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Short Paper

Education 4.0: Using Web-based Massachusetts Institute of Technology (MIT) App Inventor 2 in Android Application Development

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Abstract

Purpose – The use of an online platform called the (MIT) Massachusetts Institute of Technology App Inventor 2 provided an easy-to-use tool for students in developing an Android mobile application. Education 4.0 is about the use of technology like the MIT App Inventor 2. The MIT App Inventor 2 is an alternative to developing mobile Android applications.

Method – This paper utilized a Descriptive Research Design which used a quantitative method. The survey questionnaires were validated by IT experts.

Results – 90% of the respondents are Very Satisfied in learning the MIT App Inventor 2 platform. 93 respondents answered and marked the use of MIT Inventor 2 as Very Satisfied and 7 respondents marked the use of MIT Inventor 2 as Satisfied.

Conclusion – The students were able to develop Personal Mobile Apps, Educational Mobile Apps, and Internet of Things Mobile Apps using the MIT App Inventor 2. The students were able to integrate Arduino microcontrollers into their Android apps.

Recommendations – To integrate the use of MIT App Inventor 2 in K12 courses.

Research Implications – This research seeks to promote the use of MIT App Inventor 2 to help non-programmers in developing an Android-based mobile application.

Practical Implications – This research proves that technology integration enhances work efficiency.

Social Implications – This research shows opportunities for students to use technology.

Keywords – Education 4.0, 4IR, Industry 4.0, Android mobile application, Internet of Things, MIT App Inventor 2, Arduino

INTRODUCTION

The 4th Industrial Revolution (4IR) represents Industry 4.0 which is also called the Smart Factories (Gabriel & Pessi, 2016). Here, Industry 4.0 allows for smart manufacturing and the creation of intelligent factories. It aims at enhancing productivity, efficiency, and flexibility while allowing more intelligent decision-making and customization in manufacturing operations. It was first introduced in 2011 by the Fraunhofer-Gesellschaft Institute and the German federal government (Gangopadhyay & Mondal, 2016). The convergence and synergy of this latest ICT-based industry which is Industry 4.0 in the areas of mobile computing, Robotics, Internet of Things (IoT), Cyber-Physical Systems (CPS), and Embedded Systems (ES) influenced the educational curriculum in Higher Education specifically in the field of IT and Engineering nowadays (Chung & Kim, 2016). Industry 4.0 in education means that the conventional ways of teaching and learning will become more diverse and will be more diverse. Technology will be mostly used in education. In a study by Sabado (2024), the introduction of technology has paved the way for the simplification of tasks. The plethora of computer applications can be used nowadays in school, at home, or in the workplace. According to Ahmad and Lily (1994), the rapid growth of computers in schools has become a major force for change in educational institutions.

A computer application is a software package that performs a specific function to be used by an end-user. Computer applications can range from word processing, spreadsheet, presentation, educational, personal, simulation, entertainment, and many more. These applications can be in mobile or desktop form. Mobile applications are applications that can be run on mobile computing devices such as smartphones and tablets. Similarly, desktop applications are applications that can be run on desktop or laptop computers. The computer applications can be installed on the aforementioned devices provided that it supports the computer's operating system. Moreover, computer applications can also be categorized as mobile applications or web applications. Mobile

applications are applications that can either be Android-based or iOS-based. Web applications, on the other hand, are applications that can be opened using web browsers.

