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# Using App Inventor as Tool for Creating Mathematics Applications for Mobile Devices with Android OS

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author BC designed the study, performed the application analysis, and wrote the first draft of the manuscript. Authors MC and AAC managed the analyses of the present study, and managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

People are programming on their personal computers since the 1980s, but today's mobile applications are making computing as "personal" as never before. Never in the history of the use of technology in education has there been a technology so widely available to citizens as mobile technology. According to this trend, we are moving into a new era of consuming information via mobile computing, one that promises greater variety in applications, highly improved usability, and networking. Our consuming information culture gives us all sorts of opportunities for entertainment, even learning using high-tech devices, which are considered to be black boxes to most of us,

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because only few people can create applications. Even though, more and more students are interested in developing their own mobile applications. In this context, we present our experience with App Inventor - a user friendly platform and drag-and-drop block language to create Android apps. The present paper is an intro to the creation process for an applied mathematics app, started 4 years ago, corresponding to the requirements of our classroom consuming information culture.

*Keywords: App Inventor; Android devices; applied mathematics; mobile learning.*

## ABBREVIATIONS

*AIA: App Inventor for Android; app(s): application(s); AVD: Android Virtual Device (Emulator); ECAR: Educause Center for Applied Research; e-learning: learning utilizing electronic technologies to access educational curriculum outside of a traditional classroom; MIT: Massachusetts Institute of Technology; m-learning: learning utilizing exclusively mobile technologies and afferent devices to access educational curriculum outside of a traditional classroom; IDE: Integrated development environment*

## 1. INTRODUCTION

People are programming on personal computers since the 1980s, but today's mobile applications are making computing "personal" as never before [1]. Never in the history of the use of technology in education has there been a technology so widely available to citizens as mobile technology. According to this trend, we are moving into a new era of consuming information via mobile computing, one that promises greater variety in applications, highly improved usability, and networking.

We are confronted with another perspective on informatics - mobile learning which seems to be very similar to e-learning, but different at the same time, as demonstrated in Fig. 1, because mobile devices - the fundamental vectors of delivering mobile learning - bring a new dimension to learning and education allowing learning to occur in authentic contexts. These authentic contexts and real environments, together with the mobile devices, enable student learning activities characterised by communication, collaborative knowledge building, observation (facilitated by the mobile devices cameras), and innovation (using new devices and new contexts). Thus, using mobile devices students are able to develop useful knowledge in real situations [2].

Our information consumer culture gives us all sorts of opportunities for entertainment, pleasure and sometimes even learning [3] using computers and other devices. The high-tech devices (cell phones, tablet computers, TVs etc) that we use today to consume entertainment and information are considered to be black boxes to most of us, because only few people can create applications for these gadgets. Even so, more and more students are interested in developing their own mobile applications. Incorporating mobile technology into classrooms can greatly capture student attention, improve student engagement, and improve student achievement.

Today, we have mobile portable computers, e.g. smart-phones, tablets. More significantly, today is increasing the social and personal experiences that fundamentally transforms our experience and our perception of our world. Experts predict this "perfect storm" requires transformation in higher education practices to make a quality postsecondary education affordable, relevant, accessible, and desirable. The Educause Center for Applied Research study the university student perceptions and usage of technology. Their reports are shown in Figs. 2-5 [4].

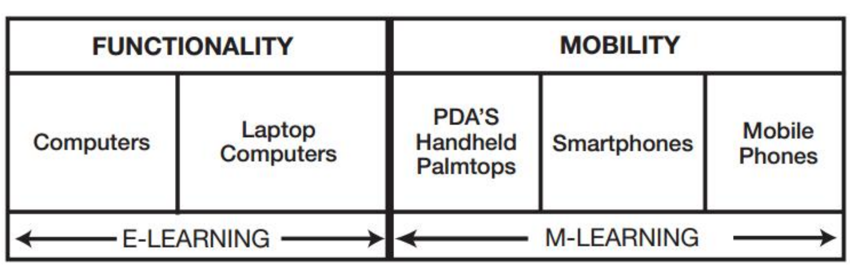



**Fig. 1. The main differences between e-Learning and m-Learning**

Fig. 2 shows that 43% of students agree the idea that educational institutions needs more technology, concluding that improving the availability and effectiveness of technology on university campus is an real opportunity for learning system.

