The Use of Mobile Compilers for Learning Computer Programming in Higher Education Institutions: A Case of IAA and ATC

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Abstract- This study examined the use of mobile compilers for learning computer programming in higher education institutions (HEI) in Tanzania. The paper presents findings of the use of mobile compilers for learning computer programming conducted at Institute of Accountancy Arusha (IAA) and Arusha Technical College (ATC). The study used case study research design with a randomly selected sample of 170 computing undergraduate students who positively responded to questionnaire and became suitable for the study. The data collected was analysed and results were presented using descriptive statistics. The results of this study show that computing students use mobile apps for learning computer programming. However, results indicate that facilitators of the computer programming courses do not emphasize on the use of mobile compilers for learning and self-practice. The study also indicates that mobile compilers offer great benefits that allow students to learn computer programming using mobile technology.

Index Terms- Mobile compilers, mobile apps, computer programming, higher education, IAA

I. INTRODUCTION

The world is moving from traditional computing technology to mobile computing [1]. The invention of mobile devices, such as smartphones, tablets, and e-readers, has created new opportunities for the devices and mobile applications [2]. This means that the most activities performed on computers are now definitely performed on mobile devices. As a result, software developers are also engaging themselves in the development of mobile applications.

The availability of mobile applications, also known as 'apps', gives users flexibility on performing different activities on mobile devices in everyday life. There are personal and professional mobile apps that can be used for leisure as well as promoting business. There are several categories of mobile apps for business, communication, education, entertainment, games, finance, maps and navigation, music, photography, shopping, sports, video players, and weather.

The use of mobile apps in education provides an opportunity for instructors and students to improve teaching and learning inside and outside of the classroom [3]. This means the apps can make it easier for instructors to change the traditional teaching methodologies to the digital learning using mobile devices. As a result, students will be more engaged in mobile learning that improves participation and learning experience [4].

This study aimed at examining how HEI students use mobile compilers for learning computer programming courses. The study looked into the extent to which computing students are familiar with the use of mobile compilers in computer programming, mobile compilers usage for learning computer programming, and benefits of the mobile compilers as learning tool.

II. LITERATURE REVIEW

The use of mobile devices and mobile apps in education has increasingly gained popularity over recent years. The impact of these smart gadgets and the apps cannot go unnoticed in the modern world for both instructors and students. [3] argued that educators from all disciplines have to adopt the use of mobile devices and mobile apps as instructional resource. Additionally, the devices and apps are the centre of mobile learning which provides flexibility for students to learn anywhere, anytime [5].

Mobile Apps in Education

According to [3], mobile apps have penetrated and become available in academics. The use of the apps in education has been accepted by students and paved a new way for instructors to engage them with more learning activities. Mobile apps have improved ways of delivering teaching and learning, communication, assessments, and participation in learning activities. Fully engaged students are likely to complete their undergraduate studies and even continue with postgraduate studies [6].

The use of mobile apps in higher education has created a new platform for learning known as mobile learning [7]. In the study conducted by [7] demonstrated that mobile learning improves learning by facilitating communication that extends outside the
classroom between instructors and students (60%), students with other students (65%). Moreover, the study observed the use of mobile apps makes it easier to access coursework (72%) and increases the motivation to complete coursework (42%). Despite the benefits that mobile apps offer, the study proposed that students and instructors require technical, logistical, and pedagogical support for integrating mobile apps in education.

Research study in emotions and continued usage of mobile apps found that students are motivated to use mobile apps in their studies due to positive emotions and enjoyment [8]. Their research concluded that positive emotion is influenced by perception of benefits offered by mobile apps. Also, the element of the enjoyment in the use of the mobile apps improves participation and engagement of students in learning process [9]. The study underpins the fact that mobile apps are very important in education sector as mobile technology continues to draw attention from every field.

The use of social media apps has positively affected the education field [10]. Social media apps provide instructors and students with ability for sharing, exchanging, commenting, discussing and creating information and knowledge in a collaborative environment [11]. The freedom of expression provided by the social media in learning groups can significantly improve the learning process. It was observed that most of instructors have used a social media in a class session [12]. This study also suggested that social media apps can be used as a teaching tool in higher education.

