising for the Educational Community. This challenge is the archiving, grouping and characterizing mobile applications under a specially designed tag system that can address directly the educational use of these applications. In this paper we target addressing this issue, by proposing a metadata model for describing educational mobile applications and we present the implementation of our proposed model to a newly developed mobile market, named the ASK4Apps Market.

1.2 Structure of the Thesis

Issues that will be covered in this paper will include the following:

i. Brief review of the current Mobile technologies, including reviews of several leading educational applications. Moreover a review of Educational Markets in various formats, can be found in this section (Chapter 2).

ii. Proposal of a Metadata Model for Educational Applications. This will be created on Basic Elements based on IEEE LOM plus Additional Elements based on popular elements used in existing Mobile Markets (Chapter 3).

iii. Brief overview of the newly created Mobile Educational Applications market ASK4Apps. This will cover all its functionalities and will include a Search Evaluation (Chapter 4).

iv. General Discussion over the paper, including conclusion and future work targets (Chapter 5).

Chapter 2: Background – Review of Mobile Devices Technology – Review of the Latest Releases of Educational Applications & Markets

2.1 Mobile Devices

The main reason that mobile applications became so popular over the last years is of course the rapid development of mobile technologies. While mobile technologies where developing, increasing amount of computing power was managed to fit into various small and handy devices such as smart-phones and tablets. This section of the chapter will present both hardware and software that are used into the latest devices that can be found in the market. Special reference will be done on devices that function on Android OS, as it constitutes the targeted platform where ASK4Apps Market will be developed. Moreover, it is attempted to provide a complete overview of the evolution of those devices during time, in order to achieve a greater insight to the mobile application's and mobile applications market's outbreak.

2.1.1 Smartphones

Mobile phones weren't always as we know them today. It has been a long way until the first smart-phone reach the market. Martin Cooper, Motorola's general manager in 1973 had successfully stated: "People want to talk to other people - not a house, or an office, or a car. Given a choice, people will demand the freedom to communicate wherever they are, unfettered by the infamous copper wire. It is that freedom we sought to vividly demonstrate in 1973".After years of research, first mobile phone introduced in the market in 1983. It was called "DynaTAC" and was produced by Motorola. That device was rather big and rather expensive, weighted almost 500 grams, and cost $3,500.

Mobile phones continued to develop and in 1996, Nokia introduced what today considered to be the first smartphone. Nokia Communicator 9000, as it was named, seemed like a normal phone in first site, although it could be opened it was unveil a big screen with a full QWERTY keyboard. Through this user could access his messages and organizer keep memos etc. Internally it had 8MB of memory of which 4 MB was used for its GEOSTM 3.0 operating system, 2 MB for programs and 2 MB for user data. It was powered by an Intel 24MHz 386 microprocessor (Nigel Linge, 2010).

Figure 1: Nokia 9000 Communicator

Nowadays, multiple different manufacturers can be found in the smartphone market. Each smartphone can provide large amounts of computing power and can function as a proper computer, offering countless possibilities to the users. User can now access the internet via his smartphone, listen to music, watch videos even in high definition, take photos, and of course to access numerous applications that can expand each device's abilities.

2.1.2 Tablets

Although many people believe that tablets are a late achievement of mobile technology, this is not true. In fact, tablets existed quite a few years before mobile phones make it into the market, of course not it the form we know them nowadays. The first try was made early in 1968 by computer scientist Alan Kay, who created a tablet prototype called the Dynabook. Dynabook never became an actual product, but it was the blueprint for the modern laptops and tablet PCs. The Dynabook had integrated physical or touchscreen keyboard and all early elements of a Graphical User's Interface. Kay's vision was this device to be used by students in order to access schoolwork via main servers. Device never produced, as the technologies needed, weren't available in 1967(Shane O'Neill, 2012).

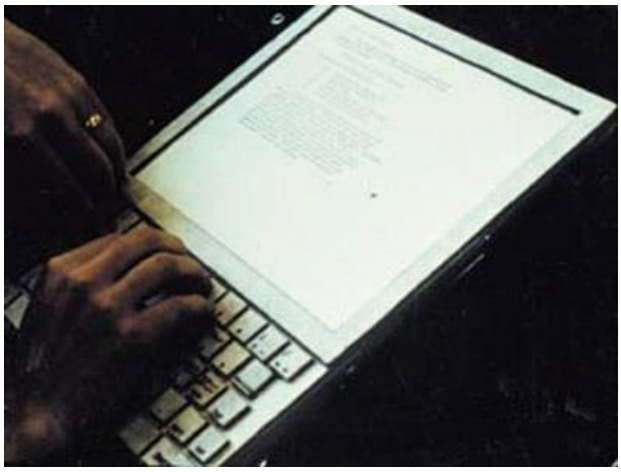

Figure 2: The Dynabook Prototype

First tablet device that it was using an Operating System and can be matched at some level with what we know today was GRiDpad. GRiDpad was running on MS-DOS and was using a 10-inch display. Its key feature was the advanced hand writing recognition capability, although it was considered to be

overpriced as it was costing $2,370. Next milestone device was Fujitsu Stylistic 2300 that was launched in 1998 and was the first device that was using a color display and was running Windows 95 & 98. As its ancestors, its cost was extremely high at $4,485 and its production stopped not long after its release. Almost a decade later, in 2007, another revolutionary device made it into the market. 2007 was the year that Amazon.com pushed Kindle to the users. Beside the main set of abilities that Kindle was offering to users the main innovation that was introduced was the direct access offered to users to the online Amazon.com store, from where they could purchase new reads that were directly downloaded to their device. The great success of this feature made manufacturers to recognize the huge value of the mobile content market, and leaded the way for the future mobile applications markets (Shane O'Neill, 2012).

2010 was the year that completely changed the perception users seeing tablets. Apple introduced iPad, a tablet that had accomplished all goals needed for a successful tablet. It was powerful as it was integrating great computing power, handy interface while using iOS and a beautiful design. All these were coming to user for a reasonable price starting from $500. Moreover, App Store which was introduced on iPhones in 2008 was pre-installed on the device providing the user with countless additions to his device. After this milestone release and its great success, all manufacturers followed this path and industry started providing to users more and more powerful and ergonomically designed tablets. It is estimated that over 130 different tablet models are available nowadays to users to choose from, fact that outlines the success of the tablet as an everyday device in users life.

2.1.3 Software

During the early days of their release, both smartphones and tablets were using mostly certain Software that was coming pre-installed by the manufacturer. As mobile devices were becoming more and more popular among the users, the problem of compatibility arisen.

First widely used software that was used by mobile devices, mostly smartphones, was the Symbian operating system. Symbian Operating System firstly launched in 2000 and was used by Sony Erickson and Nokia devices. Symbian was an open source platform that was widely developed in the years to come. Increasing number of devices were using the Symbian OS, with Nokia to lead the way as the vast majority of its devices were running on Symbian OS. Symbian was an Object oriented OS and was using GUI (Graphical Users Interface) in all its forms except versions that were running on servers. Regarding the file formatting, Symbian was using FAT protocol in order to provide reliable connectivity to users, with external removable devices (Michael J. Jipping, 2007). To conclude, Symbian OS, stopped

its development in November of 2010, as a result of the Android OS overtake on the mobile operating systems market.

In 2003, Android Inc. started to develop a new open source operating system meant to be used by smartphones and tablets. Google backed financially this try, and later in 2005 bought the company and the copyrights of the Operating System (Elgin Ben, 2005). Google continued its development, and Android OS made its debut as a smart phone operating system in 2008 running on HTC Dream smartphone. Android OS consists a Linux Based operating system, with its bottom layer functions to execute on Linux Kernel version 2.6 for most Android OS versions and on Linux Kernel versions 3.x for the latest versions of the operating system. Android's main libraries are using C and C++ programming language, with the top layer, which includes the various applications, using Java libraries. Below is provided a full overview of the Android OS Architecture.

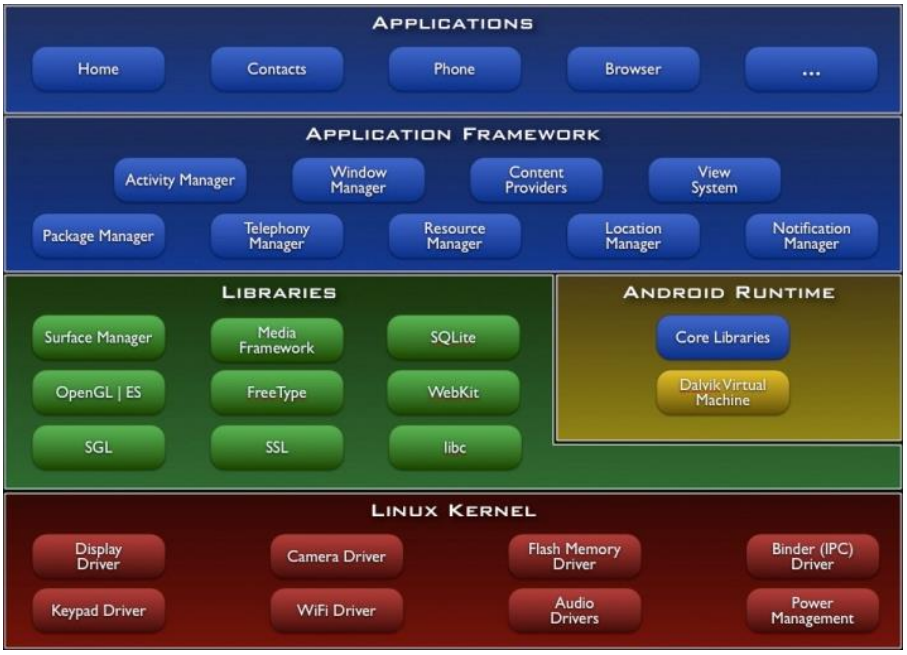

Figure 3: The Android OS Architecture (Source: http://developer.android.com)

Regarding Android Applications, their main functionalities are developed under Java programming language and the Graphical User Interface is developed using a dynamic extensible XML library (Payet, Spoto, 2012). Graphics are being added via XML tags, and their functionality is being handled using Java code. Java library used for the reason in named Android SDK (Android Software Development Kit) and has been created exclusively for the Android Applications development. For the final interpretation of the code, any Java interpreter can be used, although for its final form that is meant

to be handled by the phone OS it has to be interpreted to a final highly optimized form of Dalvik bit code (Payet, Spoto, 2012).

Latest addition to the mobile operating systems family, is the Windows Phone Software. Microsoft, decided to enter the phone software market in November of 2010, releasing the first version of Windows Phone 7. After minor updaters during 2011, and early 2012, Microsoft released Windows phone 8 in October of 2012. This was a more user friendly operating system, mainly used by latest Nokia phones after a partnership between two companies agreed in early 2011.

Main competitor of the above operating systems is iOS. iOS is the operating system developed by Apple being used by all iPhone and iPad devices. First version of iOS was released in 2007 embedded into the first iPhone device released. Although iOS is being used only by Apple devices, because of their high popularity among users iOS has the second place behind Android OS regarding the overall market share.

To conclude, in this section it has been provided to the reader a complete review of the current field in mobile devices market, including both hardware and software information. All the above intent to present the rapid development of the mobile devices and applications market over the last years, and underline the need of educational mobile applications to gain a well stated presence in this field.

2.2 Educational Mobile Applications

Since the first development of mobile applications, the educational value that these could have was noticed by educational experts. Soon after the first application releases, applications that were entitled as "Educational" started to appear in markets. Some more sophisticated than others, some simplistic yet useful and others that were meant to bring revolution in education as we know it. In current section of this chapter, will be introduced a review of various Educational Mobile Applications, trying to identify the functionalities and patterns that give an application the role "Educational". A definition for Educational Mobile Applications will be suggested in a later chapter of the present thesis.

2.2.1 IBM Think

To begin with IBM Think is considered an application that demonstrate to the user a different approach regarding the ways that science has improved our everyday life, and the new opportunities that arise through the use of technology. It is being used to offer information, tools and algorithms, providing the opportunity to obtain a better understanding about the world we are leaving into. Different matters, more or less easy for human perception to decode can be understood using IBM Think. IBM Think, is based on the fact that every step of progress demand cleverness along with hard work and these two

usually consist a repetitive pattern. As an overview, this application explores the ways that progress is being shaped via a common and systematic approach.

Figure 4: Seeing: How THINK offers the ability to navigate an illustrated timeline documenting the quest to measure the world with increasingly precise tools.

IBM Think is providing HD videos, targeting to decode the patterns of human progress, and to understand the ways technology can improve the world, using stories from the past and present. High definition scaled images and interactive courses are also available and they are based on the user's cognition using the following different parameters:

- **Seeing:** During the most part of human history, the only tools that humans could use to understand and investigate the world were their five senses. For this reason, different metric tools have been built. As the time progresses, billions and billions on different sensors and revolutionary technical imaging devices are receiving huge amounts of data for various phenomena either they are of physical of human nature. IBM Think offers the ability to navigate an image timeline displaying the evidence of human progression on all these metric devices being used to measure the world with more precision.
- **Mapping:** All the information are being understood by human easier when they are organized under certain collections. During human history, different kinds of maps were able to reveal patterns in occasions where data themselves seemed chaotic, inspired researchers and consisted

guidelines for development and innovation. Nowadays, dynamic maps are dynamic and multidimensional and can be used cooperatively. Mapping platforms of the application can offer great organization and presentation of any information in real time.

