# Programming Language-Based Multi-Platform Applications: Digital Learning Tools for Computer Programming Courses

Brandon G. Sibbaluca<sup>1,a</sup>, Beronika A. Peña<sup>1,b</sup>, Jester Lhee I. Pandio<sup>1,c</sup>, Reginaldo S. Belza<sup>1,d</sup> and Earlson C. Pasco<sup>1,e</sup>

<sup>1</sup>Academic Research Group – IT and Engineering, STI Head Office, Ortigas Avenue Extension, Cainta, Rizal, Philippines

a<brandon.sibbaluca@sti.edu>, b<br/>beronika.pena@sti.edu>, c<jester.pandio@sti.edu>,
d<reggie.belza@sti.edu>, e<earlson.pasco@sti.edu>

Keywords: programming, multi-platform, application, digital, courses

Abstract. This paper is a furtherance of the authors' previous project on the development of interactive learning tools for the tertiary level students of an engineering program. These multi-platform software applications will deliver assistance to the subject-teachers handling various computer programming courses to deepen the programming abilities and skills of their students by providing various digital learning activities on desktop, Web, and mobile platforms during class. Digital learning tools are designed and developed in different forms; it may serve as a form of a motivational activity, a recap of the previous lesson, or an interactive learning game. These programming language-based applications will also encourage student engagement to keep the students more focused and motivated to learn different computer programming courses. With the advancement of these multi-platform software applications, students taking computer programming courses will be fascinated to learn the programming concepts and the fundamentals of different programming languages.

#### 1. Introduction

In this fast-digital age, learners tend to be more engaging in classrooms depending on the type of strategy that the educator implies with the educated. It is imperative, nowadays, that both the learner and the learned learn to adapt to certain changes in education [1]. The learner and the learned must aim for outcome-based goals that are set between them. Adapting them must have certain mindsets and skills to accomplish tasks, which would take them to the real, competitive world ahead [2, 3].

In order to adapt to these changes, the educator must be fully aware of the two types of students in today's classroom: proactive students and reactive students. Proactive students have the desire to learn from educators who have well-mastered the course subject and can establish and prolong rapport. Reactive students tend to be reactive in the sense that they do not see the importance of the subject and do not feel that they are included in the classroom during lecture – like in the old way of educating: teacher speaks, students listen [4].

By establishing these identifying marks of students, establishing outcome-based goals, and using technology as a means of boosting-up students' performance, there are several tools which we may consider in prolonging the participation of the students. These are digital learning tools. These tools have the potential to capture students' attention and be active during class discussion through activities, such as interactive games or drills, which will then improve the students' critical thinking skills and elevate their motivation [2]. In addition, these also assist 21st century learners to engage in social skills with their fellow learners or even to their educators [5, 6].

Due to the complexity and difficulty of these programming languages, there are times when students lose interest in pursuing these. Thus, the implementation of digital learning tools is necessary

to coexist with the present education through driven assistance from the educator [9]. For the development of these tools, Java, JavaScript, and C# programming languages are being considered.

Programming languages are vocabularies of instructions that, whenever encoded to a computer, can perform various tasks. Each of the programming languages has its own edge in a particular platform to be used. It provides wide areas of the solution—from complex algorithms to a mere computation of arithmetic, which can cater to specific needs. These programming languages offer different platforms where users would run into [7].

Platforms, on the other hand, are areas where people commune with technology, such as a means of gathering and processing information and communicating with other people. In order to get that information, these platforms provide users' interactivity with different kinds of software, whether the desktop-based program, online interactive Web form, or standalone mobile application. Each platform has a particular device in which software will run into [7, 8].

Since it is evident that these platforms and programs exist due to the development and innovation of programming languages, incorporating these with students is of great challenge and responsibility [1]. There is also a need to establish a digital learning tool to tertiary schools that would greatly aid students in their learning and aid educators in assessing and deepening students' capability [2].

#### 2. Objectives

This developmental project aims to achieve the following:

- 1. Application software by means of the programming language used in a particular computer programming course that will offer added learning resources to the students.
- 2. Multi-platform applications that will serve as innovative teaching tools for the teachers handling computer programming courses.
- 3. Promote the 21st century teaching strategies essentials.

#### 3. Literature Review

In this digital age, technology progresses to the extent of a few months with another milestone of discovery. In looking towards future perspective, these learners are equipped with broader insights, skills, and capabilities to drive themselves for further growth. One aspect of these is communication. From these learners, communication will play a vital role since they will interact and participate in group learning activities. Since they, as a fact, are more inclined to technology, it is a must that the educator uses technology as a sort of a weapon to promote learning interactivity, develop good moral character, and foster a deeper understanding within the subject matter. The 21<sup>st</sup>-century digital learners must be able to possess certain qualities and skills for them to survive for the real and competitive world [1, 9]. In order to show these skills to these type of learners, certain strategies must be fostered and adapted in this 21<sup>st</sup>-century.

