

PROMOTING COMPUTATIONAL THINKING SKILLS IN AN EMERGENCY MANAGEMENT CLASS WITH MIT APP INVENTOR

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Abstract

At Jackson State University (JSU), an innovative module has been developed and integrated into an existing “Emergency Management Technology” course. This course module involved four faculty members. Faculty from several different departments (Computer Science, English, and Technology) developed teaching materials for the module. Through this course, students have opportunities to explore the exciting world of computer science from the perspective of mobile computing. This course module is part of a project, Computational Thinking as an Approach to Refining the Critical Thinking and Analytical Reasoning Skills of Undergraduates, sponsored by the National Science Foundation (NSF). The goal of the project is to develop new courses and course modules to broaden participation in computing.

This course module is designed to use MIT (Massachusetts Institute of Technology) App Inventor to introduce mobile application (app) development concepts. Students are required to design apps which can be used before, during, and/or after an emergency. MIT App Inventor is a drag and drop programming tool that enables users to create applications for Android devices. MIT App Inventor makes mobile app development highly visual and highly intuitive. MIT App Inventor can engage students in developing not only fun and useful apps, but also in logical thinking skills, problem solving techniques, and creativity. The students found MIT App Inventor to be very accessible and quickly learned how to develop their own apps. MIT App Inventor can allow students without any background in information technology to

see computing concepts in a context that is of great interest to them.

Introduction

The trend of declining student interest in computer-related fields [1-3], combined with increased demand from the industry, challenges instructors to come up with new methodologies to attract students. Furthermore, with the diffusion of information technologies into almost all disciplines of study, introductory computer courses need to have new approaches that can motivate students from all majors to feel comfortable with the computing concepts and tools.

Emergencies often occur with little or no warning. No one is ever ready for an emergency, but people can be prepared. Emergency management is the discipline of dealing with and avoiding both manmade and natural disasters. Jackson State University has established an “Emergency Management Technology” (EMT) program [4]. The goal of the EMT program is to train future emergency management professionals to have the skills needed to manage a crisis, to help prevent the worst, and to improve outcomes in all types of disasters.

There has been a growing awareness of the need for more effective Emergency Management tools. As we know, mobile apps have created a new approach for interaction and communication. Mobile technology has expanded dramatically around the world. With its growing usage, this technology can be a powerful tool to help in case of emergency.

MIT App Inventor is a graphically rich visual programming tool [5-8]. Since it is drag and drop, MIT App Inventor does not require writing code and enables users, regardless of skill set, to create applications for devices running the Android operating system. MIT App Inventor has become popular in the classroom for introductory courses for computing students. Many researches have also been conducted to evaluate the feasibility of using MIT App Inventor to promote computational thinking among students [9].

The rapid pace of technological advancement makes it difficult to determine which software, technology, or skills should be addressed in the classroom. To provide students with a competitive edge for their future, science, technology, engineering, and mathematics (STEM) educators need to observe a trend and recognize the most important technology skills. Because today's students are learning with their tablets and smart phones, mobile services and applications should be extremely engaging for this generation of students.

To diffuse computing technology into other disciplines as well as to motivate EMT students to be interested in computing concepts and mobile applications, one course module has been developed. This course module was integrated into an existing technology course "Computer Applications in Emergency Management". This course module exposed technology major students to mobile application development, an area that is unfamiliar to them. Students with no prior programming experience designed and created mobile applications. In addition, this course module introduces students to computational thinking, especially focusing on creativity, problem solving, and programming concepts, which are needed to develop applications for mobile platforms. A survey was implemented to collect students' perceptions of learning activities and perceptions of MIT App Inventor as a tool to create mobile apps.

The Emergency Management Technology Program

Technology curricula at JSU are designed to prepare students to work in a wide range of industries, giving them a broad base upon which they can build, with subsequent education and training, to meet industry-specific needs. The EMT Program at Jackson State University is an interdisciplinary venture that blends the expertise and strengths of faculty from the Technology Department. Building on traditional broad-based programs in the department, the EMT program has been designed to prepare the next generation of emergency management professionals with the knowledge and skills they need to improve outcomes in disasters of all types. Students will gain an essential understanding of the mission and principles of emergency management with an emphasis on management, use of technology, and cross-agency collaboration.