Fig. 3 presents, based on respondents' responses, the student perceptions referring to software use in higher and university educational system. I underline the information that seems to be the most relevant for the topics of this thesis such as the student perceptions related to programming languages.

Fig. 4 illustrates the student perceptions of hardware use in educational system. As I underline about 55% of questioned students own smart phones as technology devices, and only 37% of them have used those devices for academics before.

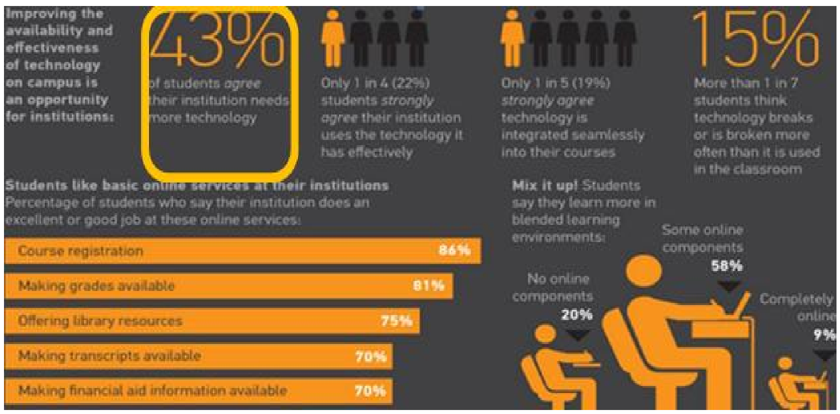



**Fig. 2. Student perceptions of technology use at universities [4]**

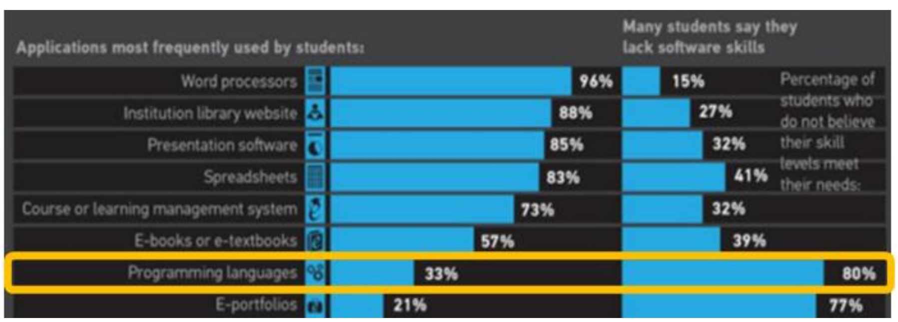



**Fig. 3. Student perceptions of software use in university education [4]**

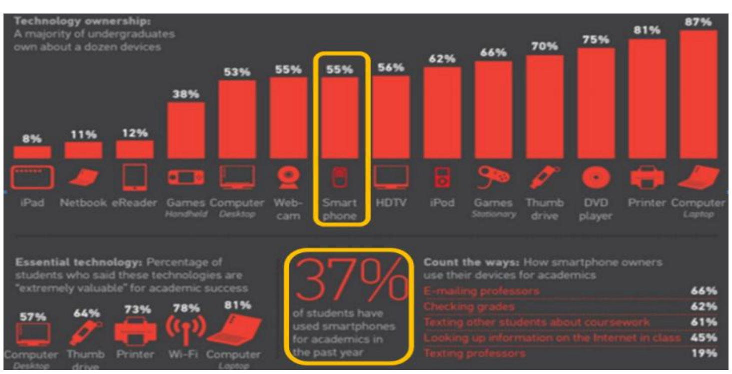



**Fig. 4. Student perceptions of hardware use in higher and university education [4]**

There are already many mobile platforms on the market today, including Symbian, iOS, Windows Mobile, BlackBerry, Java Mobile Edition, Linux Mobile and more. Android is the first environment that combines a truly open, free development platform based on Linux with a component-based architecture inspired by Internet services, automatic management of the application life cycle, high-quality graphics and sound, plus portability across a wide range of current and future hardware.

According to the students perspective presented above, I present my experience, findings, and lessons learned from working with App Inventor [5] - a user friendly platform to create easily Android applications.

App Inventor for the Android [6], as part of information consumer culture, is a blocks language for mobile phones and a powerful visual and drag-and-drop tool. The software could be used to build mobile applications: game design, multimedia quizzes and guides, educational software, design complex applications that control robots or communicate with the web - with no programming experience required.

