Classroom Mobile Devices: Evaluation about Existing Applications

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Abstract: Mobile devices are tools that provide resources for building a seamless teaching and learning process. Smartphones offer features such as sensors, interfaces, and wireless interfaces that are still little explored in classrooms. The identification of programs for mobile devices adapted to a new model of use of information technologies allows recognition on the current panorama of use of mobile devices in the modality of classroom teaching. Smartphones in schools present a new reality about the insertion of the technologies in the school environment in conflict with the ways of trying to use computers as an educational tool. In this work, it was sought to identify, in a database, applications for mobile devices products that may be adequate to support the teaching and learning process in the context of an educational ecosystem.

1 INTRODUCTION

The use of information and communication technologies in the school environment was initially delineated by managers and administrators. This model of adoption of the new technologies defined by the holders of formal power can be represented by a tax format, the top down type. The major challenge of this process was the definition of strategies and procedures to leverage new technologies to support the teaching and learning process.

In addition to the entertainment offered by some computers, such as personal use, these were brought a tool to simplify the calculation, write texts as well as create and show presentation (Turkle, 2017). The emergence of the Internet presented the possibilities of using this technology for the wide dissemination of knowledge through browsers. At school, specific spaces were made available for use of computers and access to networks for use by students and teachers in a supervised manner (Castilho et al., 2007b; Vaca, 2005).

On the other hand, mobile technologies emerged at school with students and teachers bringing their devices into the classroom (Kraut, 2013) While the insertion of computers into schools took place in a more gradual and controlled fashion, mobile devices quickly became present in schools. This new wave of technology use, where students, teachers and school employees become agents of insertion of tools, has a bottom up representation.

The bottom up model of introducing new technologies in schools poses new challenges for an appropriate use of emerging computing and communication technologies (ICTs). This model tends to be preponderant in the coming years, faced with an uncertain future of new devices resulting from the popularization of the Internet of Things (IoT). Wearable things, particularly smartwatches, are already realities that offer virtually untapped educational potentialities.

Studies evaluating the growth of mobile device processing capacity (Sharples and Beale, 2003; Viberg and Grönlund, 2013) with their capacities in the educational context. These studies focused on the equipment available at the time since the great popularization of this type of equipment had not yet arrived.

The reduction in the price of mobile devices since the mid-2010 (Viberg and Grönlund, 2013) allowed greater access to these tools for people with different socio-economic profiles. Teachers and students demonstrate knowledge in the use of applications and resources of embedded systems in their daily activities, but in the classroom there is a

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restriction on the use of new technologies (Grinols and Rajesh, 2014).

The traditional model of teaching and learning is still prevalent in schools around the world. Desktop computers are less commonly used than smartphones, while computer labs are underutilized. This does not mean that laptops or desktops should be abandoned as an educational tool. The integration between different architectures advocates integrated environments using smartphones, single board computers, embedded technologies, cell phones among others in an ecosystem model.

Ubiquity (Pimmer et al., 2016), context-aware (Kalaivania and Sivakumar, 2017) and seamless (Looi et al., 2010) provide a vision of an innovative educational model, capable of promoting effective improvements in the teaching and learning process. Learning anywhere at any time, seamlessly and seamlessly becomes a reality with proper strategies for using mobile tools. The presence of mobile devices adapted to the context of classrooms allows the applicability of ubiquity and seamless concepts in the teaching and learning process.

Although smartphones and tablets have great potential as teaching and learning tools, little is known about strategies for adopting them as an instrument for improving the quality of education in the school environment. Applications aimed at the proper use of mobile devices in the classroom are instruments for more intensive use of these tools in the school context.

Modern smartphones and tablets have different communication interfaces in data networks, are mobile and have input and output interfaces that provide interactivity. Applications that are able to take advantage of these features can adjust to context much more efficiently than older computers. Programs developed to enhance the use of the interfaces of networks allied together as sensors and input and output peripherals allied with IoT tools are decisive in the empowerment of mobile devices as an educational tool.

The objective of this work is to evaluate applications, declared with educational by their developers, from the perspective of supporting the process of teaching and learning context-aware classroom.