Mobile application is already part of one's smartphone. Smartphones are becoming smarter because of their apps. These apps are intended to make our tasks easier and faster. Android is a mobile operating system acquired by Google in 2005 (Felker, 2010). It is considered the leading mobile software for smartphones and tablets. The use of mobile devices is very common nowadays. It is said that usage will increase tremendously in the coming years as more people have smartphones because of their mobility and their applications that are useful on a day-to-day basis. This open-source Linux kernel-based operating system offers high flexibility due to its customization properties making it a dominant mobile operating system (Sarkar et al., 2019). Mobile devices like smartphones and tablets are a hit for consumers because of their uses, most especially the apps. A mobile app or mobile application is software that is designed to run on mobile devices such as smartphones or tablets. Mobile applications are also one of the reasons why a person would get a smartphone. Applications like games, social networking media, entertainment, and many more are some of the typical software that a user would normally use. Many professionals consider their mobile devices important in their jobs. Apart from the typical call and text features of a regular phone, most professionals rely on mobile applications for their tasks. An engineer may need an app that deals more than what a regular calculator would do, a Fitness Instructor may need an app about exercises and diet programs, a teacher may need an app that records data of his students like quizzes, exams, etc. Similarly, students can find mobile apps like Android apps useful. Numerous Android-based mobile apps can help students in their classroom activities. Additionally, numerous Android-based mobile apps can also help teachers in their classes. Common applications for teachers are attendance systems, grading systems, quiz systems, and many to mention. A teacher may resort to using the technology due to the changing landscape in education like what transpired during the Covid-19 pandemic. The teaching and learning have transitioned from the usual face-to-face classes to online classes.

LITERATURE REVIEW

Industry 4.0

The major idea of Industry 4.0 is the introduction of Internet technologies into the industry (Gabriel and Pessi, 2016). The advent of this revolutionary technology, the Internet of Things (IoT) brings people to a smart world or simply a techy world. The Internet of Things (IoT), also called the Internet of Everything or the Industrial Internet, is a new technology paradigm envisioned as a global network of machines and devices capable of interacting with each other (Lee & Lee, 2015). It rapidly changes the daily activities of individuals -- from being simpler to smarter. Living in this world is easier because everything can evolve into automation.

According to Udvaros et al. (2023), Industry 4.0 or what is commonly known as the fourth industrial revolution. It is a means the automating the industrial processes, automation, and the use of data to increase the efficiency and quality of production processes. The fourth industrial revolution also affects other areas of the economy such as education. The concept of Industry 4.0 is to prepare the students about the industrial processes that will implemented with the use of technologies. Industry 4.0 is the latest trend that has been implemented by many companies to increase their production and process efficiency.

Nowadays, there are many Internet of Things devices emerging in the market like smart watches, wireless smart buttons, smart home security cameras, smart rings, smart outlets, and so on. The term Internet of Things (IoT) was coined by Kevin Ashton in 1999 (Gangopadhyay and Mondal, 2016). The Internet of Things is being utilized in Industry 4.0 since it is more on automating the process. This simply means that manual processes can be automated with the use of technologies like hardware, software, or both.

Education 4.0

Education 4.0 is a concept that aims to modernize education by using new technologies and methods to prepare students for the challenges of Industry 4.0 (Udvaros et al., 2023). Higher Education in Malaysia has been adopting Education 4.0 to meet the needs of the Fourth Industrial Revolution. One of the pointers highlighted by Universiti Technologi Malaysia (UTM) as they embraced the Fourth Industrial Revolution is Innovation among Universities. The Covid-19 pandemic that affected the world has also forced schools to implement online learning.

In this fast-changing world, challenges are the major factors that will be associated with the Industrial Revolution. These challenges are how to cope with this new technology. How this technology can benefit the different sectors, especially in education (Rojko, 2017). During the Covid 19 pandemic, the education landscape has changed dramatically. From the usual classroom setup to the online classroom setup. According to Udvaros et al. (2023), the main goal of Education 4.0 is to prepare students for the challenges that might transpire in Industry 4.0. Also, the goal of Education 4.0 is to give the students additional knowledge and skills needed in the current digital age. This educational model is no longer not just about the transfer of information but also focuses on developing students' problem-solving skills and abilities. Education 4.0 is student-centered which aims to increase students' motivation, develop their skills, and improve learning outcomes.

In a study by Singh et al. (2023), Education 4.0 refers to the integration of digital technologies into the education system, making it a more flexible and student-centered approach in terms of teaching and learning. The use of technologies provided

opportunities for students, teachers, and administrators. Utilizing the technology poses challenges and these must be addressed.