- **Understanding:** In order to improve understanding and cooperation between systems across the globe, it should be clear in the first place, the way certain systems are functioning, both their different parts but also as whole. This is the goal of the application while it is creating models, from physics prototypes to mathematic calculations, investigating different hypothesis that until today was hard or even dangerous to investigate. Tools towards this direction are supercomputers, software analytics and network technologies that allow simulate the functionality and the interactions between enormous systems.
- **Believing:** Progress is not possible unless commitment and skill will be invested in order to overcome the concerns of the people that refusing to thing out of the box and overcome the status quo. Beside the power of the will, in order to back the faith for something technology provides reliable evidence, maps as well as simulations that can contribute towards progress.
- **Acting:** Progress requires massive coordination, cooperation, continuous observation and automation. Requires teamwork and use of different aspects of technology in order to handle complexity. IBM Think, demonstrates the way with which hard progress is being achieved, contributing to evolution and knowledge.

Figure 5: Acting: How THINK offers the ability to Travel across a virtual globe to discover some of the most inspiring examples of systemic progress around the world.

To conclude the moment that this thesis is being written, application is compatible with devices that running Android 3.0 or higher versions, including tablets with display from 800 pixels as well as Xlarge displays. Moreover, it is compatible with Apple iPad given the fact that they are running on OS X 5.0 or higher.

2.2.2 DailyArt

Daily art is a free of charge application that every day publish one different piece of art. For each classic piece of art, extensive information is being provided regarding the artist created it and the era that this took place. Moreover user has always access to pieces of art that application demonstrated previous dates. All the content is organized in such a way in order to offer extensive variety of creations. All the information that accompanies the art pieces is provided in a highly simplistic manner in order user to be able to receive it. Daily art has been nominated as one of the best 12 educational application in 2012 according to Next Web.

Each publish in Daily Art contains all the basic information about a creation such as the title, the artist, the year of creation, the technique used and finally the venue that this piece is being exposed today. Daily Art is integrated with Wikipedia in order any interested user to have the opportunity to learn more about a specific piece.

Figure 6: A screenshot of the DailyArt application.

On the latest versions the ability to search for a specific artist has been added as well as the ability to modify the font behind the displayed art. Moreover, users can share the pieces of art to facebook or twitter an to receive a certain notification each time the application has a new piece of art. As an application the time that this thesis is being assembled it is on the version 1.1.3, it can function on android devices that run on Android 2.3 or higher and at the same time it is available via iTunes store for Apple devices that run on iOS 6.1 or higher.

2.2.3 WikiWeb

Wiki Web is an iPhone, iPad or iPod Touch application functioning as a Wikipedia reader, visualizing the various references and connections between the multiple articles of Wikipedia. WikiWeb is not a free application as the two aforementioned applications while it requires operation system versions iOS 6.1 or higher. Its core functionality is to offer information to the user of Wikipedia provided via a more readable and interactive interface. Moreover user has the ability to share the articles with other users as well as the path he/she followed to retrieve them. The visualization of the various links of the articles offers a huge amount of information and makes the search and retrieval of each subject far easier. To conclude, more than 110 different languages are being supported by the application giving the opportunity to expand its user base without limits.

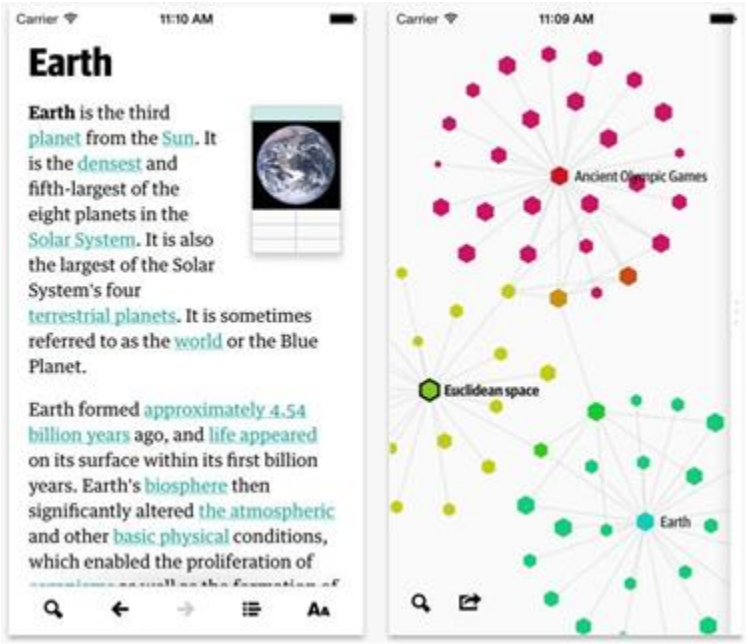

Figure 7: Screenshots of the Wikiweb application.

2.3 Educational Applications Mobile Markets

In the previous sections of this chapter a few mobile applications that are being labeled as educational have been presented. In the current chapter, a short review can be found regarding mobile application markets that are hosting Educational mobile applications. The goal of this section is to introduce these markets and their establishment. Further analysis will be performed to a later section of the current thesis.

2.3.1 Google Play Education

Educational App Store is a sub-category market of Google's App Store, addressing education. Google Play as a mobile applications market comes second in applications sales behind Apple's store and is including over 50.000 educational applications.

Figure 8:The Educational App Store

When it comes to application retrieval though, many times it can be difficult to identify and retrieve the required application that would fit the educational goals. Exactly because there is such a huge selection of applications for various subjects, Educational App Store has been created aiming to enhance the retrieval of the best educational mobile applications for teaching and learning. In order to achieve this goal in the highest possible way, educational experts from United States and United Kingdom have been approached to contribute towards this effort. Educational experts are evaluating the applications that are being submitted to the educational store and their evaluation is being followed by a certification for the educational value of its submitted application. Educational applications are being organized in the following categories:

- Student Tools
- Teaching tools
- Games
- Maths
- Languages
- English Language

- Science
- Geography
- History
- Computer Science
- Art & Music
- Literature
- Assessment Tools
- Books
- Reference
- Medical
- Health & Fitness
- Alternative Healing
- Special Needs
- Religion

As a result of this, teaching practitioners and learners, by the use of Educational App store can track down educational applications that are being interested on and fit their educational program structure, based on their content aiming to retrieve the most useful application for their learners. Following this, education professionals can buy the application their interested on and distribute it to their audience. At this point it should be mentioned that purchases being carried out from administrators or education professionals can be carried out using standard institutional payment mechanisms whether the number of the students is small or big. Statistically, it is being mentioned that more than thirty millions of learners, education professionals and other staff are using already such applications and more Google services, fact that proves that indeed store includes content that is being considered useful for the educational process by the experts of the educational industry, especially applications that are using Google sign-on.

According to Google, the major advantages that Educational Applications Market is offering can be summed up to the below bulletins:

- Applications that are being added are as valuable as it could be, as educational applications experts and learners have evaluated them.

- Critic and in-depth description is being provided for each application.
- Educational applications are being offered for classroom use but also for personal learning.
- In order to enhance traceability and retrieval of the educational applications, search is being based on categories such as age group that application aiming at, its subject, its cost and its evaluation by other users that downloaded the application.
- Offered applications are covering all range of basic education as well as lifelong learning for various subjects.

Specifically, based on case studies that have been carried out by various schools and organizations, the results of the use of educational applications on Android tablets have been very positive. Schools and organizations studied are based at United States and are offering primary and secondary education programs. Problems that were aimed to be resolved with the use of Educational Applications Store were usually being identified to the lack of technical infrastructure of the school, and to the inability of the students to access technical resources outside school. Positive results could be identified in the quality of the written projects of the students, as they were having access to greater amount of information to research. Moreover, subjects understanding during classes displayed improvement, while students displayed higher levels of engagement with the course as applications consisted a greater motivation for students in order discuss and present their thoughts [12]. In general, it has been created an more enjoyable educational environment that could offer a more personalized approach to knowledge. Finally, it has been noticed that all students had a more focused and independent approach to learning process and research.

Educational Applications market is running on Android devices as it has been developed by Google and it needs Android version 2.3.3 or higher.

2.3.2 Apple in Education

Apple is offering its own version of an Educational Applications Market with educational applications for iPad and iPad Air. As a company it claims that it is offering more than sixty-five thousand applications in the field of education, such as interactive books, virtual tours and videos from specialists and institutions on each field from all over the world. Apple's Educational applications are being offered via App Store, iBooks and iTunes that are applications that offer the ability to the user to download and install various applications form different subject categories.

In App store each interested education professional can chose among applications that enhance his/her course. This includes applications about for study and knowledge enhancement with exercises and practical theory application, while at the same time they have been built is such a way in order to cover different styles of learning. Goal of these specific applications is to inspire the learners to think new ways of learning through innovative teaching processes. In order to make search and retrieval of suitable applications easier, applications have been organized in categories based on their subject and their level of difficulty.

Regarding students with special needs, there is a special collection of educational material on App Store. Specifically it should be mentioned that after research, the use of special applications for iPod and iPhone devices and use of iTunes and iLife can help people with lack of concentration, difficulties in communication and other forms of disability. Results have indicated that teaching and learning process has been improved in classroom but also in home schooling with the use of such applications. Nowadays, more and more applications are being developed for App store addressing students with disabilities. Some of them have been specifically designed for users with special needs while others are offering universal benefits.

Figure 9: Dragon Box Application. Teaching Algebra through an entertaining game process

Moreover in App store applications collection there are applications only for education professionals, that can help them to organize and teach their subjects in a more efficient and productive way.

iBooks, are offering the user great variety of educational content while a great amount of them are being offered free of charge. According to Apple, iBooks is including content from classic literature to more specific scientific educational books from well-established publishing houses, even e-books that have been created by educational professionals with the use of iBooks Author. More specifically, the books that are being included into iBooks have been created in such a way in order to stimulate students' interest. They are including 3D objects, videos, photo material as well as interactive quizzes to revise the sections' content .

iTunes U courses are including exclusively educational content that corresponds to a variety of subjects and educational levels. It is including 750.000 applications that can add up to any course teaching process. They can be presumed as a collection of free educational material from well-known organizations. As an example, movie clips from Smithsonian are being included as well as interactive collections of art creations from MoMA, as well as educational material from schools from all over the world etc.

To conclude, special courses are being included that are being published by educational professionals from all over the world in order to achieve ideas exchange in order to identify new ways of teaching and new approaches constantly. In order teachers to register to iTunes U and have access to videos, digital books and applications have to have special "rights" in iTunes store .

2.3.3 Role Widget Store

Role Widget Store has been developed by IMC in the scope of ROLE (Responsive Open Learning Environment) Project. Role Widget store is a web platform that is including a wide collection of learning widgets and widget bundles that can be added to the learning environments of interested teachers ad learners. Widgets Bundles are collections of smaller of small web-based applications that can support specific learning object and enhance specific activities with the use of multiple tools. The different widgets of a bundle can interact (exchange and save user data) in order to support specific learning activities that are depending on each other . Role widget store is including seven different categories of widgets that are being demonstrated below.

- **Plan & Organize:** Tools in this category facilitate the planning and organization of your learning activities, process and resources as well as the setting of your learning goals (for example Google Calendar, Media List Widget)

- **Search & get Recommendation:** These tools facilitate the searching process for learning resources and/ or give recommendation for suitable tools, widgets or bundles (for example Media Search Widget)
- **Collaborate & Communicate:** These tools provide the possibility to collaborate and communicate with other participants of your learning process (for example XMP Multi-user Chat, Twitter Gadget, Ether pad etc.).
- **Explore & View:** These tools provide access to domain specific learning content. Content may be static (e.g. PDF-Reader, Wikipedia Gadget) or interactive (e.g. an applet to demonstrate mathematic formulas).
- **Train & Test:** These tools provide support for knowledge acquisition as well as training and testing of skills (for example Vocabulary Trainer or Record-Yourself – Tool).
- Create & Manipulate: Tools in this category facilitate the creation and manipulation of content in your learning environment (for example Google Docs, Ether pad and Mind mapping tools).
- **Reflect & Evaluate:** These tools facilitate reflection on learning processes, progress, results and environments. (Prototypes and widgets for this category are being tested and will be soon launched in the widget store).

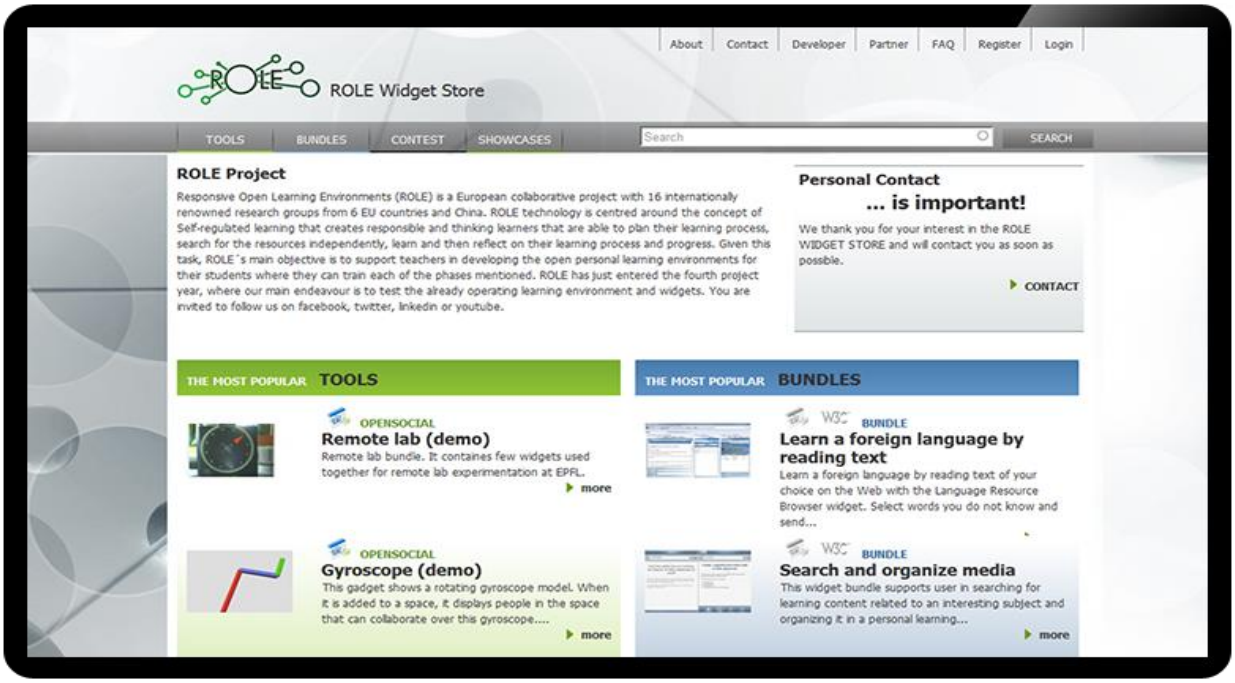

Figure 10: Role Widget Store

3. The Proposed Metadata Model for Educational Mobile Apps

3.1 Introduction

In the current chapter of this thesis, a new metadata model for educational applications will be fully documented and proposed. Multiple issues will be covered, starting with the identification of these characteristics that defining a mobile application as "educational". Following this, there will be a presentation of the latest metadata that are being used by Google Play mobile applications market. Moreover, a walkthrough of the fundamental IEEE LOM schema will take place, leading to the final part of the chapter that will be the proposal of the EMAM (**E**ducational **M**obile **A**pplications **M**etadata) model as a conclusion of this chapter.

