ACTA SCIENTIAE

ISSN: 2178-7727
DOI: 10.17648/acta.scientiae.v21iss3id4591

An Outlook at the Educational Mobile Apps to the Physics Subjects Available In the Android Operating System

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Received for publication on 24 Jul. 2018. Accepted, after revision, on 28 Sep. 2018.
Assigned editor: Renato P. dos Santos.

ABSTRACT

The presence of smartphones in the classrooms have been the theme of big debates among those involved in educational spaces. It is undeniable that its inclusion in teaching and learning processes approaches the school to the world where the student is in and an important step to elaborate strategies that involve the use of smartphones is to know the educational apps functionalities. In this context, this article is proposed to do a systematic mapping of free educational apps to the physics teaching, available at the Android operating system presented in most smartphones and available at Google Play Store. It was adopted as methodology a systematic mapping organized in four steps. At the first moment the research was made with the use of the word "Physics" and 250 apps were found, the second step was intended to select the apps with physics content in Portuguese, which brought the number of 42 apps. Following, the third step was intended to map the specific apps for the physics subjects, excluding those that present in their content several subjects or only exercises collection, finding, so, 25 apps. Lastly, in fourth step, it was made a description of the apps selected from step 3 with more than 10.000 *downloads*. What was noticed in the description is that practically none presents the contextualization of physical phenomena or simulations; they only highlight nature theoretical or mathematical descriptions.

Keywords: Teaching Physics. Mobile Learning. Educational Apps. Smartphone. Android.

Um Olhar sobre os Aplicativos Móveis Educacionais para os Temas de Física Disponíveis para o Sistema Operacional Android

RESUMO

A presença dos *smartphones* nas salas de aula tem sido tema de grande debate entre os envolvidos nos espaços educativos. É inegável que a sua inclusão nos processos de ensino e aprendizagem aproxima a escola do mundo no qual o estudante está inserido e, por isso, um

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importante passo para elaborar estratégias que envolvam o uso dos *smartphones* é conhecer as funcionalidades dos aplicativos educacionais. Nesse contexto, este artigo se propõe a realizar um mapeamento sistemático de aplicativos educacionais gratuitos para o ensino de Física, elaborados para sistema operacional Android*,* presente na maioria dos *smartphones*, e disponíveis na loja virtual Google Play Store. Adotou-se como metodologia um mapeamento sistemático organizado em quatro etapas. No primeiro momento, a pesquisa foi realizada por meio da palavra "Física" e foram encontrados 250 aplicativos, a segunda etapa foi destinada a selecionar os aplicativos que contêm assuntos relacionados à Física e em português, chegando ao número de 42 aplicativos. Na sequência, a terceira etapa destinou-se a mapear os aplicativos específicos para a disciplina de Física, excluindo aqueles que apresentam, em seu conteúdo, várias disciplinas ou apenas coletâneas de exercícios, encontrando, assim, 25 aplicativos. Por fim, na quarta etapa, fez-se a descrição dos aplicativos selecionados na terceira etapa com mais de 10.000 *downloads*. O que se notou na descrição dos aplicativos é que praticamente nenhum apresenta contextualização dos fenômenos físicos ou simulações, apenas destacam descrições teóricas ou matemáticas da natureza.

Palavras-chave: Ensino de Física. *Mobile Learning*. Aplicativos educacionais. *Smartphone*. Android.

INTRODUCTION

Nowadays, the production and dissemination of technology is growing at an accelerating pace, and therefore, radical changes in the forms of social organization, communication, culture, teaching and learning processes are changing the way people relate and interact. In this scenario, teachers are challenged to coexist with these transformations and adapt their teaching methods, incorporating technological advances.

In the opinion of Almeida and Silva (2011), knowing and mastering the use of technologies is a challenge for teachers, since students are responsible for the use of communication technologies with technological artefacts (cell phones, computers, tablets, among others).

In Brazil, some actions have been carried out to include technologies in the teaching and learning processes. In the 1980s, the term "Information Technology" (TI) began to be used when the first computer labs were installed in schools. From this point of view, educational software and continuing education courses emerged, addressing the use of IT in the educational context. With the onset of the internet age, in the late 1990s, distance-learning courses for continuing teachers' training began. In that period, the term TI "information technologies" was replaced by "information and communication technologies" (TICs). With the improvement in the Internet connection and the sophistication of communication resources, the term "digital information and communication technologies" (TDICs) has emerged, which is characterized by easy access to videos and simulations and by the use of social networks, online applications and mobile and portable technologies (Borba, Silva, & Gadanidis, 2014).