## 2. METHODOLOGY

There are a lot of players out there in the mobile development framework world, as shown in Fig. 5. This section points out the differences, strengths, and weaknesses in a few of the tools out there in order to understand the mobile development environment concepts.

App Inventor has empowered students to create applications for android phones. This task was impossible before due to the numerous demands and requirements of the Android app creation process: knowledge of Java, comprehension of computer science principles, and familiarity with software development tools such as Eclipse, NetBeans, etc.

Each of the software development tools and environments for mobile devices are described below using a table format with a few different sections:

**Strengths** - Why is this a good tool?

- free, extremely easy to get started and use, IDE runs on any OS that supports Java;
- no coding necessary for layout or behavior and includes an device emulator and predefined “blocks”, no phone required.

**Weaknesses** - Why might it not be a good tool?

- create apps for only one platform, no other platforms supported, with pure visual design style that may be difficult for seasoned developers;
- does not output native source code, only native package, so no direct code creation or modification is possible.

| | App Inventor | DroidDraw | Rhomobile | PhoneGap | Appcelerator | WebView | AML |
|---|---|---|---|---|---|---|---|
| **Mobile Platform Compatibility** | | | | | | | |
| Android | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| iPhone/iPad | No | No | Yes | Yes | Yes | Yes | Planned |
| Windows Mobile 6 | No | No | Yes | Maybe | No | Yes | Planned |
| Windows Phone 7 | No | No | Maybe | Maybe | No | Yes | Planned |
| Palm | No | No | No | Yes | No | No | No |
| BlackBerry (RIM) | No | No | Yes | Yes | Planned | Weak | No |
| Symbian | No | No | Yes | Yes | No | No | No |
| **Development Environment OS Support** | | | | | | | |
| Windows | Yes | Yes | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) |
| Mac | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Linux | Yes | Yes | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) | Yes (no iPhone) |

**Fig. 5. The Android IDE and other platforms for develop Android apps**

**Development Requirements** - How do I get started building apps with it?

- create an account in order to access or to work on projects and install different r development kits.

**Deployment Requirements** - How do I get my apps onto a device?

- build and sign apps packages for desired platforms, or nothing special required.

App Inventor is the newest tool out there, a friendly GUI for building and coding Android applications, great for anyone who wants to learn programming concepts using their Android device. For other platforms or other types of developers, it's probably not the best choice.

Since its conception (release in 2010), App Inventor has been used as a teaching tool in many schools and universities. It has gained popularity amongst educators and students around the world as a learning tool (having the characteristics from Fig. 6) for fundamental concepts in computer science, and more importantly, as a medium through which students can exercise creativity [6,7].

App Inventor is first of all an educational learning tool, provided by Massachusetts Institute of Technology - Center for Mobile Learning, that allows (enables) users - almost everyone - to develop applications (apps) for Android-based smart mobile devices without writing a single line of code (or without any knowledge of programming languages – Fig. 7).

App Inventor can also be considered as an Online Development Environment or web-based tool [6] developed jointly by MIT and Google Labs in which the App Inventor servers store all the work (Fig. 8). When the app is finished it can be packaged as an "Android application package" (.apk file) that can be shared around and installed on any Android devices [8].

| | Strengths | Weaknesses | Development Requirements | Deployment Requirements |
|---|---|---|---|---|
| App Inventor | ✓✓✓ | ✗✗ | ✗✗ | ✗ |
| DroidDraw | ✓ | ✗ | ✗ | ✗ |
| Rhomobile | ✓✓ | ✗✗ | ✗✗✗✗ | ✗ |
| PhoneGap | ✓✓✓ | ✗✗ | ✗✗✗ | ✗ |
| Appcelerator | ✓✓✓✓ | ✗✗ | ✗✗ | ✗✗ |
| WebView | ✓✓ | ✗✗✗ | ✗✗ | - |
| AML | ✓✓✓ | ✗✗ | ✗ | ✗ |