3.2 Educational Mobile Applications – Building the Context

In order to conclude to a discrete Metadata model that will be used to identify educational mobile applications, a context should be created first in order to define what are those characteristics that make applications to be considered and characterized as "Educational". In this section of the thesis this context will be structured.

3.2.1 Mobile Learning Essentials

As the mobile technology progressing rapidly the last two decades, learning process is changing following the same pace (Green, 2000). Before technology booming, traditional knowledge resources such as books and teachers were the most frequent sources of information. Nowadays, these resources have been alternated in a high presentence as information can be accessed easily using the Web via PCs and mobile devices (Dawood Salim Al Hamdani, 2013). Based on these new factors, a need to define a universal term to refer to the new educational processes soon raised. The term **Mobile Learning** introduced in the early 00's when Bryan Alexander built the context of it in his article titled "Mobile Learning in Higher Education" in 2004. As Alexander stated, Mobile learning can be defined as the use of mobile devices as mediator in the process of learning and teaching. With Mobile Devices, a wide range of hardware is included such as mobile phones (of which smartphones are their evolution), laptops and lately tablets.

3.2.2 Mobile Learning Characteristics

As the term Mobile Learning has been defined above, in this section of the chapter the characteristics that consist Mobile Learning will be identified. In other words, we will try to identify, what are those characteristics that differentiate a Mobile Learning practice, from a commonly used traditional educational practice such as a lecture for example. Cornerstone of Mobile Learning is of course what it defines by name, *Mobility.* Since devices can provide network connectivity to users, students can have anytime-anyplace access to coursework, by having the ability to interact with the instructors and co-learners in the same course (Steifield, 2003). This is leading to the next major characteristic of Mobile Learning, which is *Accessibility* as students have easy and immediate access to course material whether it is a podcast, a video or a text file (Luvai F. Motiwalla, 2007). Additionally, as Ben Moussa suggested in 2003, as mobile connectivity is carried through personal mobile devices, high levels of personalization can be achieved. Therefore, since Mobile devices are the tool of mobile learning it is easily assumed that *Personalization* of the learning process can be considered another characteristic of Mobile Learning. Moreover, as mobile devices integrate multiple different time management features such as calendars and event planners, they can provide the end user the *Flexibility* to plan his own learning plan inside the limits each course demands (Boja, Batagan, 2009). Finally, the ease of connectivity is proving learners with limitless *Collaboration* opportunities (Boja, Batagan, 2009).

3.2.3 Defining the Educational Mobile Application

As the theoretical context of Mobile Learning has been constructed above and its different characteristics have been defined, this section will conclude to a definition for Educational Mobile Applications. On the previous section the characteristics of mobile learning have been identified. Stated this we can conclude to the fact that a mobile application is integrating and enhancing one or more of the mobile learning characteristics (Boja, Batagan, 2009). Moreover, the user role of the mobile application inside the educational process should be identified too. These roles are including the teacher or instructor, as well as the student or, in a more global term, the learner. Finally, the different purposes of use should be identified too. The purposes of usage can vary in the educational process. A mobile application can be used as a tool to enhance the procedural activities inside the learning process, like scheduling or communication (Luvai F. Motiwalla, 2007), as a tool to access and retrieve learning objects (García, Esteban, 2011) or as learning object itself as it can consist "a collection of content items, practice items, and assessment items that are combined based on a single learning objective", as learning objects defined

by Wayne Hodgins in 1994. Concluding, an **Educational Mobile Application** can be defined as "A *Software Application* that is running on a *Mobile Device* and can be used by the *Instructor* and/or *Learner* within the Learning Process, as a *Procedural Support Tool*, a *Tool* to *Retrieve Learning Objects* or as *Learning Object itself*, integrating and enhancing at the same time one or more of the fundamental characteristics of Mobile Education, *Mobility, Accessibility, Personalization, Flexibility* and *User Collaboration".*

3.3 Review of the Metadata being used by Google Play Mobile Applications Market

In this section of the present thesis there will be an attempt of recognition of the structure of the Metadata models that are being used by the most popular Mobile Applications Markets, and will be introduced. This is considered to be really important in order to identify the main trends and combine them with LOM model (will be introduced in the next section) and conclude to a well-structured new Metadata model for Educational Mobile Applications.

3.3.1 Metadata in Mobile Application Markets

Since Mobile Application Markets are the tool to search and retrieve different mobile applications Metadata is of high importance in their functionality. Generic metadata are being used for each application to describe several attributes, such as its title, the category, the developer, the evaluation score etc. Key factor is the tagging section where the uploader can input several key-words as tags, in order to describe the context of the application. After all, the metadata tags that will be used are a core factor of the discoverability of the application and what will provide more downloads. Thus, Mobile Application Markets are operating under a free tagging system, which means that there is no limit in the number or the nature of the keywords that will be used to characterize the context of the uploaded application. Of course, on each mobile applications market it can be recognized a slightly different metadata model structure. In the following sections the metadata models that are being used by the most popular mobile markets will be introduced.

3.3.2 Google Play Metadata

In this section of the present thesis, there will be a description of the metadata that can be recognized when studying the way Google Play Mobile Applications Market is characterizing its applications. This is consisted by certain fields set by Google that the application uploader should set before the upload. Google will review these metadata and when they will be approved the application will be uploaded to the market. Data elements that describe an application are grouped into different categories. In the schema proposed there can be identified 6 different categories of data.

i) ***Product Details*** where general details such as the title and description are included
ii) ***Graphic Assets*** where specific graphic elements are included in order user to have the ability to review the application interface
iii) ***Categorization*** where uploader is defining the categories under of which his/her application should be categorized
iv) ***Contact Details*** where certain contact information with developer should be included.
v) ***Privacy Policy*** which is an optional field where certain Privacy policy's link with which application complies is including
vi) ***Pricing and Distribution*** where information regarding the pricing and the country availability is including

Each of the above categories is consisted by specific data elements. Below the data elements of each group will be introduced and described.

Product Details

Language: This element defines the language of the application. Different sets of product details can be inserted for different countries. If a prefixed set of product details is not inserted for a certain language Google will auto-translate it to the language of interest.

Title: This will be the appeared titled of the application. Input allowed up to 30 characters

Description: In this field any description can be added by the uploader including certain key-words (in form of free text) in order to introduce the context and the scope of the application. Up to 4000 are allowed in this field.

Short Description: Here a short description is being added in order to provide to the user a sum of what is the application's use and functionalities.

Full Description: In this section a more brief description of the application can be offered. Moreover Notes regarding past versions and updates can be added here as well.

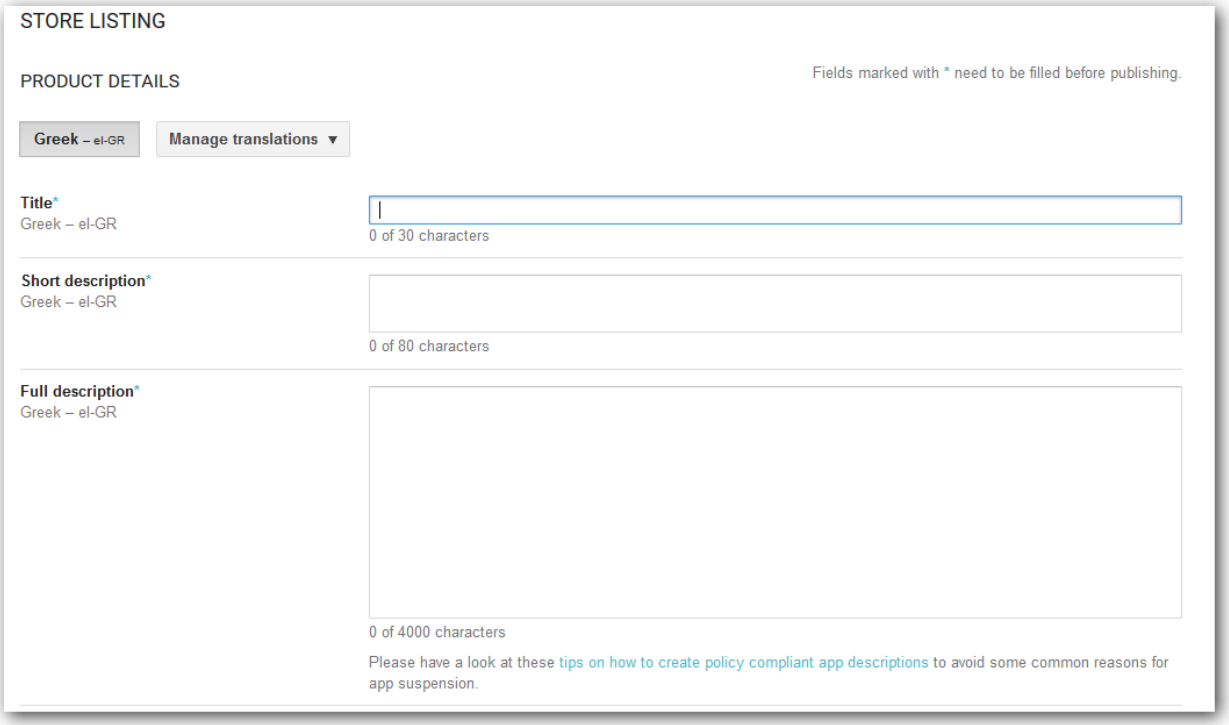

Figure 11: Language, Title, Short Description and Full Description Definition in Google Application Upload process

Graphic Elements

Screenshots: Specific screenshots of the application should be added here. At least 2 screenshots should be added within all categories, and at most 8 in each of the below categories.

Phone Screenshot

7-inch Tablet Screenshot

10-inch Tablet Screenshot

Television

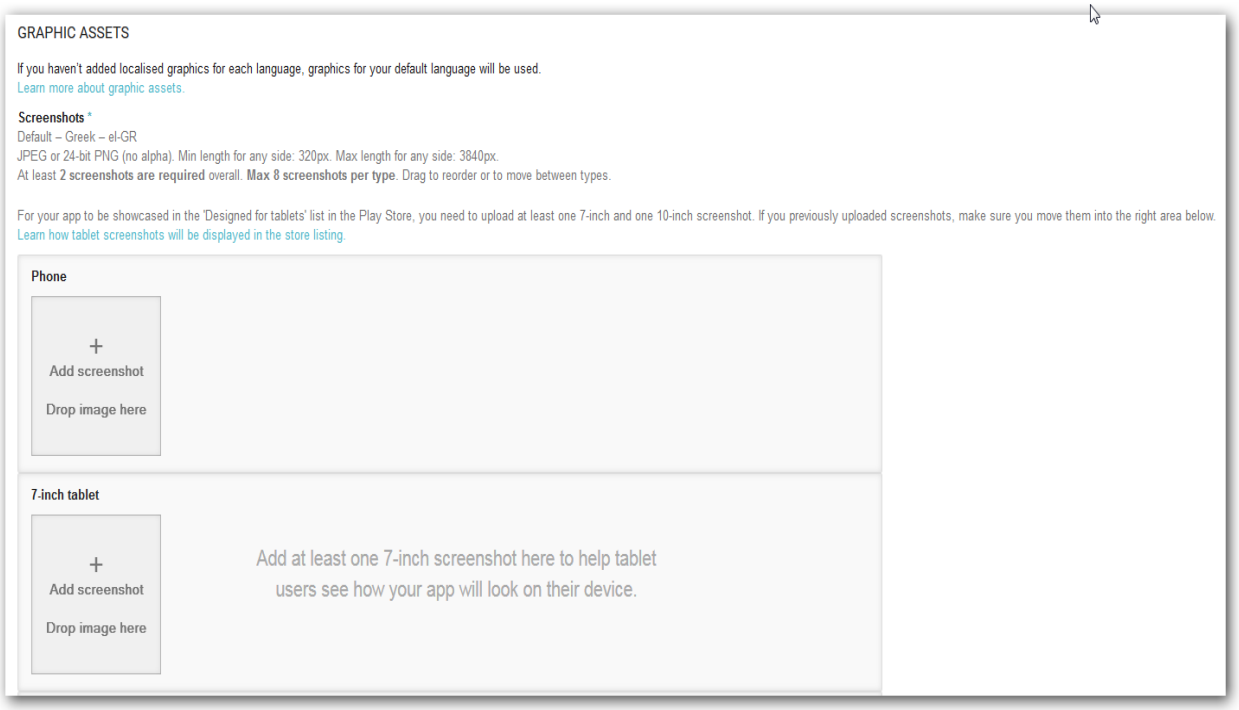

Figure 12:Sample of Graphic Elements upload section

Categorization

Application Type: In this field the type of the application is defined. Uploader can choose between two different types. Applications and Games

Category: Depending on the application's type different categories can be selected.