In this sense, considering the term TDICs, Borba and Lacerda (2015), commented the use of the computer laboratory in schools, questioning their viability, arguing that due to the high cost of maintenance, schools would face many difficulties to maintain an

infrastructure, and often, the space does not even contain a single class with one computer per student. In addition, other problems, such as the configuration of computers, the speed of the Internet, among others, often prevent teachers from using the laboratory with their students.

In this way, the teacher needs to find alternatives for the inclusion of technology in their classes, especially the TDICs. Almeida and Silva (2011) consider that technologies cannot be restricted to computer labs but must be integrated into classroom activities and other spaces. Only the performance of classes in computer labs as a way to explore the use of TDICs, in an instrumentalised perspective of use, distorts the essence of digital technologies, in which the learning process is dynamic and occurs through interactions in networks, which connect users to an enormous ocean of information (Ribeiro, 2016).

One of the possibilities for the use of TDICs without the school necessitating large investments and the use of resources for equipment maintenance can be in the hands of the students themselves: the mobile devices that accompany them daily and connect them to the internet. One factor that can contribute to the use of these devices is the use of some educational applications, which are available in the virtual stores and are often free. Another positive point is access to these devices. According to a survey released by the Getúlio Vargas Foundation [FGV] (2018), in 2018 Brazil reached the number of 220 million smartphones, that is, more than one smart phone per inhabitant. Therefore, even in schools located in the poorest regions of Brazil, it is possible to find a good number of these devices in classrooms.

Considering the great potential that smartphones can offer for teaching and learning processes, this study aims at a systematic mapping of the free educational applications for physics education available for devices with Android operating system and found in the platform Google Play Store.

MOBILE LEARNING

The terms used to designate teaching practices made possible by the use of digital mobile technologies are mobile learning or m-learning. These are concepts that aim to improve access to information and content anywhere, at any time, as well as facilitating interaction between teachers and students (Pina et al., 2016). Generally speaking, digital mobile technologies are devices with reduced format, portable, autonomous and that accompany people in any space and time. Thus, the term m-learning essentially has the mobility of technology (Moura, 2010).

Certainly, smartphones are devices with great potential for deploying learning with m-learning mobility. They are used daily in classrooms to access search sites such as Google, social networks or even pages that are often unrelated to the subject of class – which causes concerns among educators. However, these devices bring together many resources that can be used in teaching and learning processes, such as text, sound, images, videos, and others. In addition, the possibility of access to the Internet extends the forms

of communication and access to information; both these qualifications are desirable attributes for this activity (Fonseca, 2013).

Mobile technologies create new eras and educational spaces; however, its simple insertion in schools is not enough for a differentiated pedagogical practice to become effective. The potentiality does not lie in devices, but in their interactivity with the user. The key to change this is the teacher. The appropriation of these technologies by the teacher for pedagogical purposes requires a broad knowledge of the technological and communicational specificities, which must be combined with a thorough knowledge of teaching methodologies and learning processes so that they can be systematized in their pedagogical practice. Therefore, teacher's training and the need for researches on the possibilities of using these devices as pedagogical resources are essential, for example through knowledge of the main functionalities of educational applications and the means to find them (Sousa, Miota, & Carvalho, 2011).

At this moment, there is no longer needed to discuss the presence of cell phones in the classroom, since they are already present in this space – in many situations, not as educational tools. Borba and Lacerda (2015) defend the idea of using the Internet through cell phones, democratizing access to information and enabling students and teachers to use applications for educational purposes. However, researchers warn about the need of studies on existing applications and the development of others, as well as the creation of continuing education courses and the inclusion of these ideas in initial teacher's education.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) promotes UNESCO Mobile Learning Week every year. It is the main event on ICT in education of this institution. In 2018, the meeting was held in Paris and the theme Skills for a connected World was discussed. Educators and researchers shared experiences focused specifically on educational approaches through mobile technologies and sought to disseminate and stimulate innovative approaches to teach. This proves the attention to the theme in a global context and, above all, the belief that, through digital mobile devices, it is possible to construct new formative processes.

In line with the worldwide trend, Brazilian researchers are also conducting studies on the use of mobile learning in the classroom. In a consult to the thesis and dissertations bank of the Coordination of the improvement of personnel of higher level (CAPES), it is possible to find some of these investigations, among which we highlighted the works of Raminelli (2016) and Teixeira (2016). It is also possible to find articles in magazines intended for physics teaching, such as Miquelin, Da Silva and Kielt (2017), published in the Brazilian Journal of Physics Teaching.