2 BACKGROUND

The approach closest to an educational ecosystem is brought about by the concepts presented in context-aware and U-Learning studies. The notion of an ubiquitous and individualized education refers to the relationships between devices and people as tools of teaching and learning. This session presents a critical reading on the state of the art applied to these concepts.

2.1 Ubiquitous and Context-aware Education

Ubiquitous computing in education through the use of mobile devices (Pimmer et al., 2016) depends on specific hardware. Traditionally, ubiquitous computing is characterized by the use of portable devices, initially in the use of personal digital assistant (pdas) and, more recently, in the use of smartphones (Al-Emran et al., 2016). The IoT concepts, however, suggest new opportunities for educational environments that can hardly be solved by software alone on tablets or smartphones.

Kalaivania and Sivakumar (2017) present works related to concepts of context-aware and learning, in a review of the literature. In this work the authors emphasized approaches that involve integration between different devices and architectures focused on solutions of specific problems. However, none of the papers presents a strategy focused on generic problems through an architectural proposal about an ecosystem approach.

In a presentation of the concepts relevant to understanding U-Learning (Lopez et al., 2016), and from its environment are explored various devices and how these interact in the context of teaching and learning.

Recent studies on contextualized and ubiquitous education concepts highlight the relevance of IoT (Kalaivania and Sivakumar, 2017; Yamada et al., 2017). In the identified studies there is a concern with the insertion of this new technology in the context of education, but none of them presents strategies for the use of integrative tools capable of providing the necessary infrastructure for a truly ubiquitous and context-aware implementation.

Knowledge of the context applied ubiquitously in the educational context depends on a large amount of information so that it is possible to select the content or approach most appropriate for each student or teacher. Forkan, Khalil, Ibaida and Zahir (Forkan et al., 2015) assess the need to use strategies from Big Data to a context-aware environment. Although the work does not address educational issues, the need for infrastructure to process context-aware information is in line with the proposal of this research.

These uninterrupted concepts present the importance of using different portable or fixed technologies, online or offline, acting together for a seamless learning experience for students. Teachers act as facilitators and use technologies for content delivery, management and monitoring of the teaching and learning process (Sharples, 2015).

2.2 Top down based Projects

The top down model was used in computer projects in schools and defines the taxing way of adopting computers as an educational tool. This model has been used since the adoption of the first computers for students and teachers, but it is not suitable for the growing use of mobile devices as a teaching and learning tool. In this model students and teachers are elements that receive a ready computational infrastructure and must be trained to potentiate the use of the available devices.

By the year 2012, this model had already been started in about 50 countries with more than two million devices distributed (Beuermann et al., 2015). Data from the year 2015, however, indicate that only two countries, Peru and Uruguay, were able to fully implement the use of XO computers[1] in their schools (James, 2015).

Despite its educational approach, the use of devices proposed by On Laptop per Child project (OLPC) did not present classroom contents or instigated changes in pedagogical practices by the use of laptops (Cristia et al., 2012). Sharma (2012) highlights slightly positive results in teaching mathematics and language negatives due to the use of computers in public schools in Nepal.

The recent migration to other types of mobile-based computer technologies represents an important factor for the review of the hardware model used by programs using the XO architecture (James, 2010). The cost of modern mobile devices, their increasing popularity and ease in transport and handling tend to show that this type of equipment may be more suitable for use in one computer mode per student (Hockly, 2016) than laptops used by Classmate or XO.

In Spain, a technology insertion project called Educational Technological Network (ETN), translated in English as Technological Educational Network, (Berrocoso, 2008; Vaca, 2005) proposed a model of use of technologies for incorporation into the educational system of the state of Extremadura. This project was concerned with the creation of infrastructure, research and support to the installed computer park. In search of vendor independence, the project adopted the use of free software as a form of autonomy and control of the technologies used (Berrocoso, 2008).

As a result of the RTE, Extremadura has 60,000 computers in elementary and secondary schools in 2016 (Díaz, 2016). However, computer use adopts the model of computer labs with the configuration of one computer for every five or six students. Despite all state investment, the appropriation of the technologies offered by RTE by teachers is still very small (Díaz, 2016).

The ecological-informative term used by Berrocoso (2008) to describe the implementation of RTE shows the integrated vision offered by the project and the approach to the theme of this research. Recent project evaluations (Díaz, 2016) point to problems related to the change in the use of computers arising from the growing use of mobile technologies and IoT in education.