Android Mobile Applications in School

Android Mobile Applications are software intended to run on an Android operating system. Android is an open-source and portable Linux-based operating system used for mobile devices like smartphones and tablet computers. Android was developed by the Open Handset Alliance, led by Google, and other companies. Android mobile applications are popular in schools. Students and teachers mostly use portable mobile applications to teaching and learning easy. Android mobile applications have been developed for various purposes in the area of education. These mobile applications provide a convenient and efficient way for students, teachers, and even parents to access and manage information. In a study by Muhammad and Ipantri (2023), they developed an Android-based school information system application. This makes it easier for teachers and students to access information using smartphones. Another paper discusses the use of an Android application called Stringwan as teaching material for high school biology, specifically for the concept of tissue structure and function in animals (Viana et al., 2022).

Android-based educational applications are found to be easier, more practical, and efficient for learning compared to other media. Also, another study was done and validated the effectiveness of android-based learning media to help students learn chemical compound nomenclature, which resulted in 87.88% student completion (Chandra et al., 2022). An android English application was also developed by Gayatri and Rafdhi (2022). Android devices are commonly used in day-to-day tasks. The education sector also benefits from this technology. The use of Android tablets or smartphones in educational settings become very common nowadays, especially during the pandemic where classes are mostly done online. Schools may utilize these devices for educational apps, digital textbooks, research, or other interactive learning activities.

MIT App Inventor 2

The MIT App Inventor 2 is an online tool that can make Android programming easy. Versus the MIT App Inventor 1, version 2 now is entirely in the browser. The previous version will require manual installation.

The MIT App Inventor 2 utilizes drag and drag-and-drop method eliminating the coding process. With a few clicks, you can create your Android application. MIT App Inventor 2 is a cloud-based tool which means that you can create your Android applications using a web browser. According to Rosli and Che'Rus (2022), MIT App Inventor 2 is a platform used for developing mobile applications. The online platform allows users to create Android applications using a visual programming interface, making it accessible to individuals without extensive programming knowledge. The online

platform has a user-friendly environment for creating mobile applications. Additionally, MIT App Inventor 2 allows anyone to build complete and working Android applications without writing code (Walter & Sherman, 2015). Figure 1 shows the user interface of the MIT App Inventor 2. It shows the mobile phone interface that allows the developer to preview the content of the app.

According to its website, MIT App Inventor 2 provides the user with many different components to use while building Android mobile apps. The components are chosen on the Design screen and dragged onto the phone. The user can then change the properties of these components such as color, font, speed, etc. In the Designer view, on the left-hand side is the component palette. This palette contains different drawers such as Basic, Media, Animation, etc. which hold all of the components. These components can be clicked on and dragged onto the screen.

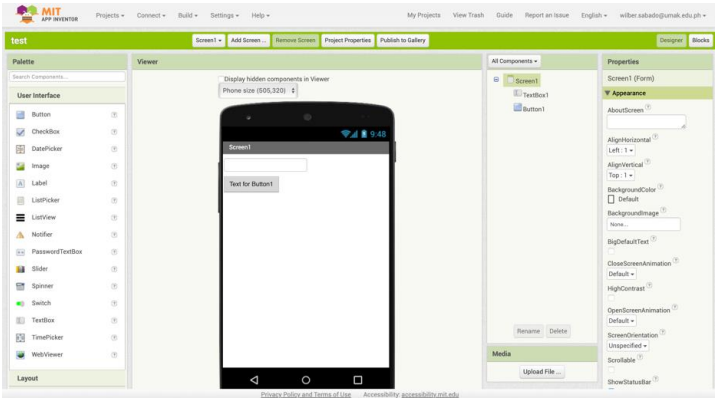


Figure 1. The User Interface of MIT App Inventor 2

Figure 1 shows the user interface of the MIT App Inventor 2. The researcher of this study introduced the Web-based inventor application called the MIT App Inventor 2 to evolve the 21st Century Classroom into Education 4.0 and to uplift the students' skills. The participants were students of Universities in Taguig and Mandaluyong. This research evaluated the experiences of students by integrating the MIT App Inventor 2 in their project developments. Assessed the learning skills of the students in building their mobile applications and evaluated the acceptability of the MIT App Inventor 2. The MIT App Inventor 2 has two environments: the Designer Environment and the Blocks Environment.