**Fig. 6. The App Inventor main characteristics as an educational learning tool**

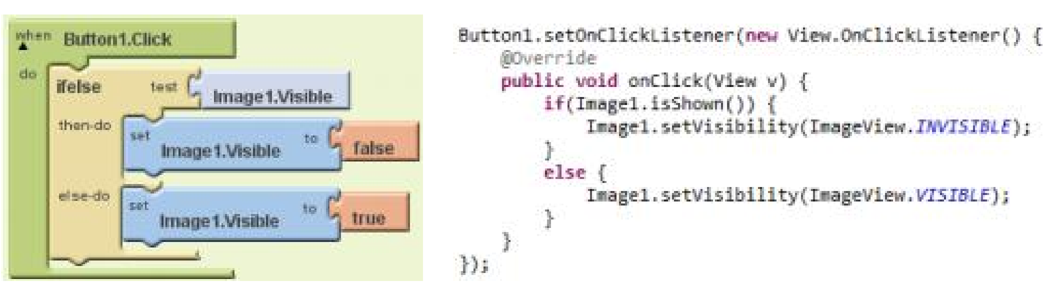



**Fig. 7. Visual code vs Textual code for handling the event of a button clicked**

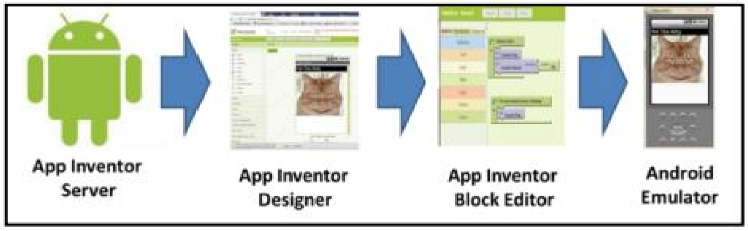



**Fig. 8. App Inventor development environment and MIT logo**

App Inventor is supported by a wide range of operating systems and web browsers, with these minimum specifications [9]:

- computer operating system requirements: Windows (Windows XP, Windows Vista, Windows 7+), Linux (Ubuntu 8+, Debian 5+) and Mac (Mac OS X 10.5+);
- web browser requirements: Internet Explorer 7.0+, Mozilla Firefox 3.6+, Google Chrome: 4.0+ and Apple Safari 5.0+.

Additionally App Inventor requires two pieces of software to be installed on computer: Java - to provide software libraries for App Inventor and App Inventor Setup - to provide client-side support for the web-based App Inventor development environment.

App Inventor is a mobile application design tool consisting of three integrated major parts:

- *Design View* - for specifying the visual components of an application;
- *Blocks Editor* - for creating behaviours for the components and
- *Android Device Emulator* - for running (testing) the applications.

Programming in App Inventor is done with colorful blocks that are designed to snap together like puzzle pieces. The blocks are like words that, when snapped together, form sentences of instruction to your phone. The Design View (for version 1.2 – Fig. 9) is laid out in five basic columns from left to right: Palette, Viewer, Components, Media and Properties.

The Component Designer is a fairly typical WYSIWYG (what you see is what you get) tool that provides the components for designing user interfaces, such as Basic, Media, Animation, Social, Sensor, Arrangement and Other. Each component can have methods, events and properties [10,11].

The Blocks Editor (Fig. 10) is used to assign behaviour to the components (e.g. to indicate

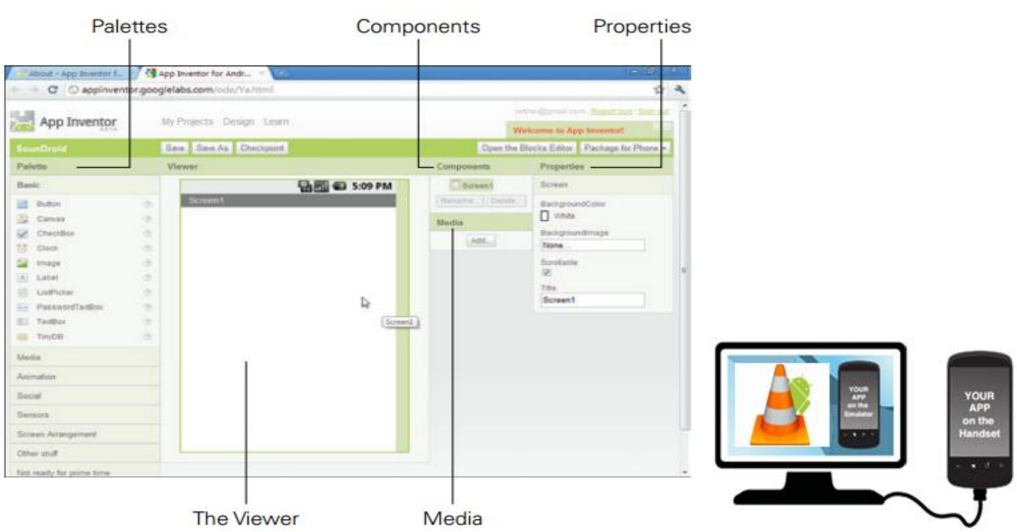



**Fig. 9. App Inventor Designer (a) and the debugging perspective for an Android application using an emulator or an Android handset (b)**