Strategies are a plan of actions that specialize in critical thinking and proper action, leading to proper end goals. As a 21st century educator, she/he must have the capacity to teach and reach all of his/her learners. According to the theory of Howard Gardner, there are multiple intelligences that a person possesses. One of which is the eagerness to teach all learners. Teaching all learners implies the readiness of the educator to extend his/her time and effort in implementing new technology, fostering healthy interpersonal relationship through social media or any communication platform media, implementing outcome-based teaching, and embracing the changing times to let the learner be ready for anything. She/He also has the responsibility of bringing those multiple intelligences out of the learner through a unique and techy way, while establishing rapport towards students and looking for

outcomes and changes [17]. Through the educator's responsibility, methods are formed from these strategies to cater different range of learners.

Digital learning methodologies are new ways of imbibing learning towards students within the graspable limits of technology. These promise tools to help the educator impart learning to students and the students to assess themselves in their personal learning through direct participation using digital learning. The trend that we are facing is that everyone is inclined with their computers, smartphones, tablets, and other gadgetry. Therefore, schools and other institutions must be able to adapt to the certain changes in imparting knowledge, deepening understanding, and developing thinking skills [9, 10]. From these methodologies, certain tools are created for the learner.

Digital learning tools use an interactive platform to strengthen the student's learning experience with a mix of tools and practices, including online and formative assessment; an increase in the focus and quality of teaching resources and time; online content and courses; and applications of technology in the course curricula among others. Tools and simulators are considered learning tools that utilize technology or the Internet to facilitate the learning process, such as computers, mobile phones, tablet PCs, projectors, or electronic books. With these tools, we can develop the skills needed by 21<sup>st</sup>-century students in order to survive the competitive world [9]. From the creation of these tools, it can help boost the learners programming capability. These tools can cater learning from these selected programming languages:

Sun Microsystems developed Java as an object-oriented language for general purpose business applications and interactive applications. It is widely popular among professional programmers because it can build visually interesting graphical user interface and Web-based applications. Some of the advantages, that make Java a popular language, are its security features and the fact that it is architecturally neutral where, unlike many other languages, you can use Java to write a program that runs on any operating system platform or devices (*i.e.*, PCs, phones, and tablet computers). If we can dwell more in Java, we will have a deeper understanding of the concepts used in object-oriented programming [11].

C# is another modern object-oriented, general-purpose programming language, created and developed by Microsoft. It has a wide variety of applications with the inclusion of .NET platforms like office applications, Web applications, websites, desktop applications, mobile applications, games, and many others. It is a high-level language that is similar to Java and C++, both of which are object-oriented. It is very simple and easy to learn and it is suitable for beginners. It is still widely used in some industries with renown companies, making it one of the most popular programming languages [12].

JavaScript, also known as the Internet language, is also one of the most popular programming languages, since the browser understands JavaScript natively independent of any plugins installed. It is not a language that can only be used in the frontend, but it can also be treated for backend processing using Node.js. It can be used for mobile development and is one of the most popular frameworks in Apache, which is a mobile hybrid framework that allows developers to code using HTML, CSS, and JavaScript, and allows you to build an app and generate an APK file for Android and IPA file for Apple iOS [13].

Through these programming languages, learning must not be bounded inside the four corners of the classroom. With the help of these digital learning tools, learning is extended through different devices in multiple platforms.

Upon the development of programs, web pages, and applications, the programming can lead developers in creating platforms, systems, applications, and services. It may be in the form of an operating system, a desktop-based program, interactive web-based forms, mobile-based applications, and so on. Platforms are media of information processing—basically hardware and software—wherein it can host particular services or applications to a particular field of work or specialty. It can also be treated as an architecture where applications or services only runs on a particular platform considering

both hardware and software specification. In today's rapid influx of technology, a single service or application can run into different platforms due to the programmers who had spent developing scripts, programming codes, and updates that could ease up exclusivity [14 - 16].

In bringing easy and motivated learning from studying programming languages, we can establish these tools to different platforms so that learning is not limited to a single medium only. Through the different platforms, learning must be continuous and should not be limited inside the four walls of the classroom to provide better engagement of students in learning programming languages. It is convenient in today's world to develop digital learning tools in the form of services or application for the betterment of these 21<sup>st</sup>-century learners and educators.

While embracing change in this fast-paced technological world, education is something that we cannot discount for in both 21<sup>st</sup>-century learners and educators alike. Therefore, it is up to us to use these digital learning tools and strategies so that it could hone multiple intelligences and bring out the best of students in this digital age. One of which we could start is by implementing these tools for all courses with computer programming subjects. These tools must be implemented in multiple platforms, so that learning is accessible and flexible.