Figure 2. The Designer Environment of MIT App Inventor 2

Figure 2 shows the Designer Environment of the MIT App Inventor 2. It has four panels; a Palette panel, a Viewer panel, a Components panel, and a Properties panel. The left panel is the Palette where the visual objects are found like the text boxes, buttons, database connectivity, labels, sensors, etc. The Viewer panel (the center part) is where the component objects are placed, and it displays the design of the mobile app. The Components panel shows all the lists of the objects that are used in designing. The Properties panel (right side) is where the parameters of component objects can be manipulated like setting up the font size of a text label, changing the color and shape of a desired object, and so on.

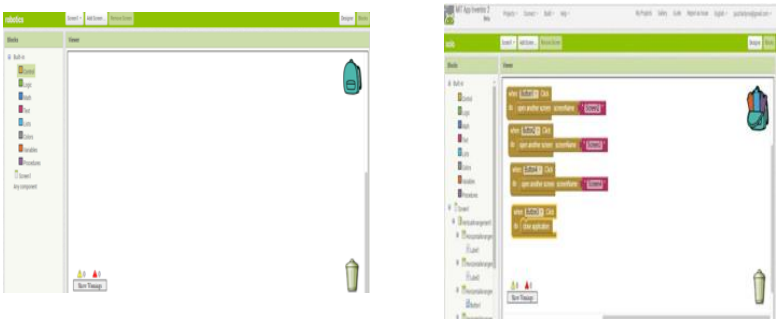
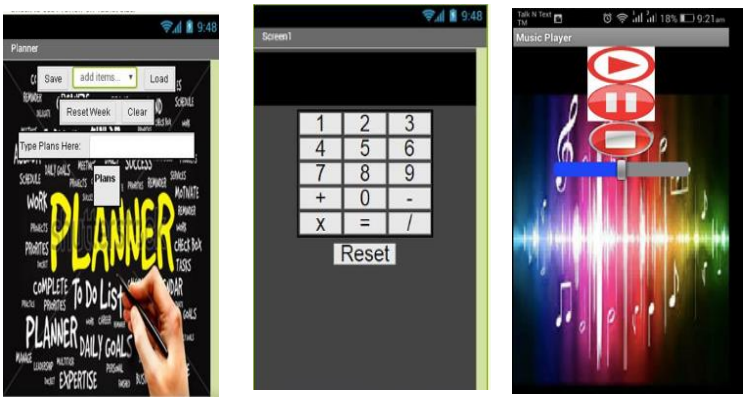


Figure 3. The Blocks Environment of MIT App Inventor 2

The Blocks environment of the MIT App Inventor 2 is shown in Figure 3. It is where the programmer can build and edit the program by dragging and dropping the blocks that should correspond to the component objects made from the Designer environment, and must also follow the program set from the Arduino microcontroller. This is merely a form of programming without the use of codes. This MIT App Inventor 2 has a user-friendly interface, and it is an easier way to create a mobile app without the use of hard coding. A beginner can make an Android App in a short period just by using the MIT App Inventor 2.

Personal Apps

Personal Apps are mobile applications that can be used in daily means. These include games, schedules, calculators, etc. Examples of the apps developed by the students are planner, calculator, and music player. Figure 4 shows the sample Personal Apps developed by the students.



(a)Planner (b)Calculator (c)Music Player

Figure 4. Sample of Personal Apps Developed Using MIT App Inventor 2

Educational Apps

The Educational App is an educational tool that can be used for classroom interventions. The students created lecture materials and course reviews using this Application.