Mobile Compilers
Compiler is a software program which converts high-level language programs into machine language [13]. Therefore, a mobile compiler can be defined as a compiler installed on mobile device that converts high-level language source codes into machine codes. It provides source code editor, compiler, debugger and other programming utilities which can be used to compile, run and debug programs on mobile devices. With mobile compilers, students can write, compile and run programs without a laptop or desktop computer anytime, anywhere and on the movement [14].

Like other apps, mobile compilers are available in app stores [15]. These compilers are available as open source while others are commercially offered. Mobile users using different platforms, such as Android, iOS, and Windows Phone, can download mobile compilers from the dedicated app stores and install them on their devices [16].

Mobile compilers can operate in offline or online mode [17]. An offline mobile compiler allows coding in source code editor without connection to the Internet. An example of the offline mobile compiler is CppDroid. One of the main advantages of offline mobile compiler over online is that mobile users are able to code all day as long as device's battery is not down. An example of C++ program and its output in CppDroid offline mobile compiler for Android is shown in Figure 1 and Figure 2 respectively.

Contrarily, an online mobile compiler requires an Internet connection to write, compile, run, and debug programs. When a mobile device is not connected to the Wi-Fi or the data mode is
switched off, the mobile compiler is not available. Online mobile compilers use cloud computing by providing convenient tools that allow programmers to compile source code and execute it in online storage [18, 19]. One of the main advantages of the online mobile compiler is that no environment configuration is required to set it up. DCoder is a good example of an online mobile compiler. Figure 3 shows an example of Java application and its output on the same screen in DCoder online mobile compiler for Android.

![Java application in DCoder](image)

**Figure 3:** Java application written in DCoder for Android

### Research Gap

Several studies have been conducted in mobile technology. The use of mobile devices and associated mobile apps has also been studied almost in every field, such as health, business, agriculture, research, and education. However, there are limited studies concerning mobile compilers for learning computer programming in Tanzania’s HEIs. This study attempts to fill this gap by conducting the study in the use of mobile compilers for learning computer programming in HEIs in Tanzania.

## III. RESEARCH METHODOLOGY

### The Study Area, Target population and Sample Size

A case study research design was used in this study because it provided an opportunity for a thorough and in-depth examination of the use of mobile compilers for learning programming [20]. The two colleges, IAA and ATC, were selected to represent higher learning institutions. The reason for choosing these colleges was that they offer similar computing programmes and are both located in Arusha, Tanzania. The targeted population was computing undergraduate students with at least one programming language skills enrolled in computer science and information technology programmes.

Simple random sampling technique was used to determine the sample size. It is a probability sampling which ensures that every member in the population has an equal chance to be included in the sample [21]. A sample size of the 194 participants was selected from the target population.

### Data Collection

This study used an online questionnaire as a method of data collection. The questionnaire was designed using Google Forms and mailed to a sample of 194 respondents. In addition, the questionnaire’s link was shared in students’ WhatsApp groups to ensure that the respondents are conveniently reached. 170 respondents carefully filled in the questionnaire and became suitable for the study. Therefore, the response rate was 87.6%. The researcher chose questionnaire because it allowed quick and easy collection, and analysis of data. Furthermore, the researcher opted online questionnaire as a precaution to protect researcher and respondents from the spread of COVID-19 [22].

### Data Analysis

The data obtained from the questionnaire were analysed using descriptive statistics. Descriptive statistics "are used to describe the data collected in research studies and to accurately characterize the variables under observation within a specific sample" [23]. The researcher opted for descriptive statistics because they present quantitative descriptions in manageable format. A frequency distribution was used to organise and summarise the research data so that they can be analysed and interpreted easily [23].

## IV. FINDINGS AND DISCUSSION

### Demographic Characteristics of Respondents

This research study involved 170 respondents from the computer science and information technology undergraduate programmes with an experience of at least one programming language. 81.2% of the respondents were males while females were 18.8%. The majority of the respondents were aged between 22 and 29 as they constituted 79.4%, while 14.7% fell into an age group of 14 to 21, and 5.9% was shared among remaining age groups. No respondent was above 45 years old. Furthermore, a greater number of the respondents, 81.2%, were bachelor students while 18.8% were diploma students. Table 1 summarises the characteristics of the respondents.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency (Fr)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>138</td>
<td>81.2</td>
</tr>
<tr>
<td>Female</td>
<td>32</td>
<td>18.8</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Frequency (Fr)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 - 21</td>
<td>25</td>
<td>14.7</td>
</tr>
<tr>
<td>22 - 29</td>
<td>135</td>
<td>79.4</td>
</tr>
<tr>
<td>30 - 37</td>
<td>7</td>
<td>4.1</td>
</tr>
</tbody>
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As Table 1 illustrates, the findings revealed that the majority of the respondents were bachelor students. To greater extent, students enrolled in bachelor programmes have more programming skills than those enrolled in diploma. Therefore, this study generalised that respondents were a great representation of the target population. In addition, the study revealed the gender imbalance between male and female respondents. The number of male respondents was extremely higher than the number of female respondents. This larger gender gap is directly related to the fact that the number of male students enrolled in computer science and information technology programmes is higher than the number of female students.