#### 4. Methodology

A developmental approach is used in this project. Details used in the development of the multiplatform applications are derived from the courseware materials of the following computer programming courses: Advanced Java Programming, Web Programming, and Mobile Programming; all of which are developed by the STI Head Office's Academic Research Group – IT and Engineering. Through this, the group came up with an idea to develop digital learning tools that will address the aforementioned objectives.

Below is the Block Diagram of the project:



Fig. 1. Block Diagram. The Academic Research Group is in charge of developing courseware materials, including handouts for the students, instructional guides for the teachers, laboratory exercises, slide presentations, and digital learning tools, which will be used by the schools across the network.

Below are some of the digital learning tools integrated in the computer programming courses.



Fig. 2. Java lines and rectangles. This is a desktop game programmed in Java where students have to draw the line or a rectangle based on the given Java statement by dragging the mouse pointer.

C     Fill in the blands     ×     +       ←     →     C     Q     Seatorth Ginoque on type a URL		- ø x 9 :	C Fill in the blands x + ← → C △ Q. Search Gongle or type & 118;		- 0 )
(tal) .cs()	Fill in the Blanks		(tts)) (CSS()	Fill in the Blanks	Harman State
<pre>.sm-boxes-container { border:1px; border:solid; border:white; } #div-html{color:#3cb371; #div-css{:2px solid #1E90FF; }</pre>	<pre>#div-js{    color:#ff6347; } #container{    color:#feff89; } .subject-title{ font:25px; font:bold; font:consolas; }</pre>	HTM.	<pre>.sm-boxes-container { border-width :1px; border-style :solid; border-color :white; } #div-html{ background -color:#3cb371; } #div-css{ border :2px solid #1E90FF; }</pre>	<pre>#div-js{ background -color:#ff6347; } #container{ background -color:#feff89; } .subject-title{ font-size :25px; font-ueight :bold; font-family :consolas; }</pre>	HTML

Fig. 3. CSS syntax checker. This is a Web-based game programmed in JavaScript where students have to type in the correct CSS syntax to complete the three different color palettes.



Fig. 3. Bubble tap app. This is a mobile game programmed in C# where students have to tap unique color bubbles to determine the secret mobile user interface component.

#### 5. Findings

Upon receipt of the complete courseware material package of the three computer programming courses, the three school officials and three teachers handling these courses have administered and facilitated these various digital learning activities in three different sections. It has also been observed through the school's Electronic Learning Management System that 90 student-respondents were motivated to learn new lessons in the courses are encouraged to participate in classroom discussions more actively. At the same time, these digital learning tools have helped them execute outcome-based education during class sessions and have brought them innovative ways to deliver up-to-date discussion. These developed tools were evaluated using the four-point Likert scale where 4; 3; 2; and 1 means strongly agree; agree; disagree; and strongly disagree, respectively. 3.26 - 4.00 as strongly agree; 2.51 - 3.25 as agree; 1.76 - 2.50 as disagree; and 1.00 - 1.75 as strongly disagree were used in interpreting the results.

General Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
As a motivational tool for new lessons	45	45	0	0
As a tool to recap the previous lesson	44	46	0	0
Increase students' engagements with the lessons	42	47	1	0

Table 1. Results of the survey from the student-respondents

Table 1 shows that fifty percent of the ninety student-respondents strongly agreed that the digital learning tools motivate them to learn new lessons in the programming course, while the other fifty percent of the total student-respondents agreed. Forty-nine percent and fifty-two percent of the student-respondents strongly agreed and agreed that the digital learning tools serve as a tool in reviewing their past lessons in the course, respectively. Forty-seven percent strongly agreed, fifty-two percent agreed

that the digital learning tools encourage them to participate in classroom discussions actively, but there is one percent of the respondents who disagreed.

Table 2. Results of the survey from the teachers.					
General Statements	Strongly Agree	Agree	Disagree	Strongly Disagree	
As a motivational tool for new lessons	3	0	0	0	
As a tool to recap the previous lesson	3	0	0	0	
Increase students' engagements with the lessons	3	0	0	0	

Table 2 shows that one hundred percent of the teachers handling the three programming courses strongly agreed that the digital learning platforms help them introduce new lessons, provide an avenue to them to have a recap of the previous lessons in the computer programming courses, and promote Outcome-Based Education delivery through various student engagements during classroom discussions.

Table 3. Results of the survey from the school officials.					
General Statements	Strongly Agree	Agree	Disagree	Strongly Disagree	
As a motivational tool for new lessons	3	0	0	0	
As a tool to recap the previous lesson	3	0	0	0	
Increase students' engagements with the lessons	3	0	0	0	

#### 

Table 3 shows that one hundred percent of school officials strongly agreed that the digital learning tools used in the three programming courses promote the 21st century teaching strategies essentials.