(a)Quiz App (b)Pet App

Figure 5. Sample of Educational Apps Developed Using of MIT App Inventor 2

Figure 5 shows the sample projects created by the students that can be used in classrooms. The Quiz App is primarily used for classroom quizzes. The Pet App can be used for the Grades School interventions.

Internet of Things Apps using Arduino

The Internet of Things (IoT) App is an Android app that is connected to a hardware component/s like the Arduino. The hardware components of the Arduino can transmit data to the Android mobile application or vice versa. The information can be configured using the mobile application. This internet-based application is integrated into a hardware system. The data results from the sensors are sent, processed, and analyzed by the internet-based server called ThingSpeak.

Figure 6 shows the agriculture applications android mobile app called Climate Smart. This app is used for monitoring and controlling the farm. Climate-smart application is mainly for farm monitoring. This mobile application retrieves data through the use of hardware components.

Figure 6. Sample of IoT Apps Developed Using MIT App Inventor 2

Arduino is an open-source microcontroller that can be integrated into Android mobile applications. Arduino microcontroller is integrated into the IOT Android Apps. Examples of hardware are servo motors, LEDs, Bluetooth modules for mobile phone connection, and Wi-Fi modules.

METHODOLOGY

Education 4.0 aims to equip students with the skills and knowledge needed to thrive in the digital age and adapt to the changing demands of Industry 4.0 (Udvaros et al., 2023). The goal of this study is to describe the students' experience in Android application development using a tool called the MIT App Inventor 2. While the school system is getting better at educating all students, many young people lack the skills and knowledge they need to be successful (Daggett, 2005). This study aimed at improving students' skills in Android development using the MIT App Inventor 2 instead of the traditional programming in developing an Android application. The respondents experienced the drag-and-drop tool of the MIT App Inventor 2 in Android app development. Additionally, the respondents were able to integrate Arduino hardware components in their developed Android mobile applications.

This paper utilized a Descriptive Research Design which used a quantitative method. A total of one hundred students were trained to use the MIT App Inventor 2 and integrate them into Arduino microcontrollers. The survey questionnaires were validated by IT experts. The survey was composed of questionnaires that identified the respondents' skills and experience in using the MIT App Inventor 2 as well as the Arduino microcontrollers.

This study was divided into two phases: the mobile app development part and the integration of the developed mobile apps and the Arduino microcontroller part.

Phase 1: Android App Development

The use of MIT App Inventor 2 in developing an Android app provided several advantages (Cárdenas-Cobo et al., 2021). The respondents were able to experience creating an Android Application using MIT App Inventor 2. Instead of the typical coding in developing an Android app, the students utilized the MIT App Inventor 2 through its drag-and-drop features. The applications developed by the students were Personal Apps, Educational Apps, and IoT Apps. The students were given time to build these apps. After creating the projects, the respondents were evaluated in terms of their skills and experience. The MIT App Inventor 2 platform was also assessed in terms of acceptability by the students.

Phase 2: Integration of Arduino Components

After developing the Android mobile applications using the MIT App Inventor 2 tool. The students were trained to integrate Arduino Microcontrollers in their developed mobile applications. Arduino components involved were servo motors, LEDs, Bluetooth module, and Wi-Fi module.

Through the developed Android applications, the students were able to control servo motors and LED lights. The mobile applications were able to communicate with the Arduino microcontrollers through the Bluetooth or Wi-Fi modules.