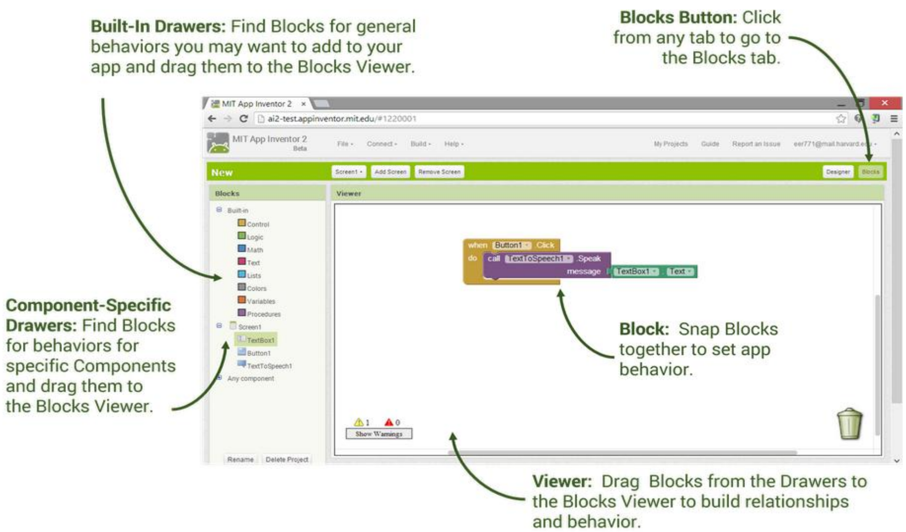



**Fig. 10. The Blocks Editor for an app created with App Inventor v. 2.0**

what events should cause action in the app and what the resulting algorithm is after the event occurs). It allows a user to set of different properties, also it can make a reference to a component via a variable (argument) and manipulate dynamically.

There are seven block categories, not including the My Blocks section: *Definition Blocks*, *Text Blocks*, *List Blocks*, *Math Blocks*, *Logic Blocks*, *Control Blocks* and *Color Block*.

One of the most important tools included in the Android SDK is emulator.exe which launches the Android Emulator [10]. The Android Emulator is used to run the applications in a pseudo-Android environment. At the same time, the emulator help to prototype, develop and test Android applications without using a physical device.

The Android emulator mimics all of the hardware and software features of a typical mobile device, except that it cannot place actual phone calls. The Android Device Emulator provides a variety of navigation and control keys [11], which can be used to generate events for the applications. It also provides a screen in which the applications are displayed, together with any other active Android applications.

## 3. RESULTS AND DISCUSSION

Education has evolved considerably over the last 50 years and the industry is now faced with a series of significant trends, as presented in [12] and as shown in Fig. 11 that offer the potential to create dramatic new opportunities for effective learning.

The implications of mobile learning are far-reaching, and its potential effect on all education is profound; as mobile learning capabilities continue to expand new forms of learning will continue to evolve and the next few years will see a period of rapid growth for mobile learning, with evolutionary rather than revolutionary changes.


**Fig. 11. The evolution steps of the informatics education [13]**

Mobile and wireless devices, especially mobile phones, have recently become increasingly common among young students. This provides new possibilities, opportunities and challenges for education (Fig. 12), and especially for mathematics education.

Recent studies examined the use of mobile phones in mathematics learning among teachers suggest that we are at the beginning of a new era for mobile phone integration in the mathematics classroom. According to this trend the MathApp Works! demonstrate that is possible to give mobile education using an integrated development environment.

App Inventor has several strengths: is free, easy to get started (web app) and use; IDE runs on any OS that supports Java; no coding necessary for layout or behavior, includes an Android device emulator, no phone required, includes predefined “blocks” for accessing web and other services; provides limited visual live debugging and testing etc). Several of its weaknesses are: it is just for Android; pure visual design style that may be difficult for seasoned developers; does not export Java code, and no java modification is possible.