Content Rating: In this field the targeted audience by the application should be defined. Uploader should select from the values Adults, Teenagers, Children, Everyone.

New Content Rating: Beside the initial rating that the developer would claim his application is eligible for, a special questionnaire should be completed in order Google itself to determine special characterization that the applications should be given. Specifically Google defines that questionnaire results will be used to:

- Inform consumers about the age appropriateness of the app.
- Block or filter specific content in certain territories or to specific users where legally required.
- Evaluate app's eligibility for special developer programmes.

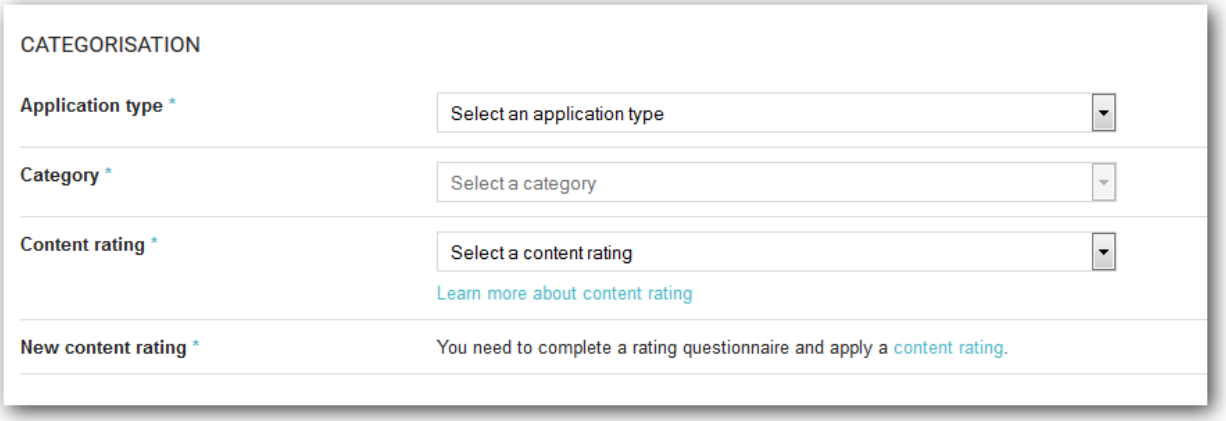

Figure 13: Categorization Attributes on Google Play

Contact Information

In the specific section, the developer should add his contact information in order Google, or clients that would be downloading his application to have the opportunity to contact him regarding matters related to the application. Specifically the developer has the option to add:

- Website's URL
- Email address
- Phone number

Privacy Policy

In this section the developer has the opportunity to provide an exclusive or separate Privacy Policy that his application is complying to. Access to this separate Privacy Policy, is being provided by a URL that developer would be adding to the specific section.

Pricing and Distribution

Pricing and distribution section is including all relevant information about the cost of the application, the location it will be available to, as well as the different Android devices that it would be supporting. Specifically developer can define:

- Pricing: This defines if the application would be available for free or it would require payment
- Countries of Distribution: Developer defining the countries on which the application will be available to.

Moreover developer can define if the application is eligible for one of the below:

- Android Wear: These applications are optimized or including features for Android Smart watches. By selecting this category on upload, application will be marked as an Android Wear Application.
- Android TV: Application is optimized for use on Android Smart TVs
- Android Auto: Application is Optimized for use in Car Devices that running under Android OS
- Designed for Families: Application is targeting family audiences and must comply with Google's regulations regarding these audiences. In order an application to be sorted inside this category, Google's special questionnaire should have been filled and application to be found eligible for it.
- Google Play for Education: As Google Play for education has been demonstrated in previous section of this thesis, by selecting this parameter, developer is submitting the application for review from educational experts in order to claim it eligibility for Google Play for Education. It is noted that in order an application to be eligible for review it must be aiming United States audience.

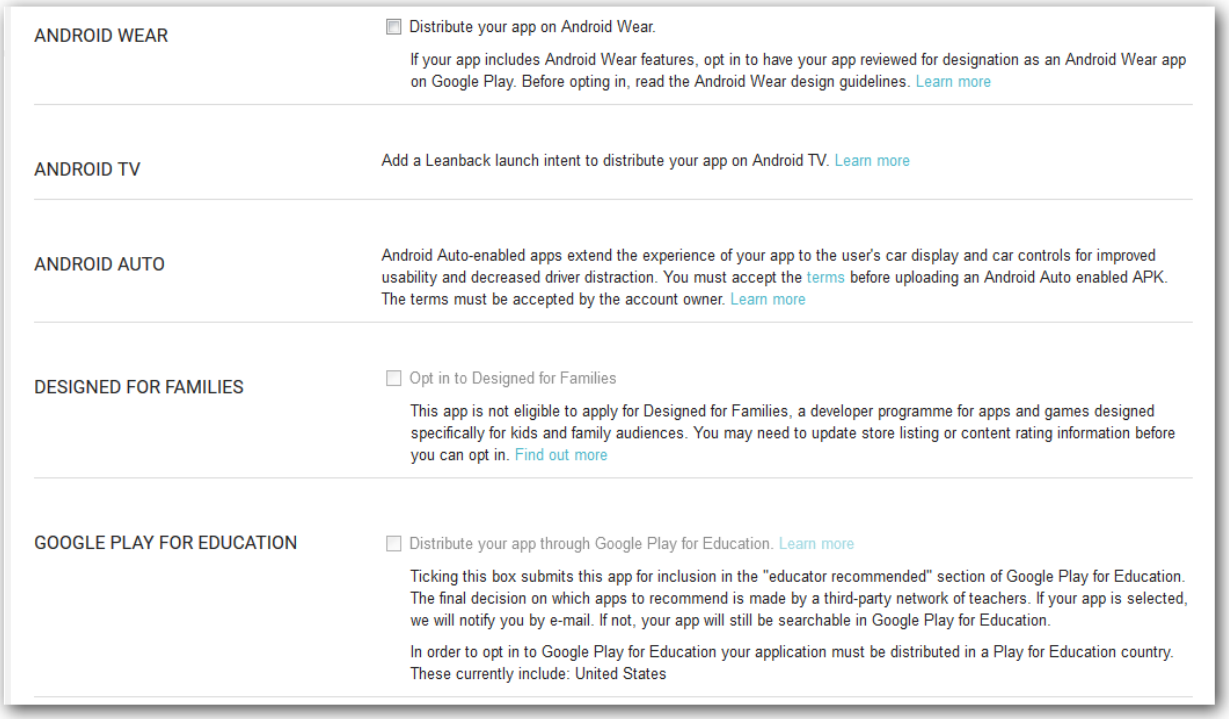

Figure 14: Categories that an Application can be eligible for

3.4 Learning Object Metadata (LOM) Model

In 2002 a specific Metadata model introduced and approved by IEEE which served to fully define and describe different learning objects. In this section of the thesis this model will be introduced as described in IEEE documentation in July, 2002.

3.4.1 Scope and Purpose of LOM as defined by IEEE

Scope of LOM is to consist a multi-part standard that specifies Learning Object Metadata. For Learning Object Metadata Model, a learning object is defined as any entity -digital or non-digital- that may be used for learning, education or training. A metadata instance for a learning object describes relevant characteristics of the learning object to which it applies. Such characteristics may be grouped in general, life cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories. These categories would be presented in the next section of this thesis.

The conceptual data schema specified by LOM permits linguistic diversity of both learning objects and the metadata instances that describe them. This conceptual data schema specifies the data elements which compose a metadata instance for a learning object. In general, LOM, is intended to be referenced by other standards that define the implementation descriptions of the data schema so that a metadata instance for a learning object can be used by a learning technology system to manage, locate, evaluate or exchange learning objects. Finally it should be noted that, LOM Standard does not define how a learning technology system represents or uses a metadata instance for a learning object (IEEE, 2002).

Purpose of Learning Object Metadata Standard is to facilitate search, evaluation, acquisition, and use of learning objects, for instance by learners or instructors or automated software processes. As a multi-part Standard also facilitates the sharing and exchange of learning objects, by enabling the development of catalogs and inventories while taking into account the diversity of cultural and lingual contexts in which the learning objects and their metadata are reused. By specifying a common conceptual data schema, LOM Standard ensures that bindings of Learning Object Metadata have a high degree of semantic interoperability. As a result, transformations between bindings will be straightforward.
Finally it is being mentioned that LOM specifies a base schema, which may be extended as practice develops, facilitating, automatic, adaptive scheduling of learning objects by software agents (IEEE, 2002).

3.4.2 Basic Metadata Structure of LOM

In current section of this thesis a short description will be provided regarding the basic Metadata structure that LOM model is using as it has been defined by IEEE committee.

Learning Object Metadata Model elements describe a learning object and are grouped into categories. The LOMv1.0 Base Schema consists of nine such categories:

1) **General category**: Groups the general information that describes the learning object as a whole.
2) **Lifecycle category**: Groups the features related to the history and current state of this learning object and those who have affected this learning object during its evolution.
3) **Meta-Metadata category**: Groups information about the metadata instance itself (rather than the learning object that the metadata instance describes).
4) **Technical category**: Groups the technical requirements and technical characteristics of the learning object.
5) **The Educational category:** Groups the educational and pedagogic characteristics of the learning object.
6) **The Rights category:** Groups the intellectual property rights and conditions of use for the learning object.
7) **The Relation category**: Groups features that define the relationship between the learning object and other related learning objects.
8) **The Annotation category**: Provides comments on the educational use of the learning object and provides information on when and by whom the comments were created.
9) **The Classification category**: Describes this learning object in relation to a particular classification system.

3.4.3 LOM Base Schema

In this section of current thesis LOM base schema will be presented as it has been introduced by IEEE in 2002. All tables that will be presented are part of LOM standard as they have been presented to the related documents. For the purpose of this thesis they have been selected for presentation the base schema's tables of which data-elements will apply to the proposed EMAM model that will be presented at the next chapter of the thesis.

Number	Name	Explanation	Size	Order	Value Space	Datatype	Example
1	General	This category groups the general information that describes this learning object as a whole.	1	unspecified	-	-	-
1.1	Identifier	A globally unique label that identifies this learning object	smallest permitted maximum: 10 items	unspecified	-	-	-
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"ISBN", "ARIADNE", "URI"
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this learning object. A namespace specific string.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"2-7342-0318", "LEAO875", "http://www.ieee.org/documents/1234"
1.2	Title	Name given to this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "The life and works of Leonardo da Vinci")
1.3	Language	The primary human language or languages used within this learning object to communicate to the intended user. **NOTE 1**:--An indexation or cataloging tool may provide a useful default. **NOTE 2**:--If the learning object had	smallest permitted maximum: 10 items	unordered	LanguageID = Langcode ("-"Subcode)* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1:1997. NOTE 4:-`This	CharacterString (smallest permitted maximum: 100 char)	"en", "en-GB", "de", "fr-CA", "it" "grc" (ancient greek, until 1453) "en-US-philadelphia" "eng-GB-cockney" "map-PG-buin" (Austronesian –Papua New Guinea – buin) "gem-US-pennsylvania"

		no lingual content (as in the case of a picture of the Mona Lisa, for example), then the appropriate value for this data element would be "none". **NOTE 3**:--This data element concerns the language of the learning object. Data element 3.4:Meta-Metadata.Language concerns the language of the metadata instance.			value space is also defined by RFC1766:1995 and is harmonized with that of the xml:lang attribute. NOTE 5:--ISO 639:1988 also includes "ancient" languages, like Greek and Latin. The language code should be given in lower case and the country code (if any) in upper case. However, the values are case insensitive. "none" shall also be an acceptable value.		

1.4	Description	A textual description of the content of this learning object. **NOTE**:--This description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether or not the learning object being described is appropriate and relevant for the users.	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 2000 char)	("en", "In this video clip, the life and works of Leonardo da Vinci are briefly presented. The focus is on his artistic production, most notably the Mona Lisa.")
1.5	Keyword	A keyword or phrase describing the topic of this learning object. This data element should not be used for characteristics that can be described by other data elements.	A keyword or phrase describing the topic of this learning object. This data element should not be used for characteristics that can be described by other data elements.	smallest permitted maximum: 10 items	unordered	LangString (smallest permitted maximum: 1000 char)	("en", "Mona Lisa")
1.6	Coverage	The time, culture, geography or region to which this learning object applies. The extent or scope of the content of the learning object. Coverage will typically include spatial location (a place name or geographic	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	("en", "16th century France") NOTE 2:--A learning object could be about farming in 16th century France: in that case, its subject can be described with 1.5:General.Keyword=("en","farming") and its 1.6:General.Coverage can be ("en","16th century France").

		coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Recommended best practice is to select a value from a controlled vocabulary (for example, the Thesaurus of Geographic Names [TGN]) and that, where appropriate, named places or time periods be used in preference to numeric identifiers such as sets of coordinates or date ranges. **NOTE 1**:--This is the definition from the Dublin Core Metadata Element Set, version 1.14					
1.7	Structure	Underlying organizational structure of this learning object.	1	unspecified	atomic: an object that is indivisible (in this context). collection: a set of objects with no specified relationship between them. networked: a set of objects with relationships that are unspecified. hierarchical: a set	Vocabulary (State)	NOTE:--A learning object with Structure="atomic" will typically have 1.8:General.AggregationLevel=1. A learning object with Structure="collection", "linear", "hierarchical" or "networked" will typically have 1.8:General.AggregationLevel=2, 3 or 4.

					of objects whose relationships can be represented by a tree structure. linear: a set of objects that are fully ordered. Example: A set of objects that are connected by "previous" and "next" relationships.		
1.8	Aggregation Level	The functional granularity of this learning object.	1	unspecified	1: the smallest level of aggregation, e.g., raw media data or fragments. 2: a collection of level 1 learning objects, e.g., a lesson. 3: a collection of level 2 learning objects, e.g., a course. 4: the largest level of granularity, e.g., a set of courses that lead to a certificate. NOTE 1:--Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects.	Vocabulary (Enumerated)	If the learning object is a digital picture of the Mona Lisa, 1.7:General.Structure=Atomic and 1.8:General.AggregationLevel=1. If the learning object is a lesson with the digital picture of the Mona Lisa, 1.7:General.Structure=Collection or Networked (since there are two descriptions of the same type of Structure) and 1.8:General.AggregationLevel=2. If the learning object is a course on the Mona Lisa, 1.7:General.Structure=Linear if the documents are intended to be viewed linearly and 1.8:General.AggregationLevel=3. If the learning object is a collection of lessons on the Mona Lisa from different sources, 1.7:General.Structure=Collection and 1.8:General:AggregationLevel=3. Lastly if the learning object is a set of courses with a full history, description, interpretation, etc. of the Mona Lisa, 1.7:General.Structure=Linear or

							Hierarchical and 1.8:General.AggregationLevel=4. NOTE 2:--A learning object with AggregationLevel=1 will typically have 1.7:General.Structure="atomic". A learning object with AggregationLevel=2, 3 or 4 will typically have 1.7:General.Structure= "collection", "linear", "hierarchical" or "networked".