A bachelor degree with a major in Emergency Management Technology requires the successful completion of 124 credits of coursework. The EMT curriculum focuses on topics such as emergency planning, incident command, disaster response and recovery, hazard identification and mitigation, agency coordination, homeland security, and community emergency training. Courses also explore the major principles of this cross-disciplinary field that integrates all activities necessary to build, sustain, and improve the ability to mitigate, prepare for, respond to, and recover from threatened or actual natural disasters, acts of terrorism, or other man-made disasters.

EMT Course: Computer Applications In Emergency Management

In today's digital world, in order to participate effectively and confidently as well as contribute productively, undergraduate students must be proficient with computing technology, regardless of their areas of study. Several new courses have been developed in response to the

EMT program. One of these courses is Computer Applications in Emergency Management. This course provides an introduction and overview of the application of computer technology in emergency management. The course presents how technology is used in the support of emergency planning, response, recovery and mitigation efforts as well as the key elements that must be in place for technology to enhance the emergency management process.

This course also helps students develop an in-depth understanding and practical knowledge of the most frequently used software such as Wiser [10], HAZUS [11], and CAMEO [12], which are all designed by federal government agencies. This course can enable students to effectively use a computer in an emergency. The students can apply this skill to analyze, predict, and prevent an emergency case.

Although different disciplines may uniquely define what computation would mean in the field, programming skills should no longer be thought of only as part of the information technology curriculum. It has been recommended that STEM students should possess a competency in computer programming. The ability to write a computer program and to solve a problem is a skill required by future professionals in many lines of work. Giving students an introduction to computer programming can help peel back the layers of what happens inside the computer. Even at a very basic, introductory-level, programming knowledge can make computing technology seem less magical and more manageable. Computer programming can also teach other important skills, such as logic and critical thinking. The Computer Applications in the Emergency Management course needs to be modified to reserve a portion of the class time to teach students the computer programming skills.

Most computer languages taught in the introductory programming course are text-based. The typical programming coursework can alienate students. Significant evidence

shows that students in the introductory course experience difficulty with both learning the programming concepts and applying those concepts in the writing of code [13,14]. Many instructors are searching for additional resources to make programming coursework more engaging to students.

With the rapid development of new technologies, people are now living in a world that is quickly changing. Programming is also shifting from traditional algorithm to so-called fast prototyping [15]. Users can take advantage of existing software development kits (SDK) and use ready-to-use functions.

In general, technology and engineering students tend to be more visual in their learning style preferences. The literature has shown that multimedia content generally enhances student interest [16]. There has been a great interest recently in using graphics to aid in the programming and understanding of computer programs. In the graphical programming environments, the graphical nature of the program can make the structures easier to comprehend. Hence, graphical languages can provide a way to introduce programming concepts in a way that caters to individuals with a visual learning style. Many STEM educators are using the Lego Mindstorms system to teach programming [17,18]. Although programming robots can motivate students to learn programming and problem solving, most students have trouble seeing a direct application to their lives.

In recent years, mobile technologies have evolved rapidly. Today, smartphones and tablets offer multi-touch screen interfaces featuring many apps with different functions. Given the popularity and ubiquity of smartphones among today's students, mobile app design and development seem to have great potential for attracting a new generation of students to computing and computational thinking.

MIT App Inventor

Mobile devices are vastly gaining popularity due to the availability of various easy-to-use mobile applications. The mobile apps have raised interest among educators because they can facilitate teaching and learning [19]. Creating mobile applications is a challenge for anyone without previous programming experiences. Fortunately, some visual programming languages have been developed to address these challenges.

MIT App Inventor is a visual, blocks-based programming language. It was initially a Google product, but later released as open-source software managed by Massachusetts Institute of Technology. MIT App Inventor enables nonprogrammers to create mobile applications for devices running the Android operating system and is capable of developing all types of applications, not just animation.

MIT App Inventor has two main windows: a Blocks Editor (Figure 1) for defining an app's behavior and a Component Designer (Figure 2) for building the user interface. The Component Designer allows the selection of "components" (objects of a certain class) to be added, by dragging it onto a screen layout, as part of the app. Once a part is added to the app, its properties can be set. The Blocks Editor uses jigsaw puzzle "blocks" (methods of the related class) which snap together to define the behavior of the app in response to various events. Users can test their apps live directly on Android phones or an emulator (Figure 3) of a phone which runs on the computer. MIT App Inventor allows students to focus on the interesting aspects of programming - solving interesting design problems and building creative mobile apps. The MIT App Inventor server can store all the projects, allowing users to log into their account and continue their work anytime and anywhere.