**Mobile Compilers Usage for Learning Programming**

In examining the usage of mobile compilers, respondents were asked different questions about the use of using mobile compilers for learning computer programming. Using a 5-point Likert scale from "strongly agree" to "strongly disagree", students were required to select the statement depending on their feelings about mobile compilers.

The respondents were asked if they were familiar with mobile compilers usage for learning computer programming, 59.4% agreed or strongly agreed that they were familiar with the mobile compilers. On the other hand, 21.8% of the respondents disagreed or strongly disagreed that they were not familiar with the mobile compilers.

The use of mobile compilers was also asked to assess if respondents use them for learning computer programming courses. The study indicated that 50.6% of the respondents agreed or strongly agreed that they used mobile compilers while 33.5% disagreed or strongly disagreed to use mobile compilers.

The respondents were also asked whether they spent more time coding on mobile devices than on laboratory computers. The results revealed that 41.7% of respondents agreed or strongly agreed to spend more time to code on mobiles than on laboratory computers while 42.9% disagreed or strongly disagreed on the same question.

This study also observed that 34.7% of the respondents agreed or strongly agreed that lecturers included mobile compilers as learning tools in course outlines or in teaching plan for programming courses while 43% disagreed or strongly disagreed on the same question. Moreover, 22.4% of the respondents remained neutral on the question.

The response to encouragement from lecturers to use mobile compilers for learning programming courses was that 39.4% of the respondents agreed or strongly agreed. On the other side, 40% disagreed or strongly disagreed. Also, 20.6% of the respondents stayed neutral on the same response. Table 2 shows the summary of mobile compilers usage for learning computer programming.

**Table 2: Mobile Compilers Usage for Learning Programming**

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fr</td>
<td>%</td>
<td>Fr</td>
<td>%</td>
<td>Fr</td>
</tr>
<tr>
<td>I am familiar with the mobile compilers for learning programming</td>
<td>44</td>
<td>25.9</td>
<td>57</td>
<td>33.5</td>
<td>32</td>
</tr>
<tr>
<td>I use mobile compilers to learn programming</td>
<td>34</td>
<td>20.0</td>
<td>52</td>
<td>30.6</td>
<td>27</td>
</tr>
<tr>
<td>I practise more on my mobile device than on lab computers</td>
<td>31</td>
<td>18.2</td>
<td>40</td>
<td>23.5</td>
<td>26</td>
</tr>
<tr>
<td>Lecturers include mobile compilers as learning tool in course outlines/teaching plans</td>
<td>20</td>
<td>11.8</td>
<td>39</td>
<td>22.9</td>
<td>38</td>
</tr>
<tr>
<td>Lecturers encourage using mobile compilers to learn programming</td>
<td>24</td>
<td>14.1</td>
<td>43</td>
<td>25.3</td>
<td>35</td>
</tr>
</tbody>
</table>

**Benefits of the Mobile Compilers**

A larger percentage of the respondents, 67%, agreed or strongly agreed that mobile compilers improved their knowledge in studies while 20.6% disagreed or strongly disagreed on the same question.

The study also indicated that the majority of respondents, 69.4%, agreed or strongly agreed that mobile compilers provided flexibility that allowed them to code anywhere, anytime and on the go. On the other hand, 18.2% of the respondents disagreed or strongly disagreed showing that they never experienced the flexibility of the mobile compilers.

The respondents were also asked if coding on mobile compilers provided enjoyment to them. A good number of respondents, 59.4%, agreed or strongly agreed with this question. However, 21.8% of the respondents disagreed or strongly disagreed that enjoyment was not felt when coding on their mobile devices.

The response to mobile compilers increase student's participation in learning computer programming showed that 67.1% agreed or strongly agreed while 17% emerged against the statement by disagreeing or strongly disagreeing.