In 2008, in Brazil, one computer-by-student (UCA) project was created to promote access to information technologies for students and teachers in elementary and high school (de Casio, 2018). The OLPC had a great influence on this project, mainly in the tools adopted for its implementation, focusing on the delivery of laptops to students. Another Brazilian initiative, the UCA project (ProUCA), sought a digital inclusion model in which the student acts as a focal point in the dissemination of knowledge, promoting access to communication technologies for the family (Direne et al., 2012).

Experiments with hardware solutions such as multi-terminal (Castilho et al., 2007a) and multimedia TVs have demonstrated that new device-based technologies can be an important tool for reducing costs and improving the computing environment. In this project, more than 40,000 computers with internet access were available in all public schools in the state of Paraná (Castilho et al., 2007b).

2.3 Bottom up Model based Projects

The use of mobile devices such as smartphones and tablets assumes the role of tools to support the teaching and learning process (Milrad et al., 2013). Affordable prices for a large part of the world's population (Viberg and Grönlund, 2013; Dabney et al., 2013) favors the use of these devices as individual tools.

[1] A low-cost personal computer manufactured by Quanta computer for children.

The ability to use mobile technologies in the production and presentation of educational objects is still limited. Looi (Looi et al., 2010) shows the growing trend of the presence of mobile devices in educational processes generates a new phase in technologies applied to education. As a result of the tendency of a greater insertion of these devices in the school environment, a reaction contrary to their use by students and teachers is perceived.

Low-cost boards, equipped with some form of communication, with other devices through network infrastructure is a new way of interacting with ITCs (Borgia, 2014). IoT tools can provide a relevant resource in the teaching and learning process, allowing interaction with real-world objects, not just simulations (Marquez et al., 2016). This type of technology is perfectly adequate so that the equipment brought by the students can be added as a tool to improve the teaching and learning process (Kuss et al., 2018).

Mobile technologies and the Internet of Things, IoT, have been one of the most important topics on new forms of education (Traxler and Vosloo, 2014). While using devices such as smartphones or smartwatches has become a part of people's lives, using it as an educational tool does not have a consensus on how to bring it into the classroom (Grinols and Rajesh, 2014).

The inadequacy of the school environment to the use of mobile devices promotes the inappropriate use of the same in the classroom. Teachers are concerned about how distracting these tools are for students (Mc-Coy, 2016). However, the administration of the insertion of the technologies, considering that these tend to occur even more intensely in the coming years, is the main responsibility of the managers in the bottom up model of insertion of technologies in the school environment.

3 METHODOLOGY

This study evaluated information on mobile apps that use Android OS available from the Play Store virtual store. Data was obtained from the database in a large mobile application service provider. This database is updated daily and counted on January 11, 2018 with 2,879,824 applications registered.

The option to use only applications for the Android platform, developed by Google, stems from the popularity of the product and variety of devices that adopt this operating system. According to the website www.statista.com (Portal, 2019) 88% of smartphones use Android while 11.9% are marketed with iOS, Apple's operating system. In this work was made the identification of general characteristics of applications, so in spite of the restriction of the chosen operating system, the information acquired is sufficiently representative.

Attempts to retrieve data by directly accessing the Play Store have been unsuccessful since there is no provision of services for information retrieval. The virtual store also does not have adequate search tools, limiting the search criteria to only the use of keywords that return a limited number of registrations.

The data was retrieved through HTTP requests using the curl tool triggered by a shell script on a computer with Linux operating system, Ubuntu 18.04 distribution. The application program interface (api) provided by the web service allows the application of several filters for more adequate selection of data according to the demand of the study. Once the data were retrieved, they were inserted into a database on the local machine to carry out a work identifying the suitability of each of the applications found as a tool to support education.

3.1 Inclusion and Exclusion Criteria

The query used the following criteria: description field and title containing the word learning or the word teaching; should be application and not game; must be registered as family of educational applications and have at least 500 ratings. The query resulted in 2,411 applications that matched the criteria you selected. A representation in the Javascript object notation, JSON format used is presented in the List 1:

```
{ "query": {
"query_params": {
"full_text_term": "learning OR teaching",
"cat_keys":["APPLICATION"],
"family_filter":["EDUCATION"],
"ratings_count_gte": 500,
"sort": "title",
"sort_order": "asc",
"include_full_text_desc": true }
```

Listing 1: JSON format used in the query.