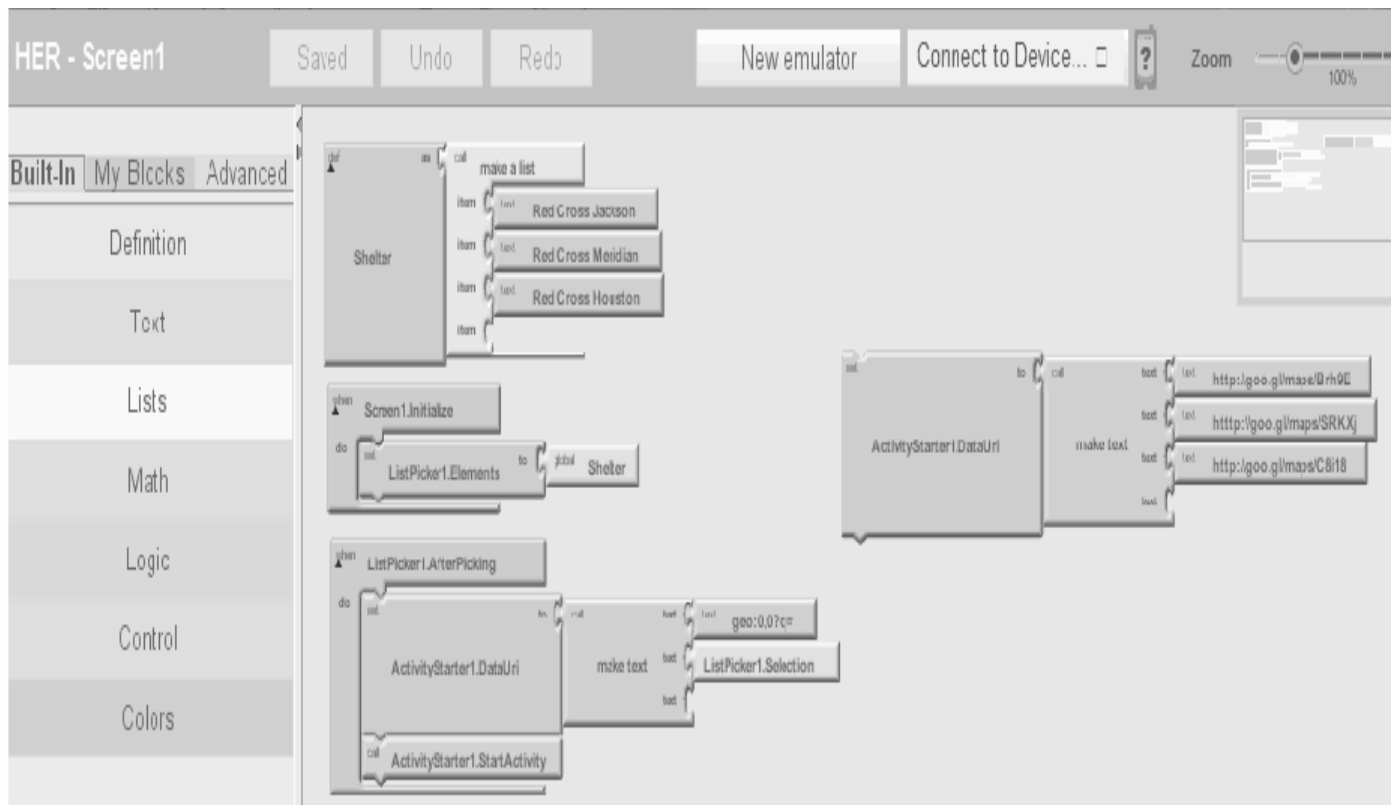


Figure 1. Blocks Editor.