The study also indicated that the majority of respondents, 66.5%, agreed or strongly agreed that mobile compilers motivated them to do self-study in computer programming courses. Contrary to the majority, 18.2% disagreed or strongly disagreed on the same
The use of mobile compilers has positive impacts on students for learning computer programming. The results of this study indicate that most students are familiar with use of mobile compilers. These results are in line with previous study which suggests that awareness of students on use of ICT tools for learning is very high and students have some necessary skills to use these tools for learning purposes [24].

Meanwhile, this study highlights that mobile learning has not dominated the use of computers for learning computer programming as students still code more on computers than on mobile devices. It is true that the number of mobile devices is outperforming computers but there are still no signs that they will completely dominate the use of computers in learning computer programming.

The availability of useful mobile apps for facilitating students' learning is one thing, the other is emphasis on use by instructors. The results suggest that the most instructors do not include mobile compilers in programming course outline or teaching plan documents. In addition, the most instructors do not motivate students to use mobile compilers as learning tool in computer programming courses. It is the duty of instructors to use all ways and means, including available mobile compilers, to make learning of computer programming easy [25].

The use of mobile compilers for learning computer programming brings great benefits to students. Mobile compilers improve students' programming skills in the field of study. This finding is consistent with study conducted by [7] that states that one of the benefits of using mobile apps for academic purposes is increasing student's knowledge in the field of their study.

Furthermore, another benefit that mobile compiler provides is flexibility that allows students to code anytime, anywhere and on the movement. This result is supported by [5] as authors claim that mobile apps provide flexibility for students to learn anytime, anywhere. This means students can learn and practise programming skills on mobile devices at their own convenience rather than relying on college computers. Geographical location, timetable and laboratory rules for college computer laboratories may slow the learning process.

The results also suggest that mobile compilers offer the benefit of enjoyment. Enjoyment of students has direct impact on the way they absorb knowledge as stated by [3]. This means that the enjoyment may positively or negatively affect the learning process. If a student enjoys learning, the cognitive absorption is increased. Otherwise, the cognitive absorption is decreased.

In a similar way, the results claim that mobile compilers increase students' participation in learning programming. The study by [26] backs up this claim as it states that the use of mobile apps improves participation and encourages continuous learning. As a result, students actively engaged in coding on mobile devices are likely to improve their participation in learning programming as mobile compilers extend the learning experience beyond the traditional learning environment.

The results of this study show that mobile compilers motivate students to do self-study in computer programming courses. This benefit is in line with previous research that suggests that mobile apps can motivate people to engage in behaviours [27]. The self-study promotes independent study that engages students in learning and improves their performance [28]. Mobile compilers, like other education apps, motive self-study that allows students to learn computer programming from the comfort of their home, on the movement, on own time, and at own pace.

### V. Conclusion and Recommendations

#### Conclusion

This study focused on examining the use of mobile compilers for learning computer programming in HEIs in Tanzania. The study concentrated on looking into computing undergraduate students' familiarity, usage, and benefits of the mobile compilers for learning computer programming. The results of this study show that computing students use mobile apps for learning computer programming. However, results indicate that facilitators of the computer programming courses do not emphasize on the use of mobile compilers for learning and self-practice. The study also indicates that mobile compilers offer great benefits that allow students to learn computer programming using mobile technology. These benefits are improved programming skills, increased flexibility, enjoyment, improved participation and self-study.

#### Recommendations

Based on the findings of this research, the author recommends that instructors should include a list of available compilers in a teaching plan document for learning particular programming language. The list should consist of traditional, online, and mobile compilers to ensure that students are aware of all
important programming tools before the teaching and learning process begins. This in fact will assist students to comprehend computer programming easily and at their convenience. Similarly, students are also recommended to use mobile compilers for learning and practice due to the benefits the compilers offer. Author also recommends that curriculum developers and policy makers should integrate mobile technology in the education to improve teaching and learning. The future research could be conducted in other education apps for improving teaching and learning of other areas of computer science and information technology.

REFERENCES


AUTHOR BIOGRAPHY

Kaanael Simon Mbise is an assistant lecturer of Computer Programming in the Department of Informatics at Institute of Accountancy Arusha in Tanzania. He has traditionally taught face-to-face, and partially online for more than 13 years. His areas of interest in research include mobile computing, computer programming, systems analysis and design, and web-based applications.