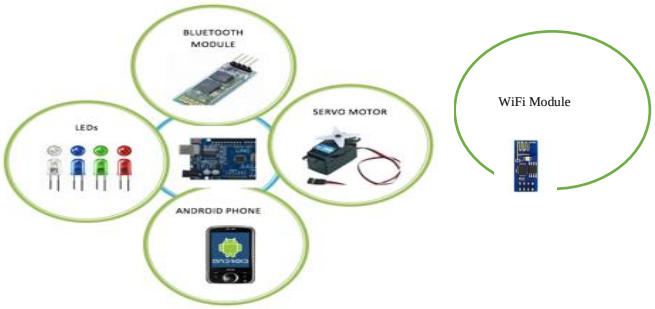


Figure 7. Integration of Android Mobile Apps and Arduino Hardware Components

RESULTS

Most of the respondents marked "Strongly Agree" on being a Hardware Enthusiast and marked "Agree" on being a Software Enthusiast. Figure 8 shows the enthusiasm of the students regarding the use of hardware and software. 70% of the respondents marked Strongly Agree in hardware enthusiasm which is higher than software enthusiasm.

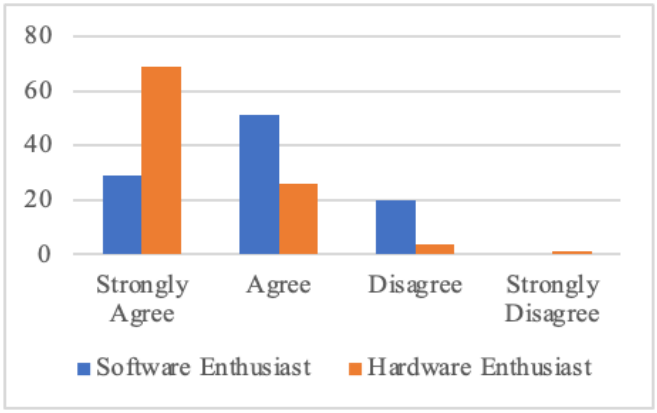


Figure 8. The enthusiasm of the Students in Using the MIT App Inventor 2

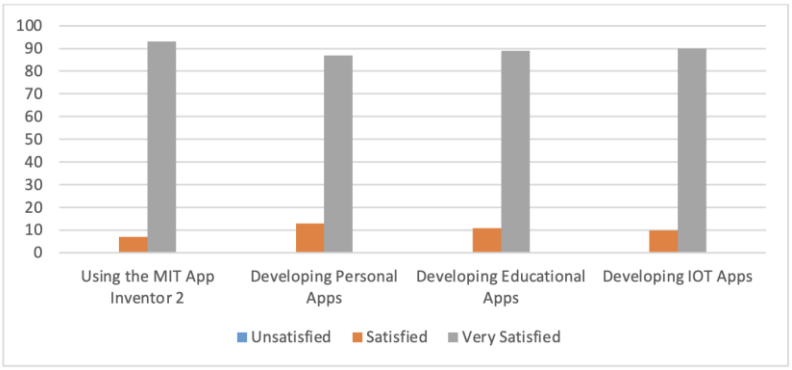


Figure 9. Percentage of Learning the MIT App Inventor 2

Figure 9 shows that 90% of the respondents are Very Satisfied in learning the MIT App Inventor 2 platform. This is because there is no need to use programming languages like C language, Java, etc. to build a mobile application.

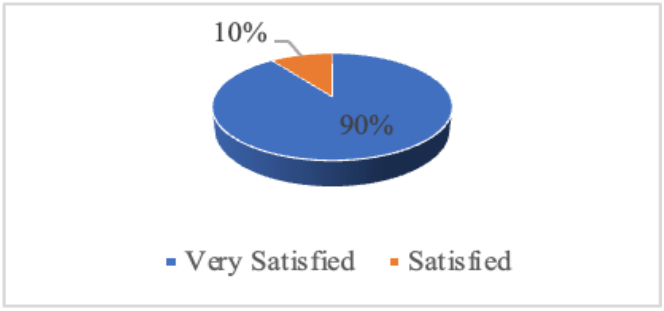


Figure 10. Acceptability of Using the MIT App Inventor 2

The respondents were asked about the acceptability of the MIT App Inventor 2 in developing Android mobile applications through a survey.