Table 1: General Category of LOM Base Schema

Source: "Draft Standard for Learning Object Metadata" (IEEE,2002)

Number	Name	Explanation	Size	Order	Value Space	Datatype	Example
2	Lifecycle	This category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.	1	unspecified	-	-	-
2.1	Version	The edition of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 50 char)	("en", "1.2.alpha"), ("nl", "voorlopige versie")
2.2	Status	The completion status or condition of this learning object.	1	unspecified	draft final revised unavailable NOTE:--When the status is "unavailable" it means that the learning object itself is not available.	Vocabulary (State)	-
2.3	Contribute	Those entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication). NOTE 1:--This data element is different from 3.3:Meta-Metadata.Contribute. NOTE 2:--Contributions should be considered in a very broad sense here, as all actions that affect the state of the	smallest permitted maximum: 30 items	ordered	-	-	-

		learning object.					
2.3.1	Role	Kind of contribution. NOTE 1:-- Minimally, the Author(s) of the learning object should be described.	1	unspecified	author publisher unknown initiator terminator validator editor graphical designer technical implementer content provider technical validator educational validator script writer instructional designer subject matter expert NOTE 2:-- "terminator" is the entity that made the learning object unavailable	Vocabulary (State)	-
2.3.2	Entity	The identification of and information about entities (i.e., people, organizations) contributing to this learning object. The entities shall be ordered as most relevant first.	smallest permitted maximum: 40 items	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday@host.com\nEND:VCARD\n"
2.3.3	Date	The date of the contribution.	1	unspecified	-	Date Time	"2001-08-23"

Table 2: Lifecycle Category of LOM Base Schema

Source: “Draft Standard for Learning Object Metadata” (IEEE,2002)

Number	Name	Explanation	Size	Order	Value Space	Datatype	Example
4	Technical	This category describes the technical requirements and characteristics of this learning object.	1	unspecified	-	-	-
4.1	Format	Technical datatype(s) of (all the components of) this learning object. This data element shall be used to identify the software needed to access the learning object.	smallest permitted maximum: 40 items	unordered	MIME types based on IANA registration (see RFC2048:1996) or "non-digital"	CharacterString (smallest permitted maximum: 500 char)	“video/mpeg", "application/x-toolbook", "text/html"
4.2	Size	The size of the digital learning object in bytes (octets). The size is represented as a decimal value (radix 10). Consequently, only the digits "0" through "9" should be used. The unit is bytes, not Mbytes, GB, etc. This data element shall refer to the actual size of this learning object. If the learning object is compressed, then this data element shall refer to the uncompressed size.	1	unspecified	ISO/IEC 646:1991, but only the digits "0".. "9"	CharacterString (smallest permitted maximum: 30 char)	"4200"
4.3	Location	A string that is used to access this learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier). The first element of this list shall be the preferable location. NOTE:--This is where the learning object described by this metadata instance is physically located.	smallest permitted maximum: 10 items	ordered	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"http://host/id"

4.4	Requirement	The technical capabilities necessary for using this learning object. If there are multiple requirements, then all are required, i.e., the logical connector is AND.	smallest permitted maximum: 40 items	unordered	-	-	-
4.4.1	Composite	Grouping of multiple requirements. The composite requirement is satisfied when one of the component requirements is satisfied, i.e., the logical connector is OR.	smallest permitted maximum: 40 items	unordered	-	-	-
4.4.1.1	Type	The technology required to use this learning object, e.g., hardware, software, network, etc.	1	unspecified	operating system browser	Vocabulary (State)	-
4.4.1.2	Name	Name of the required technology to use this learning object. NOTE 1:--The value for this data element may be derived from 4.1:Technical.Format automatically, e.g., "video/mpeg" implies "multi-os". NOTE 2:--This vocabulary includes most values in common use at the time that this Standard was approved.	1	unspecified	if Type="operating system", then: pc-dos ms-windows macos unix multi-os none if Type="browser" then : any netscape communicator ms-internet explorer opera amaya	Vocabulary (State)	-
4.4.1.3	Minimum Version	Lowest possible version of the required technology to use this learning object.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	"4.2"
4.4.1.4	Maximum Version	Highest possible version of the required technology to use this learning object.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	"6.2"
4.5	Installation Remarks	Description of how to install this learning object.	1	unspecified	-	LangString (smallest permitted	("en", "Unzip the zip file and launch index.html in your

						maximum: 1000 char)	web browser.")
4.6	Other Platform Requirements	Information about other software and hardware requirements. NOTE:--This element is intended for descriptions of requirements that cannot be expressed by data element 4.4:Technical.Requirement.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en","sound card"), ("en","runtime X")
4.7	Duration	Time a continuous learning object takes when played at intended speed. NOTE:--This data element is especially useful for sounds, movies or animations.	1	unspecified	-	Duration	"PT1H30M", "PT1M45S"

Table 3: Technical Category of LOM Base Schema

Source: "Draft Standard for Learning Object Metadata" (IEEE,2002)

Number	Name	Explanation	Size	Order	Value Space	Datatype	Example
5	Educational	This category describes the key educational or pedagogic characteristics of this learning object. NOTE:--This is the pedagogical information essential to those involved in achieving a quality learning experience. The audience for this metadata includes teachers, managers, authors, and learners.	smallest permitted maximum: 100 items	unspecified	-	-	-
5.1	Interactivity Type	Predominant mode of learning supported by this learning object. "Active" learning (e.g., learning by	1	unspecified	active expositive mixed	Vocabulary (State)	active documents (with learner's action): · simulation (manipulates, controls or enters data or parameters); · questionnaire (chooses or writes answers);

		doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is "mixed". NOTE:--Activating links to navigate in hypertext documents is not considered to be a productive action.					· exercise (finds solution); · problem statement (writes solution). expositive documents (with learner's action): · hypertext document (reads, navigates); · video (views, rewinds, starts, stops); · graphical material (views); · audio material (listens, rewinds, starts, stops). mixed document: · hypermedia document with embedded simulation applet
5.2	Learning Resource Type	Specific kind of learning object. The most	smallest permitted	ordered	exercise simulation	Vocabulary (State)	-

		dominant kind shall be first. NOTE:--The vocabulary terms are defined as in the OED:1989 and as used by educational communities of practice.	maximum: 10 items		questionnaire diagram figure graph index slide table narrative text exam experiment problem statement self assessment lecture		
5.3	Interactivity Level	The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning object . NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	NOTE 2:--Learning objects with 5.1:Educational.InteractivityType="active" may have a high interactivity level (e.g., a simulation environment endowed with many controls) or a low interactivity level (e.g., a written set of instructions that solicit an activity). Learning objects with 5.1:Educational.InteractivityType="expositive" may have a low interactivity level (e.g., a piece of linear, narrative text produced with a standard word processor) or a medium to high interactivity level (e.g., a sophisticated hyperdocument, with many internal links and views).
5.4	Semantic Density	The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or --in the case of self-timed resources such as audio or video-- duration. The semantic density of a learning object is independent of its difficulty. It is best illustrated with examples of	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	Active documents: user interface of a simulation · low semantic density: a screen filled up with explanatory text, a picture of a combustion engine, and a single button labeled "Click here to continue" · high semantic density: screen with short text, same picture, and three buttons labeled "Change compression ratio", "Change octane index", "Change ignition point advance" Expositive documents: · medium difficulty text document o medium semantic density: "The

		expositive material, although it can be used with active resources as well. NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.					class of Marsupial animals comprises a number of relatively primitive mammals. They are endowed with a short placentation, after which they give birth to a larva. The larva thereafter takes refuge in the mother's marsupium, where it settles to finish its complete development." o high semantic density: "Marsupials are primitive mammals, with short placentation followed by the birth of larva, which thereafter takes refuge in the marsupium to finish its development." easy video document o low semantic density: The full recorded footage of a conversation between two experts on the differences between Asian and African elephants; 30 minutes duration. o high semantic density: An expertly edited abstract of the same conversation; 5 minutes duration · difficult mathematical notation o medium semantic density: The text representation of the theorem: For any given set j, it is always possible to define another set y, which is a superset of j. o very high semantic density: The symbolic representation (formula) of the theorem ("j $y: y É j)
5.5	Intended End User Role	Principal user(s) for which this learning object was designed, most dominant first. NOTE 1:--A learner works with a learning object in order to learn something. An author creates or publishes a learning object. A manager manages	smallest permitted maximum: 10 items	unspecified	teacher author learner manager	Vocabulary (State)	An authoring tool that produces pedagogical material is a typical example of a learning object whose intended end user is an author

		the delivery of this learning object, e.g., a university or college. The document for a manager is typically a curriculum. NOTE 2:--In order to describe the intended end user role through the skills the user is intended to master, or the tasks he or she is intended to be able to accomplish, the category 9:Classification can be used.					
5.6	Context	The principal environment within which the learning and use of this learning object is intended to take place. NOTE:--Suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement, as in ("LOMv1.0","higher education") and ("http://www.ond.vlaanderen.be/onderwijsinvlaanderen/Default.htm", "kandidatuursonderwijs")	smallest permitted maximum: 10 items	unordered	school higher education training other	Vocabulary (State)	-
5.7	Typical Age Range	Age of the typical intended user. This data element shall refer to developmental age, if that would be different from chronological age. NOTE 1:--The age of the learner is important for finding learning objects, especially for school age learners and their teachers. When applicable, the string should be formatted as minimum age-maximum age or minimum age-. (NOTE:--This is a compromise	smallest permitted maximum: 5 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	"7-9", "0-5", "15", "18-", ("en","suitable for children over 7"), ("en","adults only")

		between adding three component elements (minimum age, maximum age, and description) and having just a free text field.) NOTE 2:--Alternative schemes for what this data element tries to cover (such as various reading age or reading level schemes, IQ's or developmental age measures) should be represented through the 9:Classification category.					
5.8	Difficulty	How hard it is to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange	1	unspecified	very easy easy medium difficult very difficult	Vocabulary (Enumerated)	-
5.9	Typical Learning Time	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	1	unspecified	-	Duration	"PT1H30M", "PT1M45S"
5.10	Description	Comments on how this learning object is to be used.	smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "Teacher guidelines that come with a textbook.")
5.11	Language	This category describes the intellectual property rights and conditions of use for this learning object. NOTE:--The intent is to reuse results of ongoing work in the Intellectual Property Rights and ecommerce	1	unspecified	-	-	-

		communities. This category currently provides the absolute minimum level of detail only.					

Table 4: Educational Category of LOM Base Schema

Source: "Draft Standard for Learning Object Metadata" (IEEE,2002)

Number	Name	Explanation	Size	Order	Value Space	Datatype	Example
6	Rights	This category describes the intellectual property rights and conditions of use for this learning object. NOTE:--The intent is to reuse results of ongoing work in the Intellectual Property Rights and ecommerce communities. This category currently provides the absolute minimum level of detail only.	1	unspecified	-	-	-
6.1	Cost	Whether use of this learning object requires payment.	1	unspecified	yes no	Vocabulary (State)	-
6.2	Copyright and Other Restrictions	Comments on the conditions of use of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "Use of this learning object is only permitted after a donation has been made to Amnesty International.")

6.3	Description	Comments on the conditions of use of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "Use of this learning object is only permitted after a donation has been made to Amnesty International.")

Table 5: Rights Category of LOM Base Schema

Source: "Draft Standard for Learning Object Metadata" (IEEE,2002)

3.5 Educational Mobile Applications Metadata (EMAM) Model

In the current section of the present thesis, the Educational Mobile Applications Metadata Model will be proposed. EMAM model is the result of the fusion of vital Mobile Applications Metadata and fundamental Educational Metadata as they have been proposed by Learning Object Metadata model, looking to describe each educational mobile application, within a standard context, fact that will enhance its discoverability and will make its retrieval more sufficient. The section will begin suggesting the scope and purpose of the proposed model, general description of its categories will follow, vocabularies and elements will be defined and finally all information will be summed up on the metadata model's table.

3.5.1 Scope of EMAM

Educational Mobile Applications Metadata model is a proposed schema that would be describing the educational mobile applications. With the use of EMAM, specific instances of metadata can be used to describe educational mobile applications as whole. For this standard, as defined in previous section of this thesis, educational mobile application is a software application that is running on a mobile device and can be used by the Instructor and/or Learner within the Learning Process, as a Procedural Support Tool, a Tool to Retrieve Learning Objects or as Learning Object itself, integrating and enhancing at the same time one or more of the fundamental characteristics of Mobile Education: Mobility, Accessibility, Personalization, Flexibility and User Collaboration.