Teixeira (2016), in an attempt to work Physics through mobile devices, created an application called "Physics in hands", which addresses the content of mechanics for High School. The specific theme was gravitation. The application presents subjects related to Kepler's laws and universal gravitation, to satellites, to escape velocity, and to circular

orbits. The activities are based on the assumptions of Ausubel's Significant Learning Theory. It is possible to affirm that the application provided a better understanding about the content of gravitation, considering the results obtained by the students in the pre-test and in the post-test. In addition, the author emphasizes that the students were more motivated to participate in classes.

Raminelli (2016) used smartphones in a didactic sequence for the teaching of electrodynamics. The activity also used Significant Learning Theory as a theoretical reference. It is worth mentioning, in this study, the use of the App Inventor 2 platform, a tool that allows the creation of applications by users who do not know programming languages. This characteristic enabled the researcher to create his own educational application. During the application of the activities, it was observed that the students, even with the cell phones in hand, were not oblivious to the proposal of the class. This reinforces the idea that using cell phones can increase the student's concentration. The results obtained after the application of the didactic sequence brought indications of meaningful learning of the contents addressed.

Miquelen, Da Silva and Kielt (2017), on the other hand, used an application that operates as a voting system of responses in physics classes, planned to use the Peer Instruction method. With this method, the researcher makes an initial exposition of the central ideas and then applies a multiple-choice conceptual test. Based on the results obtained by the students during the test, the teacher elaborates a strategy for the sequence of the activity. With the application developed by the authors, it was possible to obtain answers sent by the students during the lessons directly to the teacher's notebook. The authors report that using applications dynamises classes, can increase students' involvement in activities, enhance concentration power, and prioritize privacy, as many felt ashamed to give wrong answers to the class. In addition, the use of smartphones was well received by students, according to the authors. In this way, what was once only a source of entertainment has now became a tool that assists in the teaching and learning processes.

As pointed out the researches highlighted above, it is possible to recognize that the implementation of mobile learning can provide the realization of teaching activities that are more connected to the reality of the students. Combining the resources provided by mobile technologies, the infrastructure provided by the institutions (especially unrestricted access to the internet), teacher's training and an appropriate teaching methodology, the use of applications in physics teaching creates a teaching and learning environment in which the student is immersed in a dynamic, interactive and active situation. In this sense, the overall objective of this research is justified, because it is relevant to carry out a mapping of educational applications, offering physics teachers an overview of what currently exists, specifying the resources available in the free applications available for the Android operating system.

METHODOLOGY

To establish an overview of the applications of Physics, we used in this work the method called systematic mapping. As pointed out by Petersen et al. (2008), this methodology is applied in works related to software engineering.

Petersen et al. (2008) point out that in order to perform a systematic mapping, the process must be structured in stages. After establishing the steps, the researcher must define guiding questions in order to be able to direct what is expected in the results. For Petersen et al (2008), the questions provide an overview of a researching area, making it possible to identify the most relevant information to the study in question.

Thus, the research process in this work is organized in four stages.

The first is related to what you get from apps through a search using the word "Physics" in the Google Play Store virtual search engine and is guided by the following question: How many apps available on the Google Play Store can be found by searching for the word "Physics "for smartphones that use the Android operating system in the Portuguese language?

The second step is to analyse each of the applications, asking the second guiding question: How many of these applications offer resources that can be associated with the curricular component of Physics and what characteristics do each of them offer in relation to the content? The selection of applications in this stage is restricted to those with content in Portuguese and that are in the "education" category.

The third step is to establish the number of applications found by means of the word "Physics" which are in fact related only to the discipline of Physics. The question asked in this step was of the applications found, how many are developed only for the purpose of attending the Physics discipline? In this way, the objective is to exclude those who present, in their content, several disciplines or, even being specific to the discipline of Physics, offer only compilations of exercises.

Finally, the fourth step highlights the applications with the largest number of downloads and that offer in their content something other than exercises or college entrance exams. The choice of applications with the highest number of downloads is related to the possibility of filtering the most installed and used applications for this study. Thus, the guiding question established in this stage was which, among the applications that have more than 10,000 downloads, have, in their content, something other than physical exercises?

We emphasize that this article does not aim to perform a qualitative analysis of the applications. It only seeks to present them, demonstrating its main functionalities, leaving the reader to verify the applicability or not in its context.