However, App Inventor will not fit the programmers full expectations because is too restricted and simple, so for creating complex apps will be more difficult to use comparative to an IDE such as NetBeans or Eclipse. The MathApp Works! was difficult to made according its complexity!, the mobile educational software can solve many applied mathematics problems. The present paper is about an application with App Inventor for Android platform. It is an educational system for applied mathematics, necessary for those who wish to learn mathematics in an interactive way or just to improve their math skills.

The new software - MathApp Works! - which I have configured in [15,16] and I have fully developed it in [17] - has the following versions:

- MathApp Works! - Standard (for V-VIII grades) as shown in Fig. 13 - 5 different apps: *Calculator*, *Formulas*, *Equations Solver*, *Geometry Solver* and *Unit Converter*.
- MathApp Works! - Advanced (IX-XII grades) - 6 different apps: *Glossary*, *Financial Calculus*, *Statistics*, *Matrices & Determinants*, *Derivates* and *Integrals*.
- MathApp Works! - Professional (university level) - 3 different apps: *Transport Problem Solver*, *Simplex Solver* and *Miscellanea.*

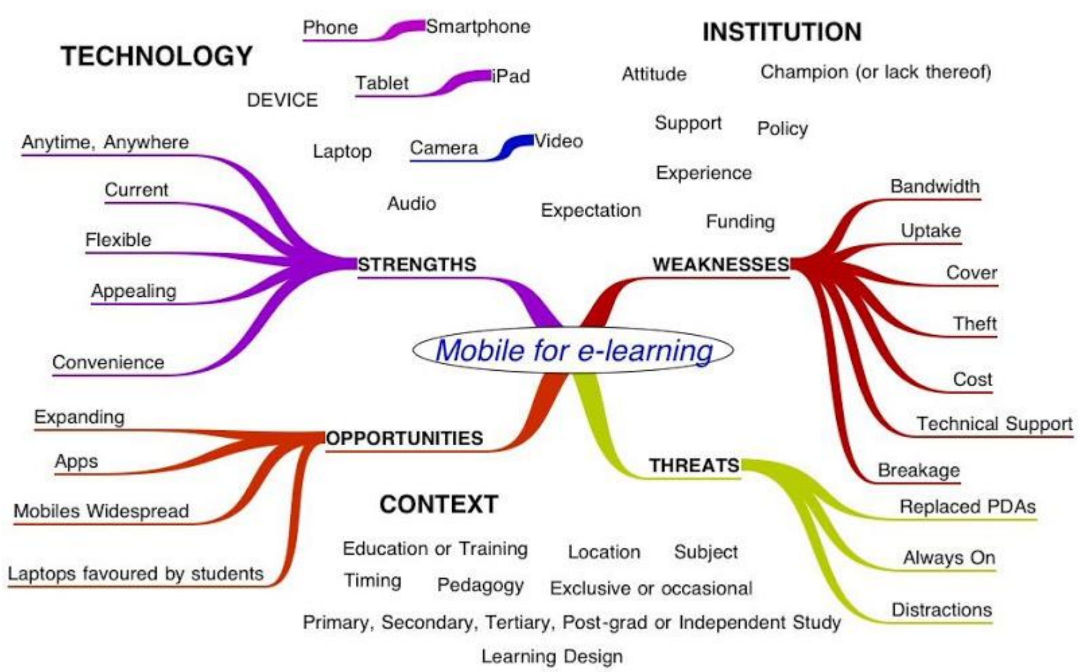



**Fig. 12. A brief SWOT analyze for mLearning [14]**

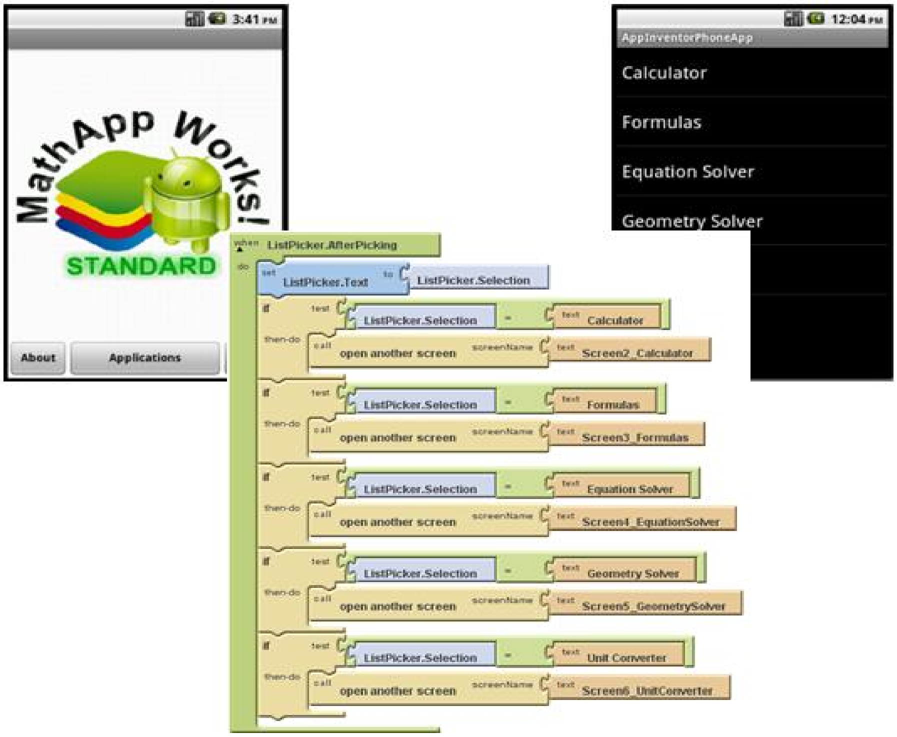
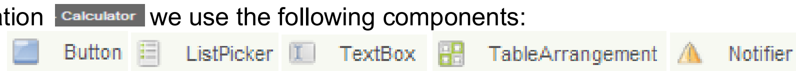



**Fig. 13. MathApp Works! Standard version**

The Calculator (Fig. 14) from MathApp Works! - Standard version includes options for solving exercises connected to algebra (+, -, *, /, log, %, !), calculus ($e^x$, $\pi^x$, $10^x$, $\sqrt{}$, $\sqrt[3]{}$, $\sqrt[4]{}$, abs, round, floor, ceiling), trigonometry (sin(), cos(), tan(), asin(), acos(), atan() etc).

For the application Calculator we use the following components:



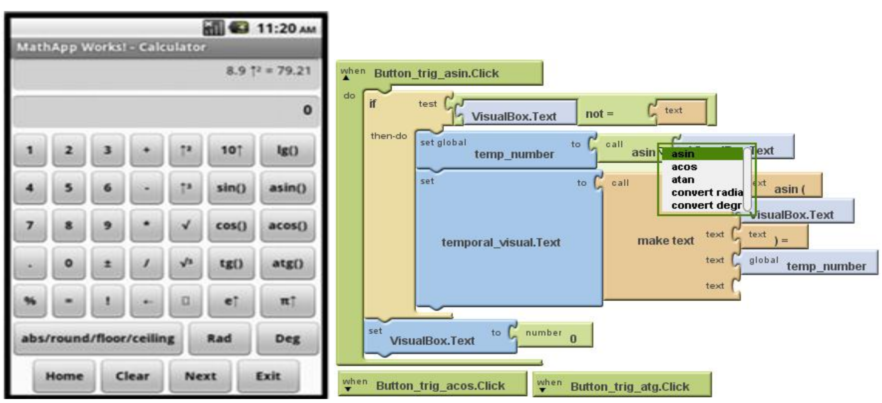




**Fig. 14. MathApp Works! Standard version - calculator design view**

Another interesting application is Geometry Solver (Fig. 15) from MathApp Works! - Standard version has implemented different options for representation and solving 2D figures (e.g. *square*, *rectangle*, *rhombus*, *parallelogram*, *triangle*, *trapezoid*, *circle*, *ellipse*, *sphere*, *cone*, *cube*, etc).

For the application Geometry Solver we use the following components:

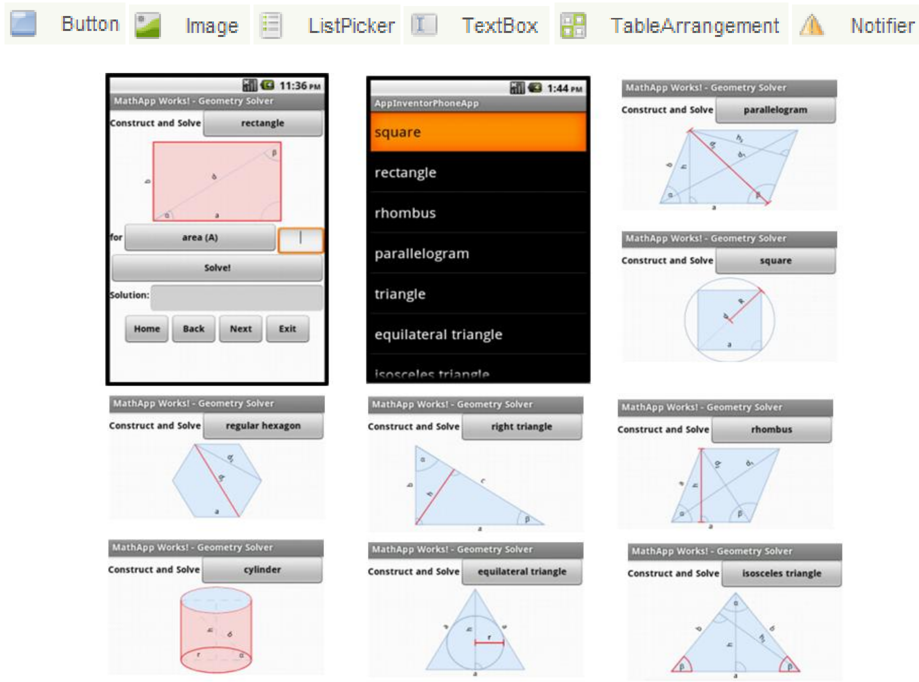



**Fig. 15. MathApp Works! Standard version - Geometry Solver design view**

The Derivates (Fig. 16) from MathApp Works! - Advanced version includes different options (*(x)'*, *(ax+b)'*, *(ax$^2$+bx+c)'*, *sin(x)'*, *asin(x)'*, *(e$^x$)'* etc) to easily access the main differential calculus.

For the application Derivates we use the following components:

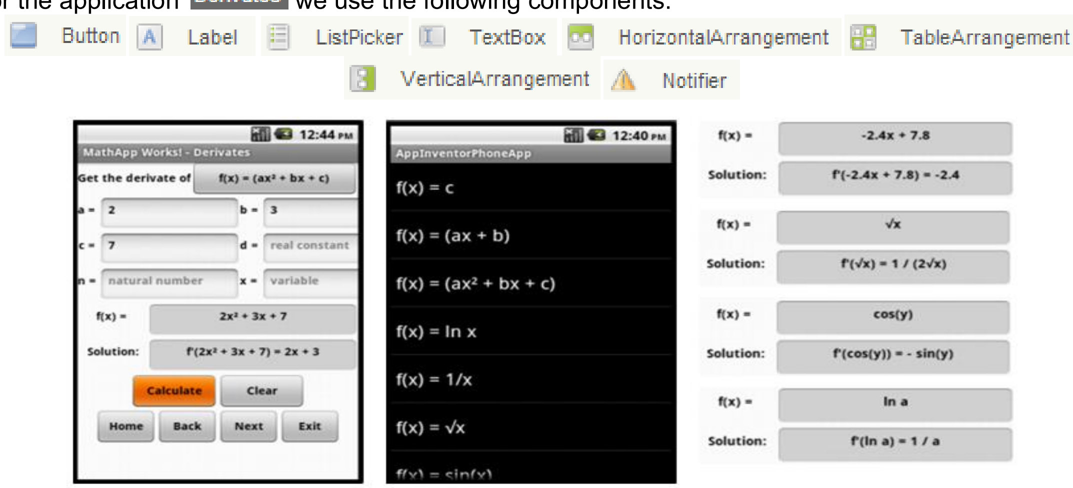



**Fig. 16. MathApp Works! Standard version - Derivates design view**

Mobile learning is an emerging field that requires more research and development if the potential of mobile learning to education and training is to be realized. Despite the ubiquity of mobile phones in every aspect of our daily lives, the use of these devices in education, to teach and learn mathematics in particular, is still new.

## 4. CONCLUSION

This paper illustrates a few App Inventor-based applications for students, integrated as an educational-platform named MathApp Works!. The MathApp Works! platform-applications are based on a various palette of components: basic, media, animation, social, sensor, screen arrangement etc and blocks, as definition, text, list, math, logic, control, color, facilitating the project design and proper functionality. The newly introduced MathApp Works! as an applied mathematics mobile software tool for learning the basis of algebra, geometry, trigonometry, differential and integral calculus etc provide a user friendly educational interface and was successfully tested on emulator and on several Android devices, and fits perfectly to the actual educational requirements of the students.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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