In EMAM model, an instance of metadata of an educational mobile application can describe it, assigning to it characteristics, that can be grouped in the following categories *General Information*, *Lifecycle*, *Technical Characteristics*, *Educational Characteristics*, *Rights* and *Annotation*. The data schema that would be presented specifies the data elements, which can form a metadata instance for an educational mobile application. EMAM model will be used by educational mobile applications market ASK4APPS that has been created during this thesis, in the form of a database being queried by a guided search

3.5.2. Purpose of EMAM

The purpose of the proposed metadata model is to enhance characterization, search, retrieval and use of educational mobile applications, that are about to be used by educational experts and learners

among any level of education. Moreover, this metadata model can be utilized for use within different software applications. Educational mobile applications metadata model also enhances the sharing and reusability of educational mobile applications, by utilizing attributes of LOM model and common Google Play mobile applications market, leading to a model that can be used by different forms of software that targeting to search, retrieval or characterization of educational mobile applications.

3.5.3 Definitions

i) **Category** (LTSC –Learning Technology Standards Committee– Learning Object Metadata): A group of related data elements.

ii) **EMAM (Educational Mobile Applications Metadata) data element:** A data element for which the name, explanation, size, value space, and datatype are defined in this proposition of the current thesis.

iii) **Datatype:** A set of distinct values, indicating common characteristics of those values and operations.

iv) **Educational Mobile Application:** For EMAM, an educational mobile application is a Software Application that is running on a Mobile Device and can be used by the Instructor and/or Learner within the Learning Process, as a Procedural Support Tool, a Tool to Retrieve Learning Objects or as Learning Object itself, integrating and enhancing at the same time one or more of the fundamental characteristics of Mobile Education, Mobility, Accessibility, Personalization, Flexibility and User Collaboration .

3.5.4 Basic Metadata Structure of EMAM

In this section of the current thesis the basic metadata structure of the EMAM model will be introduced and a short description of each of the categories. Educational mobile applications metadata model is consisted by 6 different categories of data elements.

i) **General Info:** Data elements in this category are generic, and they are describing the educational application as whole.

ii) **Lifecycle:** Data Elements in Lifecycle category are providing information regarding the origin and current status of the educational application.

iii) **Technical Characteristics:** Data elements in this category are providing info about the technical requirements of an educational application

iv) **Educational Characteristics:** Data elements in educational characteristics are providing information regarding the educational characteristics of the application defining its educational value and purpose

v) **Rights:** Data elements in rights characteristics are defining whether an application is protected by copy write laws and whether it requires some short of payment or not.

vi) **Annotation:** Data elements in annotation section are aiming to define the previous educational use that has been done with the application, share ideas and provide guidance for its future use.

3.5.5 EMAM Base Schema

In this section of current thesis, the EMAM Base Schema will be suggested, and its structure will be defined through the below table that is including all the related data elements.

Number	Name	Explanation	Size	Value Space	Datatype	Example	Element first Identified in
1	General	This category is generic, and it is describing the educational mobile application as whole	1	-	-	-	LOM, Google Play
1.1	Title	A set of alphanumeric characters or phrase set by the developer of the educational application as its name	1	-	LangString (smallest permitted maximum: 100 char)	“Coursera” “Mathematics” “Greek Driving Test”	LOM, Google Play
1.2	Language	The primary languages that are being used inside the educational application to communicate with the intended user.	1	LanguageID = Langcode ("-"Subcode)* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1:1997 (IEEE,2002)	CharacterString (smallest permitted maximum: 100 char)	“en-US” “de” “it”	LOM
1.3	Description	A set of phrases, set by the creator of the application that describing its nature and functionalities	1	-	LangString (smallest permitted maximum: 10000 char)	“Coursera connects you with free online courses from 115+ of the top universities and educational institutions in the world including Stanford, Yale, Princeton and others. Browse our catalog, join courses and watch lectures from the world’s best instructors. Learn anytime, anywhere, in topics ranging from computer science to cooking and beyond.”	LOM, Google Play
1.4	Keywords	A set of individual words that describing	smallest permitted	-	LangString (smallest	“Space”,”Course Planner”,	Google Play,LOM

		certain characteristics of the application that would be utilized in a possible search	maximum: 20 items		permitted maximum: 1000 char)	“Mathematics”,”Physics”	
2	Lifecycle	Lifecycle category is grouping the information regarding the origin and current status of the educational application	1	-	-	-	LOM
2.1	Application Version	One or more numeric digits separated with a dot (.) defining the version of the educational application	1	-	-	“2.0”,”1.5”	Google Play
2.2	Contribution	Those entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication).	smallest permitted maximum: 5 items	-	-	“University of Piraeus”,”John Papadopoulos”	LOM
3	Technical	Technical category is grouping the information about the technical requirements of an educational application	1	-	-	-	-
3.1	Minimum Required Android Version	The minimum version of Android operating system that is needed in order the educational application to function on the mobile device	1	-	-	“5.0”,”4.4.4”	Google Play
3.2	Size of Application	The overall size of the educational application that is needed to be allocated in the mobile device’s memory. The size is represented as a decimal value (radix 10). Consequently,	1	ISO/IEC 646:1991, but only the digits "0".."9"	CharacterString (smallest permitted maximum: 10 char)	“5MB”,”10MB”	Google Play

		only the digits "0" through "9" should be used. The unit is Mbytes.					
4	Educational	Educational characteristics category is grouping the information regarding the educational characteristics of the application.	1	-	-	-	LOM
4.1	Interactivity Type	Predominant mode of learning supported by this learning object. "Active" learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through	1	Active, expositive, mixed (LOM,IEEE,2002)	Vocabulary (State)	Applications Characterized as **Active** (with learner's action): · Feature simulations (manipulates, controls or enters data or parameters); · Including questionnaires (chooses or writes answers); · Exercises (finds solution); · problem statement (writes solution). Applications Characterized as **Expositive** (with learner's action): · hypertext document (reads, navigates); · video (views, rewinds, starts, stops); · graphical material (views); · audio material (listens, rewinds, starts, stops). Applications characterized as **Mixed** · hypermedia document with embedded simulation applet.	LOM

		text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is "mixed". (LOM, IEEE 2002)					
4.2	Content Type	Specific kind of learning artifacts that are being used inside the educational application. The most dominant kind shall be first	smallest permitted maximum: 10 items	exercise simulation questionnaire diagram figure graph index slide table narrative text exam experiment problem statement self-assessment lecture	Vocabulary (State)	-	LOM
4.3	Interactivity Level	The degree of interactivity characterizing the educational application. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning entities	1	very low low medium high very high	Vocabulary (Enumerated)	-	LOM

		exposed by the educational application. (LOM, IEEE, 2002)					
4.4	Semantic Density	The degree of conciseness of an educational application. The semantic density of an educational application may be estimated in terms of its size, span, or --in the case of self-timed resources such as audio or video-- duration. The semantic density of an educational application is independent of its difficulty. It is best illustrated with examples of expositive material, although it can be used with active resources as well.	1	very low low medium high very high	Vocabulary (Enumerated)	-	LOM
4.5	Indented End User	The main users that the educational application is intended to be used by. Most dominant first.	smallest permitted maximum: 4 items	teacher author learner manager	Vocabulary (State)	An educational application that featuring Theoretical Driving Tests is a typical example of an application intended to be used by learner	LOM
4.6	Context	The main environment within which the learning and use of this educational application is intended to take place. (LOM, IEEE, 2002)	smallest permitted maximum: 10 items	school higher education training other	Vocabulary (State)	-	LOM

4.7	Age Range	Age of the typical intended user. This data element shall refer to developmental age, if that would be different from chronological age. (LOM, IEEE, 2002)	smallest permitted maximum: 5 items	-	LangString (smallest permitted maximum: 30 char)	“0-5”,”18+”,”12-15”	LOM
4.8	Difficulty	How hard it is to work with or through this educational application for the typical intended target audience.	1	very easy easy medium difficult very difficult	Vocabulary (Enumerated)	-	LOM
4.9	Language	The human language used by the typical intended user of this educational application	1	LanguageID = Langcode ("-"Subcode)* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1:1997 (IEEE,2002)	CharacterString (smallest permitted maximum: 100 char)	“en-US” “de” “it”	LOM
5	Rights	Rights characteristics category is defining whether an application is protected by copy write laws and whether it requires some short of payment or not	1	-	-	-	LOM
5.1	Cost	Defining whether the download and use of the educational application requires a payment or not	1	Yes No	-	-	Google Play, LOM

5.2	Copyrights	Defining whether copyrights or other restrictions apply to the educational application, or it is an open source application.	1	Yes No	-	-	LOM
6	Annotations	Annotation category is aiming to define the previous educational use of the application via the related data elements	Unlimited	-	-	-	LOM
6.1	Entity	Entity (i.e., people, organization) that created this annotation.	1	-	LangString (smallest permitted maximum: 100 char)	"George Nikolaou, "John Alex", "University of Piraeus"	LOM
6.2	Date	Date that this annotation was created.	1	-	DateTime	"09-05-2015"	LOM
6.3	Description	The content of this annotation.	1	-	LangString (smallest permitted maximum: 1000 char)	-	LOM

Table 6: EMAM Base Schema

4. Mobile Educational Applications Market Ask4Apps

4.1 Introduction

In this chapter of this thesis, the developed android educational applications market Ask4Apps that has been developed during the thesis will be presented. All the different sections of the application will be presented, along with search examples to demonstrate how the application can enhance the search and retrieval of educational applications for educational experts and learners. Moreover, the process of the addition of an application to the cloud database of the application will be presented.

4.2 Ask4Apps Educational Applications' Market Presentation

Following the analysis that have been performed in previous parts of this thesis, regarding the theoretic part of what consists an educational application as long as the proposal of the Educational Mobile Applications Metadata (EMAM) model, Ask4Apps has been developed to host various educational applications, characterized with the metadata proposed by EMAM model, and providing the opportunity to the user to search the application needed, determining parameters defined by EMAM. Moreover the opportunity for user to submit his/her own application for review and finally addition to Ask4Apps is provided, along with the opportunity to comment on an application but also to add annotation regarding the use he performed to a specific application. Below can be found listed all the parts of the application that will be presented.

- Application Boot and Start Screen
- Application Submission
- All Applications Listing
- Sorting By Rating Listing
- Application Presentation to the User
- Guided Search using EMAM

4.2.1 Application Boot and Start Screen

By selecting the application's icon, application's splash screen will be displayed along with the logo of the application and loader icon that will notify the user that application is loading on the background. During the sort waiting time, server connection will be established and application will load its database. In case that there is no internet connection, notification message will come up, informing the user that the application needs internet connection to function. This communication window is providing

the option to navigate to settings to turn the internet connection on, or continue with previously cached data. Below, splash screen is displayed and the related screen in case application fails to establish a connection with the network.

Figure 15: Ask4Apps Splash Screen

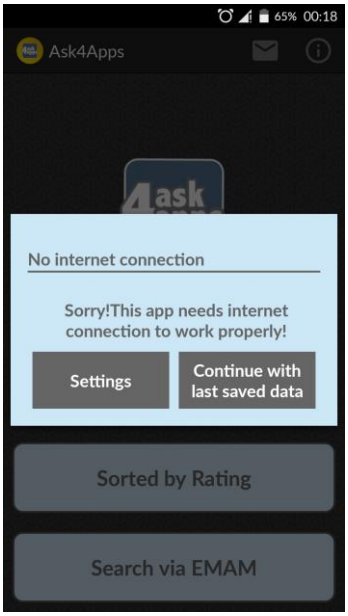

Figure 16: Network Connectivity Failure & Options

After the application load the initial selection (Start) screen will appear. On the Start screen, user can begin with the different functionalities of the application. Options available are:

- Display all available educational applications
- Display all available educational applications sorted by rating
- Start an educational applications' search defining parameters listed in EMAM model
- Submit an educational application for review and addition to the market
- Display applications' the help menu

Below the start screen is being displayed along with captions from the Help menu that is walking user through the functionalities of the application.

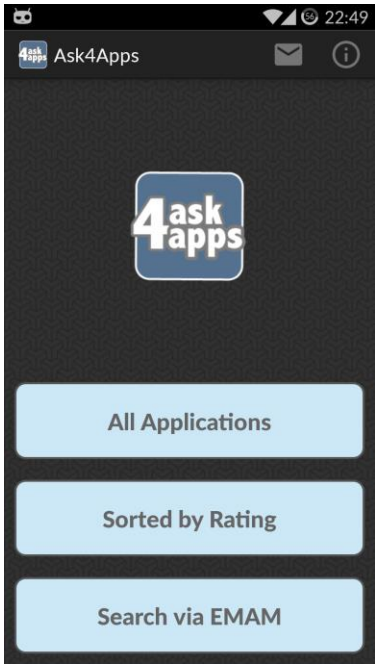

Figure 17: Ask4Apps Start Screen

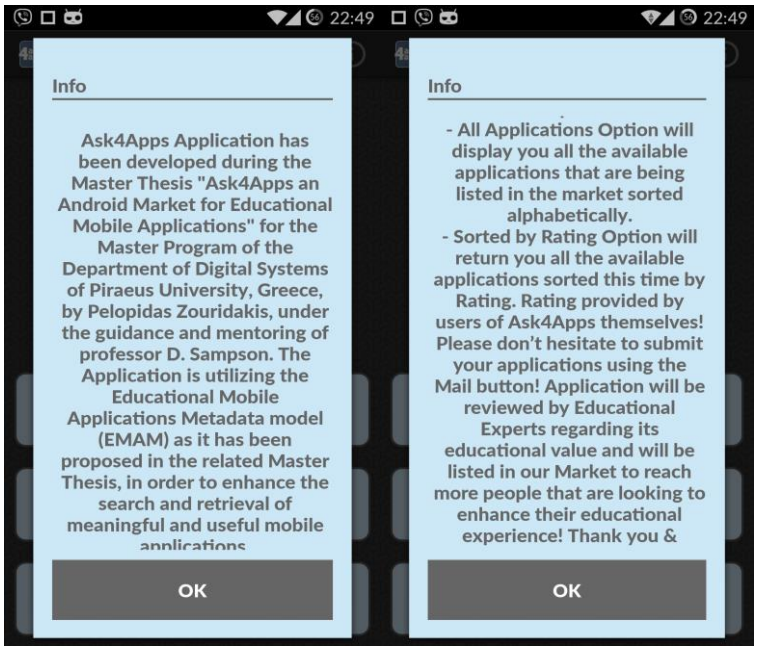

Figure 18: Ask4Apps Help Menu

4.2.2 Application Submission

Via application submission, a custom in-application window will appear where the user has the ability to add the title and the description of his/her developed educational application, and submit it to the administration team, in order to evaluate it, and since it meets the standards as an educational application, administration team will characterize it with the standards of EMAM model, and add it to the market. The value of this simple yet very importand functionality can be of great importance, as the community itself has the opportunity to contribute to build a base of high-quality educational applications, charactirized and ready to be downloaded by more Educational experts and learners. Below the submission window is being displayed.