General Statements	For Students	For Teachers	For School Officials	Weighted Mean	Equivalent
As a motivational tool for new lessons	3.50	4.00	4.00	3.53	Strongly Agree
As a tool to recap the previous lesson	3.49	4.00	4.00	3.52	Strongly Agree
Increase in students' engagements with the lessons	3.46	4.00	4.00	3.49	Strongly Agree
Average	3.48	4.00	4.00	3.51	Strongly Agree

Table 4. Summary of mean results.

The data show that digital learning tools are evaluated by the students, teachers, and school officials on the following aspects: as a motivational tool for new lessons, as a tool to recap previous lessons, and increase students' engagements with the lessons, and are highly acceptable with a weighted mean of 3.51. This validates that the digital learning tools used in the three computer programming courses are relevant and very useful.

#### 6. Conclusion

Based on the evaluation results from the students, teachers, and school officials:

- 1. Digital learning tools highly encourage student engagements among students in various activities of the computer programming courses.
- 2. Teachers observe the usefulness of these digital learning tools in teaching computer programming courses.
- 3. The digital learning tools promote the 21st century teaching strategies essentials through the use of multi-platform applications.

#### 7. Recommendations

Based on the preceding findings of the study, the following are recommended for further study and recommendations for change:

- 1. Integrate digital learning platforms in all courses—not only for select technology-related courses but also in the courses of other disciplines, as well as the general education.
- 2. Develop self-made digital learning tools using other programming languages other than Java, JavaScript, and C#.
- 3. Design an information system that will serve as a repository of these digital learning tools.

#### Acknowledgments

Aside from God Almighty, the researchers would like to express their gratitude to their families, relatives, and loved ones whose involvement made a significant impact on the successful completion of this project.

### **References:**

- [1] J. Brown, "Learning in the Digital Age", 2002.
- [2] B. Sibbaluca, R. Belza, B. Peña, J. Pandio, "Development of Digital Learning Platforms: Interactive Learning Tools for Programming Logic and Design", *Proc. Computer Applications, Innovations, Technologies, and Engineering – 6th ICpEP National Conference 2018.* Institute of Computer Engineers of the Philippines, Inc. ISSN: 2244-5668, Vol. 6, C.18, pp. 72-75, 2018.
- [3] L. Jana, "Skills Every Child Will Need to Succeed in 21st century", TEDxChandigarh, YouTube video, Accessed February 9, 2019. https://www.youtube.com/watch?v=z\_1Zv\_ECy0g
- [4] MacArthur Foundation, "Rethinking Learning: The 21st Century Learner", YouTube video, Accessed February 9, 2019. https://www.youtube.com/watch?v=c0xa98cy-Rw
- [5] T. Heick, "36 Things Every 21st Century Teacher Should Be Able To Do", Accessed February 9, 2019. https://www.teachthought.com/pedagogy/36-things-every-21st-century-teacher-should-beable-to-do/
- [6] S. Romaniuk. "25 Important Apps and Digital Learning Tools for University Students", Accessed February 9, 2019. https://elearningindustry.com/25-digital-learning-tools-apps-universitystudents

- [7] K. Lee, "Foundation of Programming Languages, Second Edition", *Springer International AG*, 2018.
- [8] "Developer Survey Results 2018", Stack Overflow, Accessed February 9, 2019. https://insights.stackoverflow.com/survey/2018/
- [9] M. Sousa, R. Cruz, and J.M. Martins. "Digital Learning Methodologies and Tools A Literature Review", *Proc. EDULEARN 2017* (Barcelona), 2017.
- [10] D. Kergel, B. Heidkamp, P. Telléus, T. Rachwal and S. Nowakowski, "The Digital Turn in Higher Education", *Proc. International Perspectives on Learning and Teaching in a Changing World* (Germany), Springer VS, 2018.
- [11] J. Farrell. Java Programming, Ninth Edition, Cengage, USA, 2019.
- [12]S. Nakov, V. Kolev et. al., Fundamentals of Computer Programming with C#: The Bulgarian C# Book. Svetlin Nakov & Co., Bulgaria, 2013.
- [13]L. Groner, *Learning JavaScript Data Structures and Algorithms, Third Edition*, Packt Publishing. UK, 2018.
- [14]S. Bigelow and M. Rouse, "Definition: Platform", Techtarget: SearchServerVirtualization, Accessed February 9, 2019. https://searchservervirtualization.techtarget.com/definition/platform
- [15]D. Crabbe, "Computing Platform", YouTube video, Accessed February 9, 2019. https://www.youtube.com/watch?v=FUDw5hS8LUU
- [16]Complexity Labs, "Platform Technologies", YouTube video, Accessed February 9, 2019. https://www.youtube.com/watch?v=d0i-iQALRac
- [17]J. Cox, "5 Essential 21st Century Strategies", Accessed February 9, 2019. https://www.teachhub.com/5-essential-21st-century-teaching-strategies