An application capable of showing the data was developed, that was more appropriate to read the information of each of the applications, especially in the field description. This application also allowed the insertion of additional information for each of the applications. The additional information entered was the classification of the software according to table 1 and the more detailed observation mark of the product.

The classification of applications for their educational use was based on the work of Cherner (Cherner et al., 2014). While reading the description of each of the 2,411 applications, new required classifications were identified, resulting in the proposed classification of applications according to table 1. In the detailed evaluation of the selected applications those that limited access to previously registered institutions as well as those that did not have a description in English.

For classification criteria, descriptions of app was the main functionality. The rating used the Skill-Based and Content-Based Apps Apps (Cherner et al., 2014). as categories. When none of the categories presented in the framework allowed classification, they were initially grouped into a generic set and later categories were created that extend the proposal of Cherner .

After all the process of classification and identification of the applications, the ones that should be analyzed in more detail were selected. The selected products underwent a revision from their textual description, access to the page of the developer when it existed besides searching for more information on search engines. If the interest for the study was confirmed, it would then be installed on a smartphone to detail its capabilities.

4 RESULTS

From the description of the applications this were classified by subjects (groups) and grouped by theme (main groups) for a better representation. The classification activity of the applications produced the results presented in table 1.

When discarding the products that met the exclusion criteria, 2333 suitable study applications were counted. Among these, those which described some specific use in the classroom, including teacher support activities, were defined as relevant for a more detailed investigation

Dictionaries, e-books and attendance can be used as a classroom support tool. Among the applications evaluated in this research were identified 470 applications that rely on the functionality of e-books and 433 dictionaries. These are grouped according to table 2, where only groups with one or more applications are displayed.

Table 1: Applications classification.

Main Group	Group	Total	Total %
Invalidated	Not Educational	33	1.37
	Not in English or Portuguese	45	1.87
Language	Dictionary	141	5.85
	Language	968	40.15
Management tools	Class Support	42	1.74
	Place Utilities	20	0.83
	Management	39	1.62
Music and Sports	Music	23	0.95
	Sports	5	0.21
Personal support	Self Help	14	0.58
	Religion	86	3.57
Preparation and Certification	Certification	88	3.65
	College Entrance	132	5.47
	Test Preparation	85	3.53
Preschool	Numeracy	15	0.62
	Literacy	77	3.19
	Ludic	170	7.05
Self-taught	How to	68	2.82
	Memorization	16	0.66
	Technology	94	3.90
Subjects	Geography	12	0.50
	Science	35	1.45
	Social Studies	6	0.25
	Mutiple-Subjects	16	0.66
	Math	63	2.61
	Hight Education Subject	29	1.16
E-Learning	Plataform	61	2.53
	Video	17	0.71

Typical classroom applications are related to presence control and timetable A search using the key words attendance and timetable returned those presented in the table 2. Only the major groups in which the query obtained at least one application in the result were shown.

Table 2: Classroom features.

Main group	E-book		Dictionary		Attendance	
	Tot	%	Tot	%	Tot	%
e-Learning	16	20.51	2	2.56	3	3.83
Music and Sports	6	21.43	0	0	0	0
Subjects	40	23.26	10	5.81	0	0
Manage-ment tools	16	15.84	0	0	26	25.74
Personal support	13	1.3%	1	1%	0	0
Language	251	22.63	386	34.81	1	0.09
Preschool	49	8.70	2	0.76	3	1.15
Self-taught	14	7.87	8	4.49	0	0
Prep. Certif.	48	15.74	14	4.59	1	0.33

Table 3: Data network and other devices integration.

Main Group	IoT		OffLine	
	Tot	%	Tot	%
E-Learning	2	2.56	20	25.62
Music and Sports	0	0	1	3.57
Subjects	0	0	15	8.52
Management tools	0	0	21	20.79
Personal support	0	0	14	14
Self-taught	0	0	26	16.25
Language	0	0	332	29.9
Preschool	1	0.38	25	9.54
Prep. and Certific.	7	2.30	64	20.98

5 DATA ANALYSIS

The application classification framework presented by Cherner (Cherner et al., 2014). is a valid reference but this study demonstrates the need to update the classification. The groups listed in the list below have their own characteristics and constitute a large number of applications that fit appropriately in these categories, as seen in the table1.