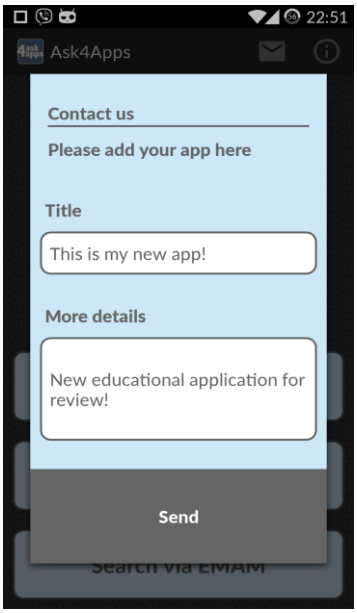

Figure 19: Educational Application Submission for review

By selecting the "Send" button, the mailing application will start, where user will add up more information about the educational applications that is being submitted along with the application's download URL. Below a screen is being displayed from this functionality.

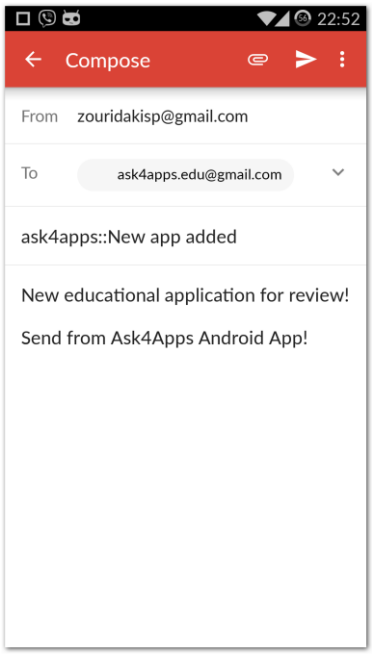

Figure 20: E-mail window following application's submission request

4.2.3 All Applications Listing

Selecting “All Applications” from the start screen, user will be displayed a list with all the available applications listed into the market. Below a screen from the all applications listing is being displayed.

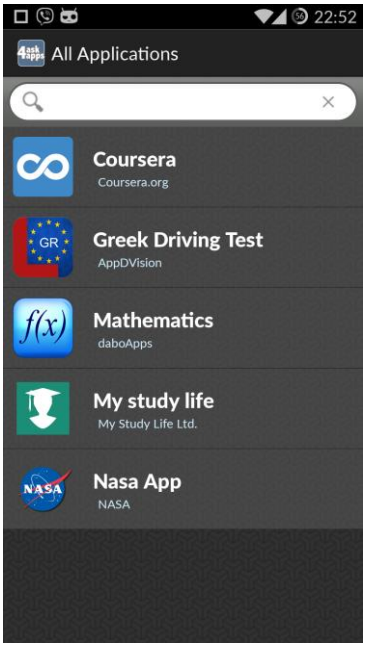

Figure 21: All Applications Listing

Using the search bar on the top of the screen, user can search an application by name. Search has been modified this ways that is being performed live, as the user is typing. Below a screen is being displayed, where the user has started typing and the results are being limited based on the user’s input.

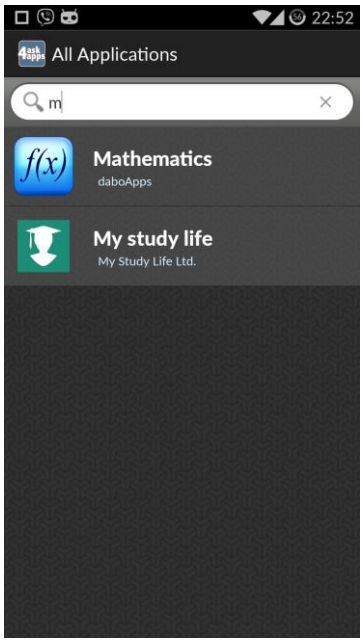

Figure 22: Results' limitation based on User's input

4.2.4 All Applications Listed by Rating

By selecting "Sorted by Rating" from the start screen, user will be displayed all the available applications listed into Ask4Apps market sorted by the rating that has been provided to them by the users inside Ask4Apps market. A button on the upper right of the screen will be giving the user the opportunity to adjust the list's sorting ascending or descending. As in "All Applications" listing, here the user has also the option to limit the results based on his/her typing input. Results will be also rating sorted Below a screen is being displayed with the applications sorted by rating. Results will be also rating sorted.

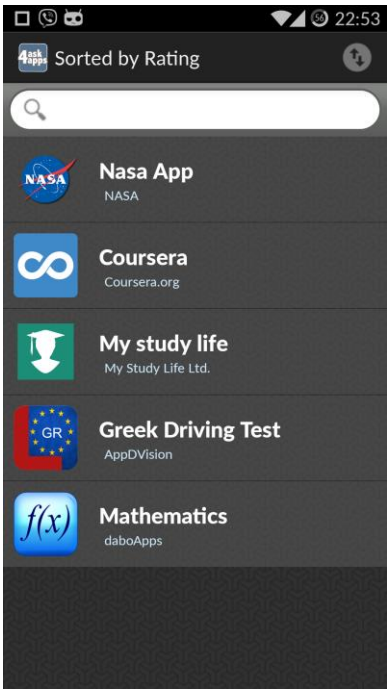

Figure 23: Educational Applications Sorted by Rating

4.2.5 Applications Presentation to the User

In any part of the application that user will be selecting an application all the characterization of its characterization will be displayed, based on the EMAM model, including options to download the educational application, to add comment but also annotation regarding its educational use. On the below screen, the initial information is being displayed that is including:

- Title
- Version of Application
- Developer
- Type of Educational Application (Active, Expositive, Mixed)
- Date
- Size of Application
- Cost
- Min Android Version Required
- Language
- Description

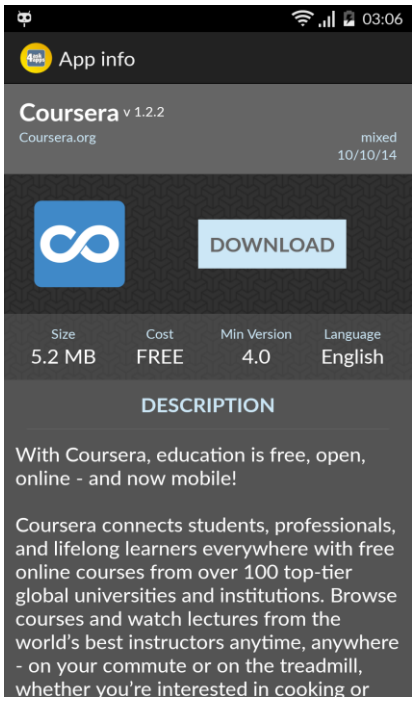

Figure 24: Information about an Educational Application as displayed by Ask4Apps

By scrolling further down, the user will receive information about:

- Keywords of the application
- Rating
- Age Range that the application is intended to be used by
- Difficulty
- Copyrights
- Developer's email

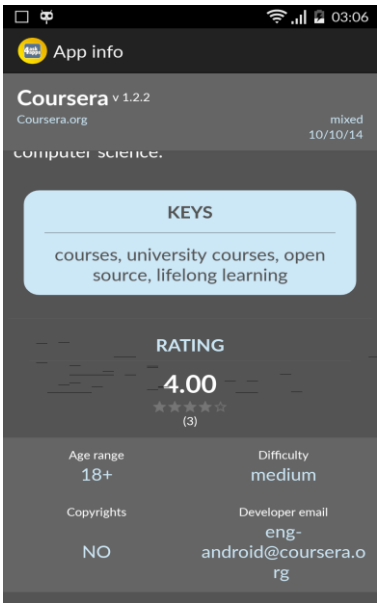

Figure 25: Information about an Educational Application as displayed by Ask4Apps (2)

Finally further educational information will be displayed including:

- Intended end user
- Semantic Density
- Interactivity Level
- Interactivity type

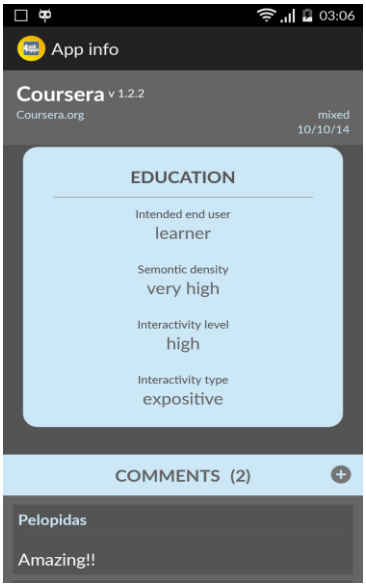

Figure 26: Information about an Educational Application as displayed by Ask4Apps (3)

4.2.6 Comments & Annotations Section

On the bottom of the screen of applications' information user can review previous comments regarding the applications as long as annotations submitted by other peers of educational field that used the related application. Also along with comments or annotations the time and date they have been added is provided. Below screens provided from annotations and comments sections as well as from selection to add a comment or annotation.

Figure 27: Comments' Section

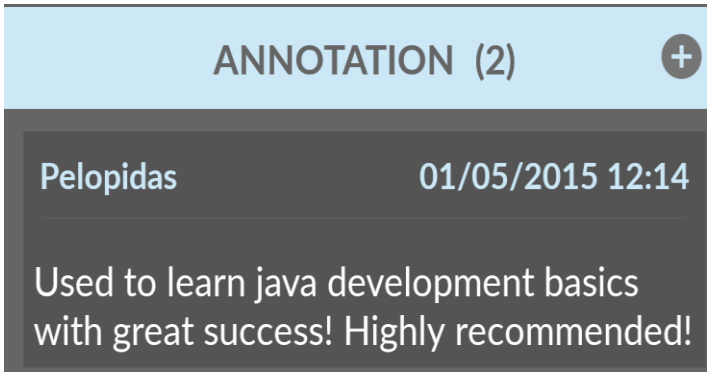

Figure 28: Annotations' Section

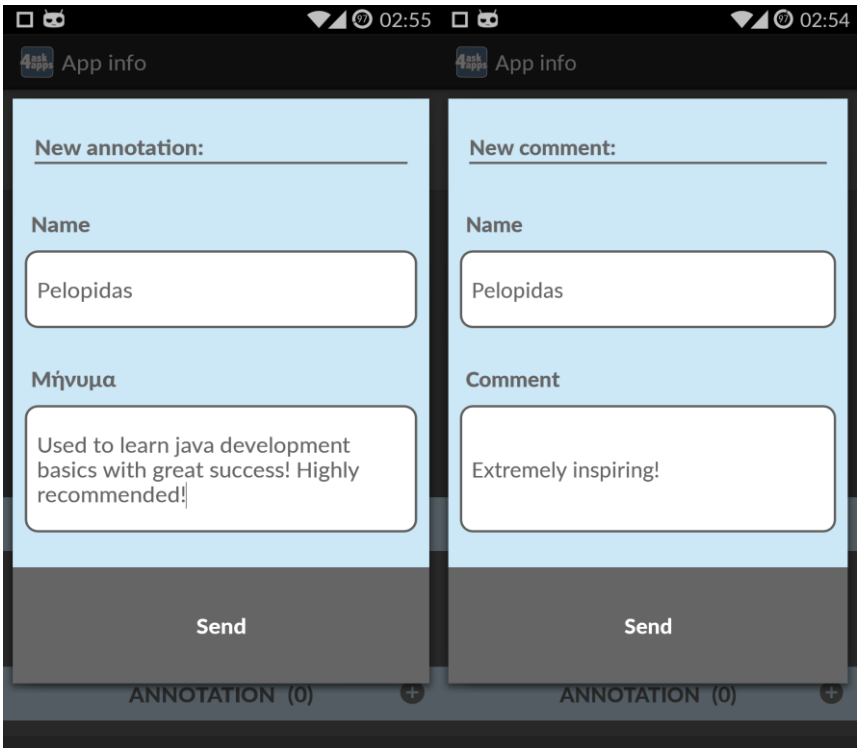

Figure 29: Comment or Annotation Addition

4.2.7 Application Search and Retrieval via Guided Search

By selecting "Search via EMAM" the user has the opportunity to search in the database of the educational applications, defining all the data elements of EMAM that describe the application as whole. Through each step, applications options are limited on the background after each step and attributes that are being available for selection on the next one are being casted based on the remaining applications. Below the search procedure will be demonstrated using a real search example through the sample applications already stored in Ask4Apps Android educational applications market.