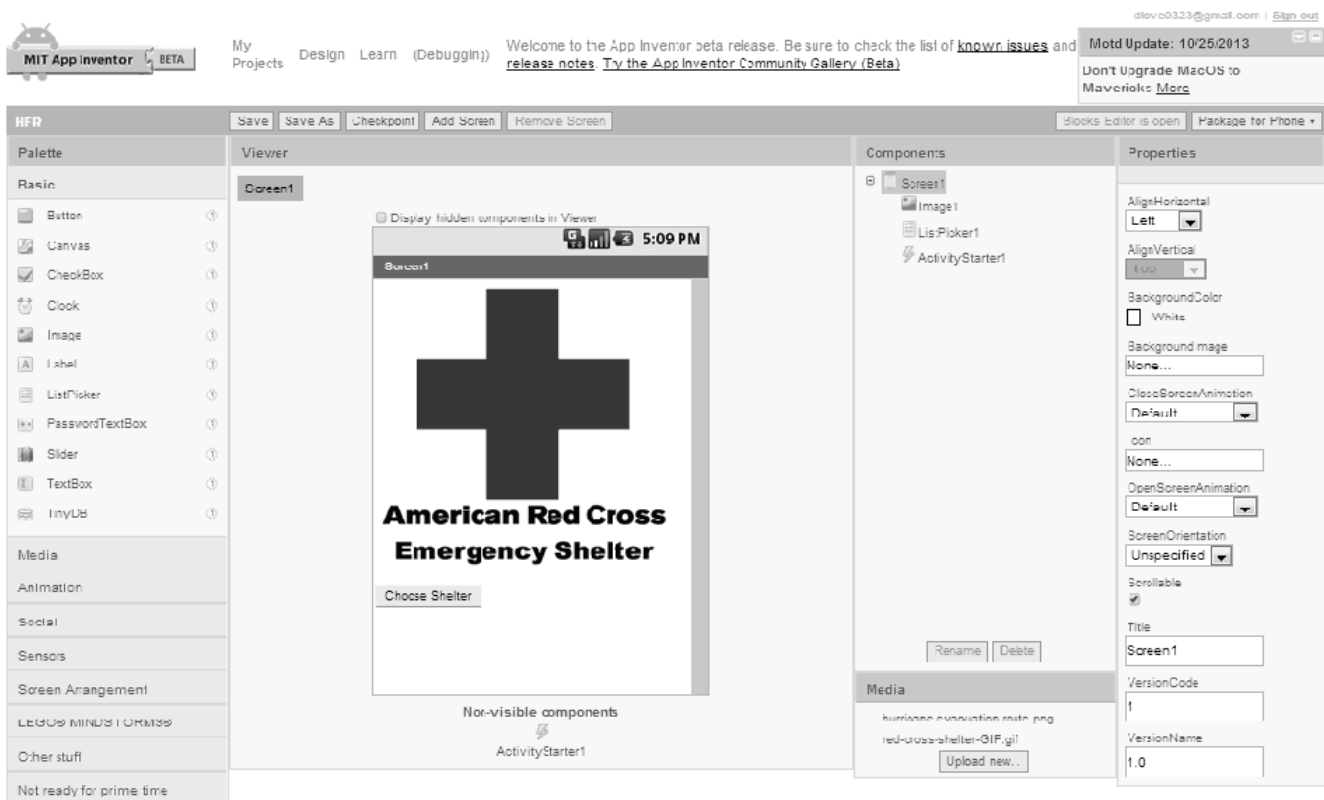


Figure 2. Component Designer.

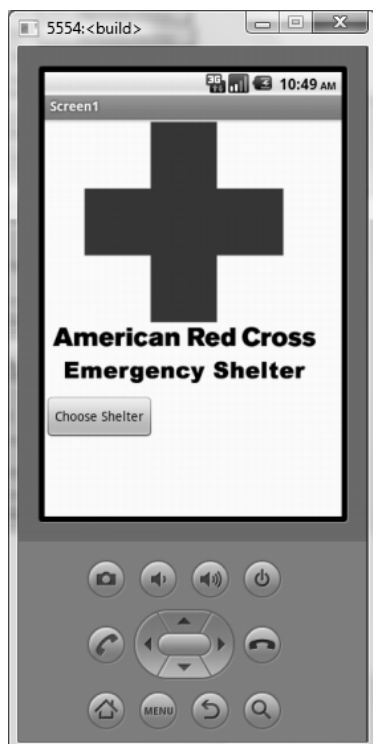


Figure 3. Emulator.

MIT App Inventor can allow non-Computer Science (CS) major students to access all of the mobile device's features and provide an easy way to build useful apps. MIT App Inventor is very feature rich. It has components for receiving SMS texts, sending messages, reading the GPS sensor, and communicating with external web resources. By using the GPS sensor, students can develop an app to help people locate themselves and potential danger. Students can also develop an app for delivering alerts in case of emergency. MIT App Inventor is Java-based and provides a good introduction to the object-oriented paradigm. It can also provide a good foundation for acquiring more advanced computing skills.