The data classification presented applications dedicated to language teaching, however a small number of applications of this category were classified as relevant to this work. Few of the applications in the Language group, presented, in their description, innovative features or focus on classroom activities. In table 4 it is noticed that although the Language group represents 45.99\% of the total number of applications identified, only 1 of these presents some connectivity with key words widely used in the literature.

Table 4: Literature influences.

Main Group	Seamless		Ubiquitous		Context-aware	
	Tot	%	Tot	%	Tot	%
Subjects	2	1.61	0	0	0	0
Preschool	2	0.76	0	0	0	0
E-Learning	5	6.41	0	0	0	0
Management Tools	7	6.93	0	0	0	0
Language	1	0.09	0	0	1	0.09

There is little connection between the applications identified in the work with the most relevant research in informatics in education. The tool group that presented the best numbers was the Management Tools with 6.93\% of applications content the keyword seamless in the description or title of the application. Ubiquity is a word widely used in describing the role of mobile devices (Kalaivania and Sivakumar, 2017) but has not been used in any of the evaluated applications.

In relation to the integration with other devices coming from the growing importance of IoT (Yamada et al., 2017) this work identified little concern of the developers with the theme as table 3. The construction of integrated environments and able to offer facilities in the use of ICT in classrooms in an ecosystem model depends on integration between devices. The bottom-up model of insertion of technologies in school demands new and low-cost technologies.

Although some of the applications tested in this study use the term ecosystem in their definition none of them presented integration capabilities with other devices and generic infrastructure. The creation of an integrated educational environment, based on a basic computational infrastructure focused on all aspects related to the educational system, differs from other attempts to insert technologies focused on specific aspects of teaching and learning activities. Bonilla (2009) presents arguments that distinguish the demands of digital inclusion from the use of ICT tools for a use as a tool to support teaching activities.

The creation of own network infrastructure proved to be an adequate tool to solve the deficiencies identified by (Moreira et al., 2013) in relation to access. Multicast-based technologies for discovering addresses and services offered (Cirani et al., 2014), popular technology in wireless printers and multimedia devices, provide simplification in building ad-hoc networks. These facilities were also not cited or identified in any of the evaluated applications.

5.1 Limitations

There are a number of applications that use the same platform but have distinct content from a developer in the Play Store virtual store that has generated some distortion in the data. These applications offer several of the features that have been identified in this work and appear with 9 different application titles. For methodological reasons each of the applications was considered independently, but it should be noted that in content presentation aspects this factor may partially compromise the results.

Some of the applications that presented features that could be better explored in this work contained restricted access to their functionality. These restrictions, often related to the link with an educational institution, prevented the installed application from running properly.

6 CONCLUSION

Providing individual computers for each student on desktop or laptop models is still far from becoming a viable country in poor, developing, and even wealthy nations. However, mobile technologies have a greater penetration in society than traditional computers. Efforts to develop applications that can bring educational services and usage to school are paths to a change in the use of ICT as an educational tool.

The change in the goal of one computer per student has an impact on reducing the need for financial investment by considering the difference in the cost of acquiring mobile devices when compared to laptops and desktops. The infrastructure to adapt to the use of these new technologies is also reduced and can be more functional if built properly. The challenge of adopting solutions in a bottom-up model of adoption of technologies in schools can be a great opportunity for initiating various governmental and institutional projects.

Applications developed for mobile devices do not have a strong focus on use in the school environment. None of the evaluated products presented integration and connectivity characteristics suitable for intensive use in classrooms. Expansive aspects of computing research in education such as ubiquity, context-aware and seamless are not part of the approach of mobile application developers.

There is an immediate need to migrate the concepts applied to the model of a computer per student to the reality resulting from the popularization of mobile devices. The emerging model of technology adoption resulting from the bottom up model does not seem to have impacted the application development environment. The proper use of these tools is an important tool for including technologies as a tool to improve the quality of teaching and learning.

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