In the next sections of this work, a description will be given of each of the steps taken to identify free educational applications for the Android operating system related

to the teaching and learning processes of Physics and available in the Google Play Store virtual store.

FIRST STEP

In this first step, the search was performed by inserting the word "Physics" in the Google Play Store search. The filters were adjusted for free applications and for a level of user satisfaction corresponding to four or more stars.

The search for the word "Physics" returned a total of 250 applications, however, it was realized that a relevant amount of them was not related to what was established for this study. Applications were found for different purposes, such as games and teaching physics in another language, as well as other sports and health related topics and in other categories that do not correspond to the focus of this research.

The applications found were analysed and classified according to the Portuguese language and the purpose established by the virtual store as "education". In this way, they were organized in five categories, as highlighted in Figure 1. Only 42 applications, corresponding to 16.8% of the total identified, are related to the teaching of Physics.

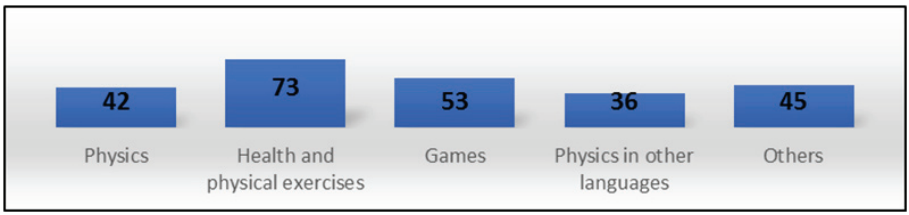

Figure 1. Graph of the number of applications by categories.

They are inserted in the category "Physics" applications that, after being installed, could be used, but with some limitations, because they presented the necessity of purchasing extensions of use. As an example, there are those that offer a certain amount of exercises released for free access and another for users who purchase the paid version of the application. These applications are also categorized in Figure 1, since they are inserted in the category "Physics" all the applications found that are in Portuguese, with Education purpose and curricular component of Physics at the same time.

SECOND STAGE

In the second stage, the 42 applications of Physics, mentioned in the previous stage, were highlighted, highlighting the title, main characteristics and number of downloads made (see Table 1).

Table 1
Main characteristics of the applications of Physics identified in the mapping.

	Application title in the Google Play Store	Features	Estimated number of installed devices
1	Brainly – estude com a gente	It presents sharing of doubts and also answers to questions, allowing other users to help.	+ 10.000.000
2	Conversor de unidades	Provides a unit converter.	+ 10.000.000
3	Khan Academy	It presents videos with explanations and exercises from various disciplines, including physics.	+ 5.000.000
4	Geekie Games Enem	Provides exercises related to ENEM.	+ 1.000.000
5	Passei Direto: o melhor app para você estudar	Provides explanations on various disciplines, including physics.	+ 1.000.000
6	Cursos de Graça	Provides links to explanatory videos.	+ 500.000
7	Enem 2018 Simulados e Redação	Teaching application for various disciplines; provides ENEM exercises, including Physics.	+ 500.000
8	Descomplica – Vestibulares 2018 & Cursinho ENEM	Offers videos with explanations from various disciplines, including Physics.	+ 500.000
9	Física Básica – Para o ENEM, Engenharias e Escolas	It offers formulas of various subjects of physics, summaries of contents, exercises and calculator applied to the formulas.	+ 100.000
10	Física Interativa	It presents Physics' formulas, summaries of various subjects and exercises.	+ 100.000
11	Formulário de Física	It presents formulas of Physics subjects.	+ 100.000
12	ENEM 2018 e curso preparatório online – Me Salva!	Features videos with explanations and exercises from various disciplines, including Physics.	+ 100.000
13	Física ENEM	It shows summaries of Physics' subjects, presents the formulas and provides a calculator of applied formulas.	+ 50.000
14	Calculadora de Física	It presents formulas of various Physics' subjects and calculator of applied formulas.	+ 10.000
15	Fórmulas – Física	It presents the formulas of various Physics' subjects.	+ 10.000
16	Vivendo a Física	It presents formulas, summaries of various Physics' subjects, and exercises.	+ 10.000
17	Física Fábris ENEM	It provides formulas for various Physics subjects, and abstracts.	+ 10.000
18	Física Divertida	It presents videos with explanations, entrance exams for download and blog.	+ 10.000
19	Auxiliar Física	Provides a calculator with the formulas applied.	+ 10.000
20	Acústica – Física no ENEM Lite	It presents explanations related to Acoustics and formulas.	+ 10.000
21	Simulado de Física (NetFísica)	It only shows exercises.	+ 5.000
22	Quiz Física	It only shows exercises.	+ 5.000
23	Fórmulas de Física – ENEM	It presents formulas of various Physics' subjects, and exercises.	+ 5.000
24	Física in Mãos	It presents the formulas, summaries of various Physics' subjects, exercises, calculator with applied formulas and biographies of famous physicists.	+ 5.000