The new version of MIT App Inventor (MIT App Inventor 2) was released at the end of the 2013 Fall semester. The classic MIT App Inventor (App Inventor 1) will still be available for several months. Unlike MIT App Inventor 1, MIT App Inventor 2 is entirely in the browser and much easier to set up. Previously, in order

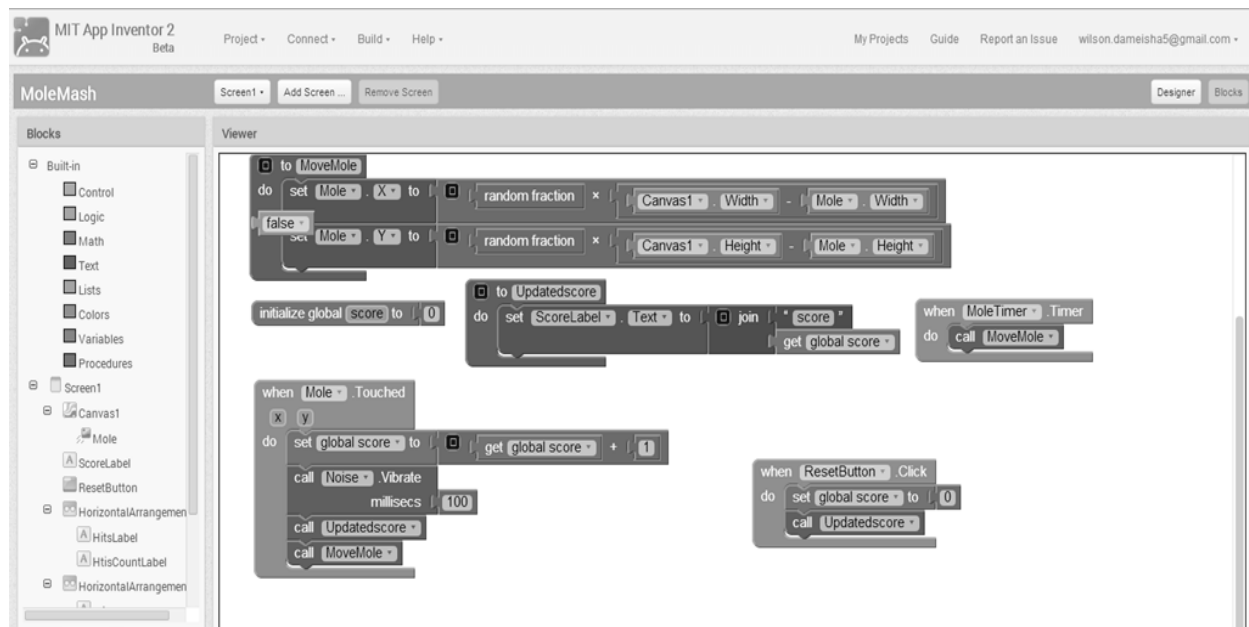


Figure 4. MIT App Inventor 2.

to run MIT App Inventor, besides installing the App Inventor Setup Software, users also had to install and run a Java file called the “Blocks Editor”. Now, the Blocks Editor is just a different mode in the project (Figure 4) and can be viewed from the web browser. The only download that is required for App Inventor 2 is the emulator. However if the user has an Android device, the emulator is not required and does not need to be installed.

Computational Thinking

Computational thinking (CT) has been described as the use of abstraction, automation, and analysis in problem-solving [20,21]. It is needed to solve problems and understand complex systems in many domains. Information technologies have reshaped nearly every disciplinary practice. Computational thinking is a fundamental skill for everyone, not just for computer scientists. This course module is part of a project: Computational Thinking as an Approach to Refining the Critical Thinking and Analytical Reasoning Skills of Undergraduates. This project intends to provide a new level of technical competence to students from a variety of disciplines and to have

a better-educated computing workforce by discovering and imparting the necessary Computational Thinking skills. The implementation plan of this project includes developing the Computational Thinking course modules that can be integrated into classes across various disciplines.