Step 1

By selecting "Search via EMAM" first screen will be displayed will ask user to define the General data elements that are describing the application he/she is interested. These are including:

- Tags of the application
- Preferred Language

- Minimum Required Rating

On specific example demonstrated, used selected:

- ✓ **Tags**: *Courses*, *University Courses*, *Driving Test*, *Driving Theory*
- ✓ **Preferred Language:** *English*, *Greek*
- ✓ **Minimum Rating:** *2 stars*

Below are being displayed screen shots from the first step of the search:

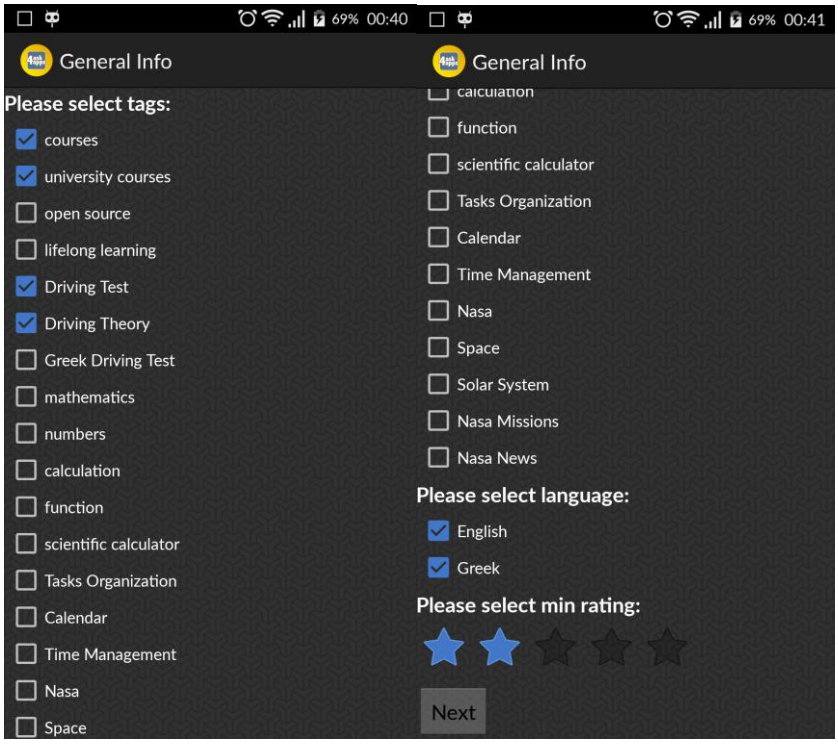

Figure 30: Defining desired Tags, Language & Rating on guide search

Step 2

By selecting next, user will be moved to Lifecycle attributes, and will be requested to define the contributors he is willing to receive results from. On the specific example demonstrated, user selected test2, Columbia University and the University. Below screen shot is provided from the related step.

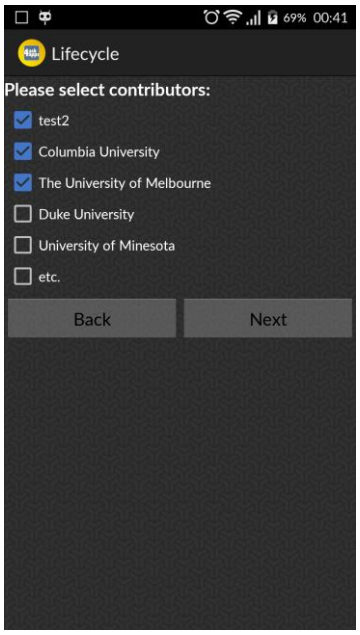

Figure 31: Defining the desired Contributors

Step 3

On the 3rd step user will be requested to define the technical attributes. These would be

- Minimum Android Version Required
- Size of the application

On specific example demonstrated used selected:

- ✓ **Minimum Android Version**: 1.5 or 4.0
- ✓ **Size of Application**: 5.2Mb or 45 Mb

Below the related screenshot is provided.

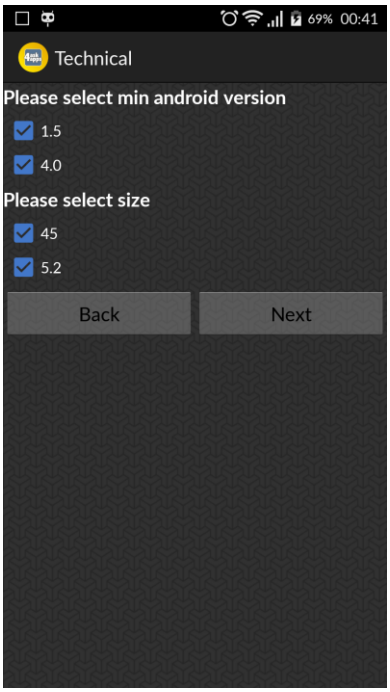

Figure 32: Defining Technical Data Elements

Step 4

On 4th step user is required to define the Educational Attributes of the application he is looking for. As in previous steps, the options that would be displayed are being pulled based of the application that made the shortlist so far. User can define the below:

- Interactivity Type
- Resource type
- Interactivity Level
- Semantic Density
- Intended end user
- Context
- Age Range
- Difficulty

On the specific example demonstrated, user has selected:

- ✓ **Interactivity Type**: active, expositive
- ✓ **Resource type**: self-assessment
- ✓ **Interactivity Level**: high or very high
- ✓ **Semantic Density**: very high
- ✓ **Intended end user**: learner
- ✓ **Context**: training or higher education
- ✓ **Age Range**: 18+
- ✓ **Difficulty**: medium

Below the related screen shots can be found:

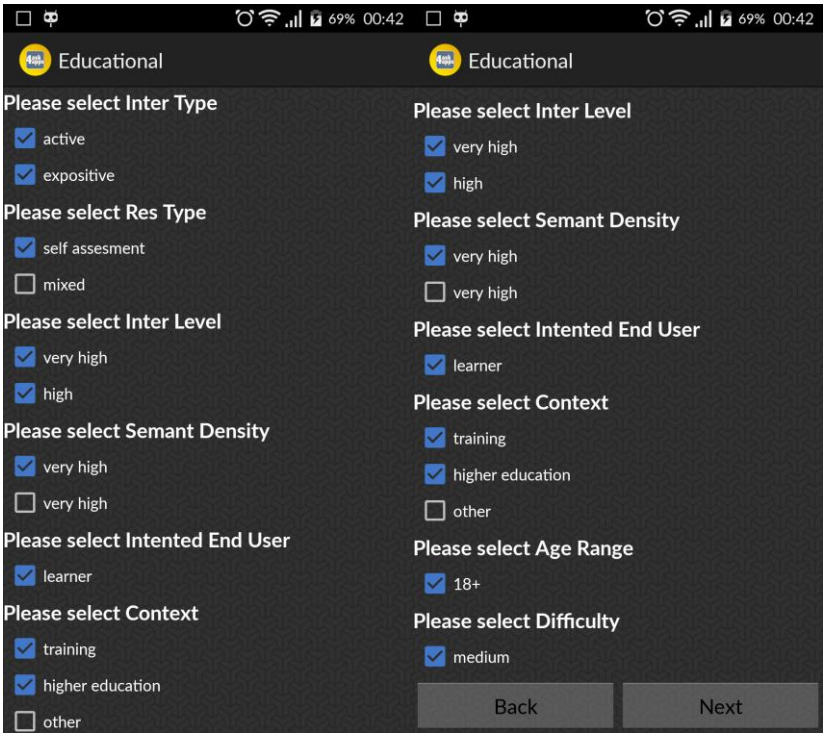

Figure 33: Defining Educational Data Elements

Step 5

Finally, of the 5th and last step, user should define data elements inside Rights category. Specifically user can define:

- Cost

- Copyrights

On the specific example demonstrated, as they were the only options, user has selected:

- ✓ Costs: 0
- ✓ Copyrights: Yes

Below the related screen shot is being demonstrated.

Figure 34: Defining Rights Data Elements

Step 6 - Results

By selecting next, search procedure will be concluded and user will receive the results of the search. Below related screenshot is being attached displaying the results of the search.

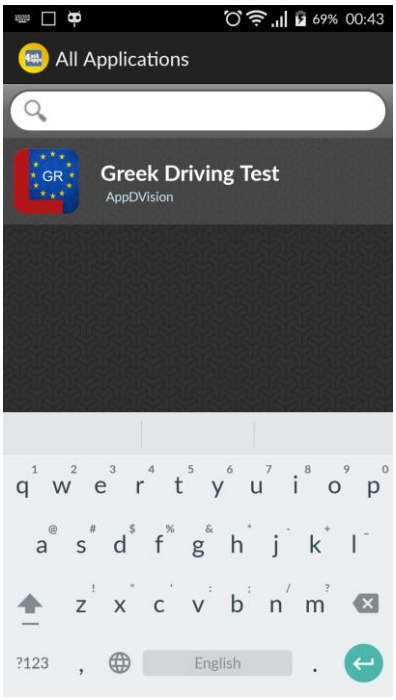

Figure 35: Search Results

As it is implemented in "All Applications" selection, a search bar is also featured here which can be utilized when excessive amount of results is casted, in order to limit search results by title. By selecting the application desired user will be displayed the application information, and by selecting download button he/she will be moved to Google Play store in order to download the desired application. Below a related screen shot can be found.

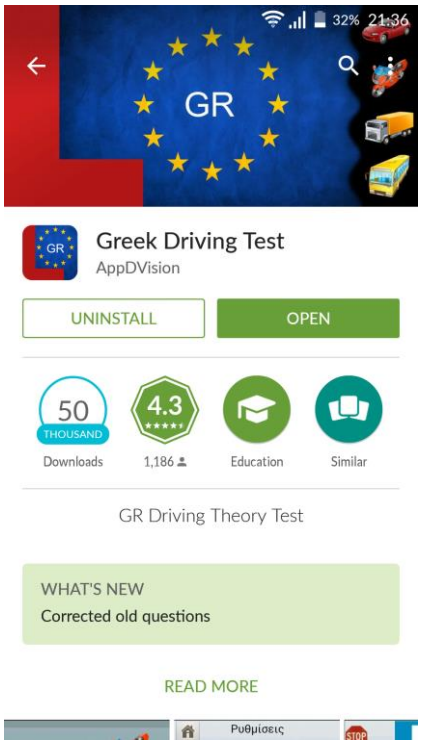

Figure 36: Google Play Navigation for Application Download

5. General Discussion & Future Work

5.1 Introduction

In current chapter of the present thesis, a general discussion regarding the assumptions and the process of the creation of the thesis is taking place, and future work is being proposed regarding the further development of the proposed educational mobile applications metadata model and the educational applications android market that has been developed, Ask4Apps.

5.2 General Discussion

During the process of the current thesis and after its conclusion, the based on the study that has been performed, the following assumption can be made.

Initially, the problem that was tried to be solved defined, as the value of mobile applications in education identified, a need aroused to define which applications have indeed educational value, how to identify them, search, and retrieve them. Following this, a review has been made on how the mobile devices have been developed through the years and what are their current capabilities. Moreover the penetration of the technology to the public has been made clear indicating how easy is nowadays for people and more specifically on the educational field to have access to such technology and make use of it during the teaching process.

Following this, a presentation has been made of the latest most used mobile application markets, and some significant educational mobile applications have been presented in order to obtain a hands-on idea on what an application that is being labeled as educational is like. At this point it has been clear that although there are quite a few mobile applications out there that are labeled as educational, an actual definition of the "educational mobile applications" was missing from the literature.

After research in older and newer publications performed, in the beginning of the next chapter a definition could be provided about what an educational mobile application actually is. This concluded to the definition of the educational mobile application which has been stated as: "A *Software Application* that is running on a *Mobile Device* and can be used by the *Instructor* and/or *Learner* within the Learning Process, as a *Procedural Support Tool*, a *Tool* to *Retrieve Learning Objects* or as *Learning Object itself*, integrating and enhancing at the same time one or more of the fundamental characteristics of Mobile Education, *Mobility, Accessibility*, *Personalization, Flexibility* and *User Collaboration"*

Based on this definition and as the context was being built, in order to conclude to a proposed metadata model for the educational mobile applications a review has been performed of the metadata that Google Play Android mobile applications market is being using in the process of uploading an application to the market. Considering and educational application as a learning object itself, the well-known LOM

model has been presented afterwards, in order to attempt to fuse the two models into one smaller and more flexible metadata model that would be tailored specifically for educational mobile applications. As a result of this, the EMAM (Educational Mobile Applications Metadata) model has been presented.

On the final chapter of this thesis, the educational mobile applications market Ask4Apps that has been created during this thesis has been presented. Ask4Apps is a native Android application that using an online database on the background is displaying mobile applications that have been approved by experts regarding their educational value. These applications are characterized in the database using the EMAM model and the user can access this information by simple selecting an application. In order to address the problem of meaningful search and retrieval, an option for a guided search has been utilized in order to extract from the user all the information needed that apply to EMAM model, to provide meaningful and useful educational mobile applications.

5.3 Future Work

Mobile applications, as any other software have limitless possibilities of evolution and expansion. In the case of Ask4Apps Android market for educational applications, it could be evolve in order to support a stand-alone database were it would hold the applications, without the need to redirect to Google Play Market. This could save time from download process that user is following.

Furthermore, a separate web-portal could be created were users could submit their applications for review online, fact that would enhance the opportunity of Ask4Apps to reach more users and become more well-known. In case a different business model would be decided at some point in future, an online characterization form could be utilized that the users could characterize their own applications using the proposed educational applications metadata model and submitting it already characterized. This could be ported into Ask4Apps database automatically, by just accepting the submission. Finally, further research could be done in order to improve Ask4Apps database queries in order to optimize their performance when database will hold excessive amount of applications.

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