	Application title in the Google Play Store	Features	Estimated number of installed devices
25	Responde Aí: Engenharia, Cálculo, Física e muito +	It presents explanations and exercises of various subjects related to Physics.	+ 5.000
26	Física Universitária	It presents videos with explanations of various Physics' subjects.	+ 1.000
27	Aprenda Física	The application was empty at the time of its analysis.	+ 1.000
28	Estudapp Física	It offers exercises of various Physics' subjects.	+ 1.000
29	Física quântica para bebês	It presents explanations on quantum physics.	+ 1.000
30	Acústica – Física no ENEM	It presents explanations and Acoustics formulas.	+ 1.000
31	Física de Bolso	It provides explanations and exercises of various Physics' subjects.	+ 1.000
32	Fórmula de Física	Only displays formulas.	+ 500
33	Física em Indagações: Dinâmica	It provides explanations and exercises.	+ 500
34	Fórmulas Física Prof Robson	Only displays formulas.	+ 500
35	Física Enem e Encena	Presents summaries of various Physics' subjects.	+ 100
36	Física GO	Provides the formulas and a calculator with the formulas applied.	+ 100
37	Física no ar	It provides summaries and formulas of various Physics' subjects.	+ 100
38	Física Clássica	Provides the formulas and a calculator with the formulas applied.	+ 100
39	Física – Ondas e Termo Física.	Only displays exercises.	+ 100
40	Física Digital	Only displays exercises.	+ 50
41	Física Lab Óptica	Features a geometric optics simulator.	+ 10
42	Biblioteca de Física	It provides explanations and formulas of various Physics' subjects.	+ 10

The main characteristics identified in each of the applications on the category "Physics" are formulas, summaries, explanations, calculators, videos with explanations, exercises, units converter, doubting sharing, vestibular tests, biography of physicists and simulators. In Figure 2, the main characteristics of the applications are highlighted, and an application can present more than one characteristic.

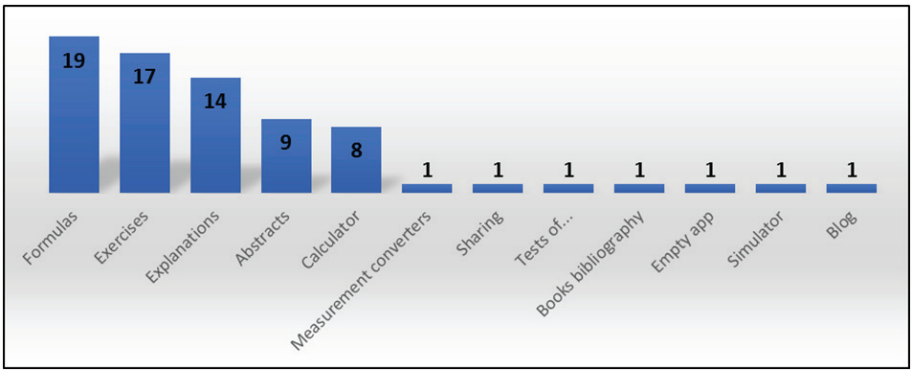

Figure 2. Characteristics of Physics applications.

The 42 applications listed in this stage of the research present a wide range of contents: while some focus on specific contents of Physics, others present a content review for the ENEM or for vestibulars, and among the curricular components, they emphasize Physics.

THIRD STAGE

In this stage, the applications mapped in the second stage that present specific content related to the teaching of Physics were highlighted. Through the description of the characteristics of each application made in Table 1, it is evident that applications that were not specific to Physics were found. In addition, some, even if developed for the discipline, presented, in their content, only compilations of exercises or even links to tests downloads and exercises of vestibular or ENEM. The reason for this step is to not include applications that only refer to exercises and also, that the interaction with the user does not occur in an evident or significant way, without the possibility of changing variables or even providing explanations or summaries.

Analysing Table 1, of the 42 applications, 31 were developed to address specifically the physics discipline. Of these, four present only exercises in their content. In Table 2, we present applications developed with specific Physics content.