Computational Thinking plays a role in every educational program. Design-based learning activities should support the development of computational thinking in students. Instructors can educate and encourage students to “think computationally” by moving projects beyond “using tools and information” toward “creating tools and information”. Mobile app design can encourage students to think about ideas and to solve problems. App design can be a means for gradual and iterative exploration of computational thinking patterns. There is no doubt that app design helps to engage students in computational thinking. With the MIT App Inventor development environment, students will immerse themselves in the design process. Students will make connections between computer science and other fields. This will develop their computational thinking skills.

Course Module Development

Emergencies often occur with little or no warning. Emergency management is the discipline of dealing with and avoiding both manmade and natural disasters. No one is ever ready for an emergency, but people can be prepared. When people know where to get information, have the right supplies, and have a plan for them, they can protect themselves and their family. This course module provides a comprehensive overview of emergency and crisis management. The course module introduces the incident command system and describes each of the four phases (preparedness, response, recovery, and mitigation) of emergency management.

Mobile devices such as smartphones can help people connect with each other and authorities, spreading critical information in a time of crisis. Many mobile applications are specifically designed for emergency management and provide information on how to stay safe and recover after a disaster as well as a map with the Federal Emergency Management Agency (FEMA) Disaster Recovery Center locations and shelters.

This course module also introduces students to the excitement of computer science and the MIT App Inventor development environment. For the course, each student is required to design a mobile application containing important information that people can use before, during and after an emergency or disaster such as: emergency text alerts, emergency evacuation routes that get people out of danger, current weather outlooks from the National Weather Service, list of shelters that are opened after a disaster occurs, disaster safety tips, etc. The emergency management app design project also encourages students to think creatively as well as apply critical and computational thinking and problem solving skills to real world problems.

Learning MIT App Inventor

As mentioned earlier, the MIT App Inventor is a graphically rich visual programming tool and aims to allow those with no background in programming to develop mobile apps. To develop mobile applications in MIT App Inventor, students do not need to write code. Instead, they visually design the way the app looks and use blocks of components to control the app's behavior. In the class, students started with the printed manuals and online tutorials. Students can quickly establish the basic programming concept and progress into creating their own apps. Students are required to keep daily journal entries to document all of their work.

Initially, many students had concerns about the mobile app design project. However, as the semester progressed, students became excited to work on their project. They continued to make improvements and add additional features up until the day they needed to present the project.

The MIT App Inventor is not perfect. It is still limited compared to a normal programming environment. It does not allow creation of new components and does not allow control over priorities of events. The MIT App Inventor can be considered as a middleware. It is ideal for introductory programming and non-CS major students. It can be used by experienced programmers to build their prototype in a very short time. However, it is not very useful for large scale and extremely advanced applications.

Evaluation

This course module was designed not only to introduce students to computing, but also to focus on problem solving and logical thinking so that students are exposed to some essential elements of computational thinking. By taking this course module, EMT students can obtain knowledge in an area other than their major.

The course was offered in Fall 2013. Eighteen students took the class. Students have been asked to provide feedback by completing a survey. The survey asked students about their attitudes toward programming (MIT App Inventor) and about their experiences with the project. Students responded positively to using the MIT App Inventor. Despite their concerns at the beginning of the semester, most of the students did not feel the project was difficult. Instead, they enjoyed working on it. They also felt very positively about presenting their projects to their peers. In addition, students' journal entries were analyzed to help interpret students' responses in the survey.

The course module has aroused students' interest and passion *in* computing and inspired them to learn more. Besides attending the class, during the Fall of 2013, several students conducted research to investigate if the MIT App Inventor can allow non Computer Science major students to access all of the mobile device's features and provide an easy way to build useful apps. This research also studied the abilities and limitations of the MIT App Inventor. An abstract entitled "Emergency Management Mobile App Development in MIT App Inventor" has been accepted by the National Conferences on Undergraduate Research (NCUR). The conference will be held in Lexington, Kentucky, April 3-5, 2014. Students will attend NCUR and present their findings. This class exposure has also spurred one student to choose computer science as her minor.

Conclusions

This paper describes a course module design that aims to motivate Technology students to be interested in computing and equip students with a broader foundation in computational thinking. The MIT App Inventor was embedded in the course module for developing mobile applications for emergency management. The MIT App Inventor provides a block-based interface to visually create Android apps. The course module was developed by two

technology faculty members in collaboration with their colleagues in the computer science and English departments. By attending this course, the students can understand the mobile app development concepts and arouse interest in learning computer science. By engaging students to create mobile apps, this course module also introduces students to computational thinking principles. A survey was also conducted to show the effects of introducing this course module.

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