DISCUSSION

Enthusiasm in Android Mobile App Development

The students were asked about their software enthusiasm and their hardware enthusiasm in using the MIT App Inventor 2 as shown in Figure 8. The use of Android Studio, a popular mobile Android development platform, in developing Android applications is no longer needed.

Software enthusiasm pertains to the fact that they enjoy developing Android applications using the MIT App Inventor 2 without the use of hardware or components. Here, the respondents only did the Android mobile development part. On the other hand, hardware enthusiasm means that the students enjoy developing the Android mobile app, and at the same time, integrate hardware components like sensors, servo motors, LED lights, Bluetooth modules for mobile phone connection, and Wi-Fi modules in their mobile applications through a microcontroller.

Figure 9 shows that the respondents were asked about their satisfaction in learning Android mobile development using the MIT App Inventor 2. 90% of the respondents were "Very Satisfied" with using the MIT App Inventor 2. Similarly, the remaining 10% were "Satisfied."

Integration of a Microcontroller Platform

Similarly, the respondents experienced the integration of hardware components in their Android mobile apps. The hardware components used are servo motors, LEDs for switch indicator, Bluetooth module, and Wi-Fi module for the IoT application. The Android apps were developed using the tool called the MIT App Inventor 2.

As shown in Figure 10, 93 respondents answered and marked the use of MIT Inventor 2 as Very Satisfied and 7 for Satisfied. In developing Personal Apps, respondents answered and marked Very Satisfied as 87, and 13 for Satisfied. In developing Education Apps, respondents answered and marked Very Satisfied 89 and 11 for Satisfied. In developing IOT Apps, respondents answered and marked Very Satisfied as 90 and 10 for Satisfied. None of the respondents gave an Unsatisfied remark. The majority of the students noted that the MIT App Inventor 2 is very useful and user-friendly. Similarly, creating an Android App like a Personal App, Educational App, or IoT App is easy.

Furthermore, some respondents indicated that using the online application doesn't require programming skills. Respondents also indicated that debugging is the challenging part of using the tool. The skills of the students in creating and presenting the apps on the other hand were evaluated by their professor. Their outputs got a passing rate based on the requirements given to them.

CONCLUSIONS AND RECOMMENDATIONS

The use of MIT App Inventor 2 in Higher Education is common nowadays. The advent of technology makes things easier and faster. The Web-based IoT Inventor called the MIT Inventor App 2 can be used to uplift the skills of the students. The students were able to develop Personal Mobile Apps, Educational Mobile Apps, and Internet of Things Mobile Apps using the MIT App Inventor 2. The online platform provides a user-friendly environment. Similarly, being an expert in programming is not a requirement since there's an option for drag and drop. The results of this study show that the MIT Inventor App 2 is acceptable to the students. The students were able to integrate servo motors, LEDs, Bluetooth modules for mobile phone connection, and Wi-Fi modules in their developed Android mobile app.

The researcher recommends that this MIT App Inventor 2 can also be integrated into other ICT courses preferably of the K12.

IMPLICATIONS

The study on the use of the web-based MIT App Inventor 2 provided an alternative to developing Android mobile applications. Instead of the usual coding using the Android Studio software, students can do the drag and drop using this online platform. The MIT App Inventor 2 has a user-friendly environment for developing Android-based mobile applications. This makes it accessible to different people even to those without a background in programming. This research can provide insights that there are tools like the MIT App Inventor 2 that can make android-mobile app development easier and faster.

This research proves that even non-programmers can develop android-mobile applications just by using the MIT App Inventor 2. This will provide opportunities for innovation without a background in programming. It also shows opportunities for students, without a background in programming, to utilize technology. The tool empowers the students to create an Android mobile app as easily as 1-2-3. This tool promotes skills development.

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This study received no funding.

DECLARATIONS

Conflict of Interest

The researcher declares no conflict of interest in this study.

Informed Consent

I have read and understand the provided guidelines in this journal publication. I am fully knowledgeable about this publication including all its rules and regulations.

Ethics Approval

I declare adherence to the accepted ethical standards.

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