Table 2
Physics applications divided by content offered.

Characteristic	Applications – numbers shown in Table 1
Applications that present specific physics content	9, 10, 11, 13, 14 ,15, 16, 17, 18, 19, 20, 23, 24, 26, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 41 e 42.
Physics applications that present only exercises on a certain content.	21, 22, 39 e 40.

As highlighted in Table 2, 27 applications are directed to the development of specific contents and activities of Physics teaching; however, two of them were no longer available for analysis at this stage of the research. Thus, only 10.8% of the sample space identified in the first phase of this mapping are applications directed specifically to Physics and offer in their content more than lists of exercises or instructional activities.

FOURTH STAGE

This last step highlights the applications found in the previous step that have more than 10,000 downloads. There were 11 applications; however, one of them (Acoustics – Physics in ENEM Lite) was no longer presented in the Google Play Store at the time of this step. Table 3 lists the 10 applications that met the requirements described and were still available for download from the Google virtual store.

Table 3
Applications identified in the fourth step.

Name	Icon	Developer
Física Básica – Para o ENEM, Engenharias e Escolas		mesoatomic.com
Física Interativa		FisicaInterativa.Com
Formulário de Física		Thiago Bell
Física ENEM		Lopes Apps
Calculadora de Física		BM IT SOLUTIONS
Fórmulas – Física		DSmart Apps

Name	Icon	Developer
Vivendo a Física		UFMS Campus de Ponta Porã
Física Fábris ENEM		Física Fábris
Física Divertida		agileTI.net
Auxiliar Física		Gustavo D.

In the following section, we describe the 10 applications specifically related to the physics discipline that offer more than simple exercises lists or content presentation and that have more than 10,000 registered downloads. In addition to the description, the level of satisfaction of the users, the screens of use and the main contributions to the teaching of Physics stand out.

DESCRIPTION OF APPLICATIONS IDENTIFIED FOR PHYSICAL EDUCATION

As previously pointed out, the use of applications in Physics teaching dynamises classes and can increase students' involvement in activities and make them active agents and transformers of their learning.

In this sense, it is essential to provide the teacher knowledge of the main applications available for Android operating system and which have a significant number of downloads. Thus, the main characteristics of the applications identified in the fourth phase of this mapping are presented below.

a) Basic Physics – For ENEM, Engineering and Schools

This app has satisfaction level 4.7 and it has been installed on more than 100,000 devices. One of the available resources is to refer the user to YouTube videos with explanations. There are also summaries of various topics, with solved exercises presented as examples. Even though it is free of charge as a search filter in the Google Play Store, the application has some usage limitations regarding the number of exercises offered, with the option to purchase a full version within the app itself. In addition, it presents in its content all the topics worked in High School (mechanics, thermophysics, optics, wave, electromagnetism and fluids), which makes it possible to replace the textbook in

certain moments, and also allows the visualization of some phenomena physical, such as universal gravitation, in an animated way.

Figure 3. Pictures from the application: Física Básica – Para o ENEM, Engenharias e Escolas. (<https://play.google.com/store/apps/details?id=com.resumosmoveis.mecanica>, 2018).

b) Interactive Physics

This app has 4.8-satisfaction level and it has been installed on more than 100,000 devices. The didactic tools contained in this application are explanations of various topics in the Physics discipline. It also presents animations of physical phenomena. Despite the filter for free applications, you have the option to purchase another version within the application itself. It presents, in its content, all the topics of Physics addressed in High School, which makes it possible to propose the use in the classroom or at home, replacing the textbook in some situations or to visualize animated physical phenomena.

Figure 4. Images of the Interactive Physics application. (<https://play.google.com/store/apps/details?id=com.fisicainterativa.app>).

c) Physics Form

This app has 4.0-satisfaction level and it has been installed on more than 100,000 devices. The didactic tool offered is a set of formulas of various topics of Physics, the so-called "form". It allows the resolution of exercises, in which the students would consult the formulas quickly, being able to be used both at the classroom and at home. The exercises cater to all topics of physics, even a few commonly addressed, such as Modern Physics.

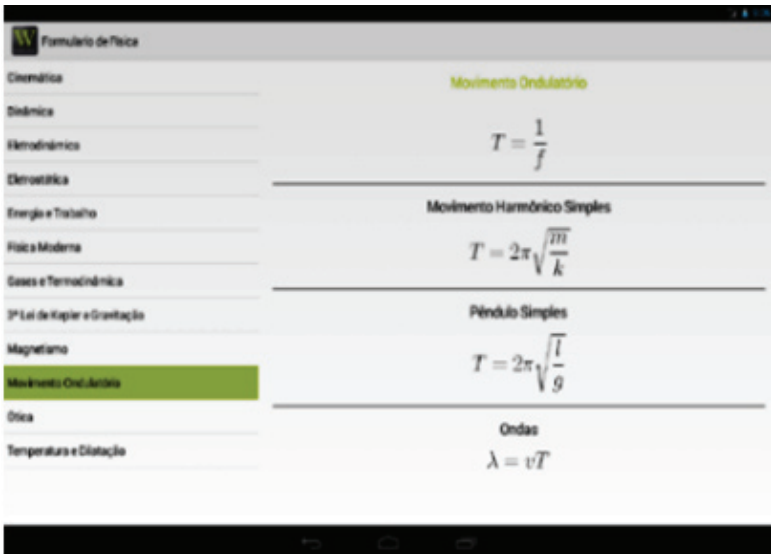

Figure 5. Images of the Physics Form application. (<https://play.google.com/store/apps/details?id=com.thiagobell.fisica>).

d) ENEM Physics

This app has 4.6-satisfaction level and it has been installed on more than 50,000 devices. The didactic tools presented in the application are formulas with the meanings of the symbols and small explanations of the appropriate situations of their use. It is free, but at times during its use, ads appear. In the classroom and at home, it allows the user to use content review classes and check the resolution of exercises, covering all the topics covered in the discipline of Physics in High School.

Figure 6. Images of the ENEM Physical Application.
(<https://play.google.com/store/apps/details?id=lopes.com.fisicaenem>, 2018).

e) Physics Calculator

This app has 4.0-satisfaction level and it has been installed on more than 10,000 devices. The learning tool of this application is a variable calculator, which presents the formulas with the spaces to fill the values found in an exercise, for example, and then presenting the value of the answer. Like previous apps, it displays ads during their use. It addresses only the content of kinematics, which limits its use at certain times. In the classroom and at home, it allows the user to solve exercises, performing the calculations themselves according to what the exercise asks for, and can check the results with the help of the application.

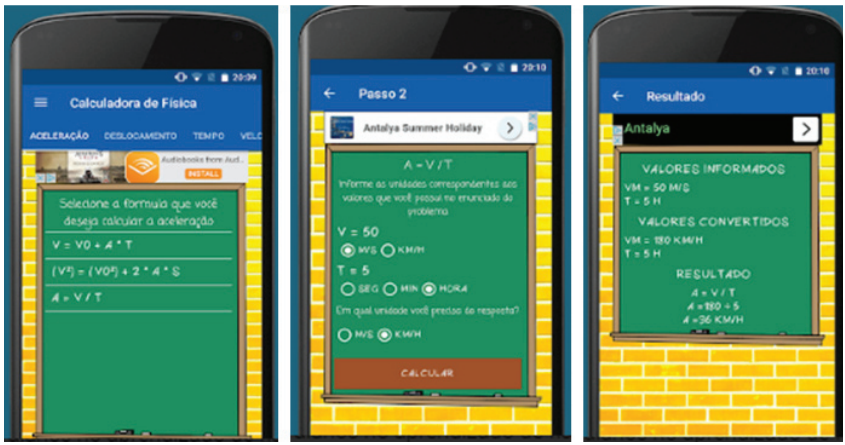

Figure 7. Images of the Physics Calculator application. (<https://play.google.com/store/apps/details?id=br.com.calculadora.fisica.v2>).

f) Formulas – Physics

This app has 4.6-satisfaction level and it has been installed on more than 10,000 devices. Its didactic tool is a form that answers all the topics covered in Physics during High School. Although it is free, it displays ads during use. Classroom use can be done for the resolution of exercises, and at home, can be used by the user as an aid in resolving tasks.

Figure 8. Images of the Formulas – Physics application. (<https://play.google.com/store/apps/details?id=com.DSmartApps.FormulasFisica>).

g) Living Physics

This app has 4.6-satisfaction level and it has been installed on more than 10,000 devices. The main teaching tools are lessons in physics, with explanations, solved exercises and multiple-choice exercises to check the user's understanding. Some formulas are also offered. You do not run into ads in your use. The only topic offered is that of kinematics, making its use restricted to certain pedagogical moments. Classroom and home use can be done during content revisions and exercise resolution, and can even replace the textbook at certain times; it also can be used at home by the user to solve tasks.

Figure 9. Images of the Living the Physics application. (<https://play.google.com/store/apps/details?id=com.ufms_cppp.livingthephysics>).

h) Physics Fábris ENEM

This app has 4.8-satisfaction level and it has been installed on more than 10,000 devices. The didactic tool it presents is access to videotapes of a given channel on YouTube and to formulas. Content is offered on all topics covered in Physics in High School and the use of the application in the classroom and at home can be done in moments that precede evaluations, as a way to review the content that will be charged. A different detail of this application is the requirement of a registration for its use.

Figure 10. Images of the Fábris ENEM Physics application. (<https://play.google.com/store/apps/details?id=br.com.app.gpu1620833.gpu142abf457b79137f7f652103330673c5>).

i) Fun Physics

This app has 4.4-satisfaction level and it has been installed on more than 10,000 devices. The didactic tools are visits, through links, to blogs with videos about subjects

related to physical phenomena and to the videos themselves of the group that designed the application. It is also possible to download several vestibular and ENEM tests. The application addresses some topics of physics, among them: mechanics, wave (acoustic), modern physics and optics. The use of the application in the classroom environment makes it possible to perform content reviews and the provision of some exercise lists.

Figure 11. Fun Physics application images.
Source: <https://play.google.com/store/apps/details?id=agile.ti.mobile.fisicadivertida> (2018)

j) Physical Auxiliary

This application has a level of satisfaction of 4.1 and it has been installed on more than 10,000 devices. The didactic tool is very similar to the one presented in the Physics Calculator application description but covering other topics. It is offered a topic approach of Mathematics (law of sines and vector product) and 3 more topics of different areas within Physics (parallel resistors, temperature and refraction of light), which leaves its use restricted to specific moments of explanation of the subject. In the classroom, it is possible to use it in moments of resolution of exercises, so that the student calculates the values and uses the application to verify the answers.

Figure 12. Images of the Physical Auxiliary application. (<https://play.google.com/store/apps/details?id=net.gustavodias.auxiliarfisica>)

FINAL CONSIDERATIONS

The research in Physics teaching finds a fertile ground when related to mobile technologies. Smartphones are becoming more and more present, and the internet is getting faster and more available in plans of mobile operators or wi-fi. There are programs, such as the App Inventor 2, that allows a user without a programming language knowledge to develop a specific application, meeting pre-established needs.

In order to trace what can be researched and developed related to mobile technologies, it is necessary to have an overview of what already exists, what resources are present in the available applications, their main contents and the ways in which they can be used in classroom.

The elaboration of the inventory made in this research presents some points of reflection. The first of these is that searching for an application that meets a specific need can lead to results that are different than intended, as the Google Play Store, for example, offers few forms of filtering. It was noticed that when searching for "Physics", one obtains a great amount of applications with little or no relation to the activities of Physics teaching.

Another finding was that a great amount of applications offers, in its content, subjects related to Physics, but they are not specific to the discipline. Many applications are related to the ENEM tests or offer only a set of formulas applied to a particular subject of Physics, the so-called forms.

A low number of applications (10.8%) from the total found at the beginning is related to physics and offers something beyond lists of exercises. It is evident once again in the description of the selected applications that most of them present only formulas and content summary.

The applications are available and are turned unavailable with a high frequency, which makes possible that new researches find different results, although realized according to the same methodology described in this work. It was also noted that part of the applications found through the "free" filter actually provides a restricted version of use, and the user is offered the possibility of purchasing a full version for payment.

In 2018, the Ministry of Education announced the new National Curricular Common Base. In its text, the use of different media and digital technologies to diversify science education is encouraged. What has been noted in the description of the applications is that practically none of them presents contextualization of the physical phenomena but only highlight the theoretical or mathematical descriptions of nature. Bring Physics to the reality of the student, seeking meaning for what is explained, removes the misinterpretation that Physics is a mere cluster of formulas and equations.

Therefore, to know the digital technologies available today is a way to devise strategies for its use, in order to develop means to promote a learning that has meaning for the student and that is also pleasurable, not a simple change of didactic resources that maintains the teaching in the same way.

AUTHORS CONTRIBUTIONS STATEMENTS

J.P.O., R.F.P., and M.S.M. conceived the idea presented. R.F.P. developed the theory. J.P.O. and R.F.P. adapted the methodology to this context. J.P.O. performed the activities and collected the data. M.S.M and M.A.K. oversaw the project. All authors discussed the results and contributed to the final version of the manuscript.

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