

**CLEARN – A CROSS-PLATFORM APPLICATION TO ASSIST
INTERMEDIATE STUDENTS IN LEARNING C LANGUAGE USING
FLUTTER SDK**



By

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ABSTRACT

Providing a thorough understanding of computer programming concepts and elements of C programming language, i.e. input/output, conditional structures, loops, and functions, constitutes a fundamental goal of computer programming curricula. Integration of mobile technology into the curriculum of computer science, particularly for Intermediate education, offers more advantages for the students to their diverse backgrounds, learning interests, and higher education prospects. A survey conducted at Govt. Graduate College G.T. Road Jhelum revealed that the majority of the Intermediate General Science students want to enhance their C programming concepts and would like to have some assistive tool preferably without the need for Internet connectivity. This research presented the implementation of a cross-platform educational application using Flutter SDK aimed at assisting college-level (Intermediate) students in learning the C programming language. Students were divided into two sections, even and odd, based on their roll numbers, ensuring a diverse test group. The primary objective of this study was to evaluate the impact of the proposed application on the academic performance of these students. Experimental results showed improved academic performance among students who utilize the application, demonstrating its potential as a valuable supplementary tool in college-level C programming courses. This research contributed to the ongoing effort to enhance computer science education through innovative technological solutions.

Chapter 1

INTRODUCTION

1.1 Background

C programming concepts were first introduced more than half a century ago and are established topics in the field of computer programming, they are particularly relevant to current and new developments like software engineering. This gives a bright perspective in terms of changes we can introduce when teaching some of these topics in secondary school since they are at a crucial level of their careers.

This research introduces an innovative pedagogical approach, demonstrating the application of C programming core concepts through a cross-platform mobile application. For the implementation of this research, Flutter¹ by Google - a cross-platform development kit is used to develop an application named CLearn. The Flutter SDK in recent times has been considered an industry standard framework for the development of cross-platform mobile applications. This framework has not previously been used to develop a cross-platform application as a teaching tool in higher education to the best of the author's knowledge. Hence, this research can be useful in providing a different understanding and valuable lessons for its use in the secondary school curriculum, particularly in Part-II of the Intermediate computer science course.

Centered on enhancing computer programming education for Intermediate students, this research is driven by three key features that can be seen as valuable contributions to this domain: (1) Given Intermediate students' innate inquisitiveness regarding mobile platforms, this initiative presents a chance to boost their engagement and achievements in computer programming subjects. (2) In light of the rising preference for pursuing a BS-CS degree post-intermediate, the methodology proposed here can furnish students with a competitive edge as they transition to university studies, (3) by demanding students to utilize mediums outside classroom to enhance their learning.

1.1.1 Secondary Education System in Pakistan

The Islamic and British origin have advanced the Education system of Pakistan. In the

¹ <https://flutter.dev/>

previous two centennial eras, this system has been enhanced, but inclined to depend strongly on outmoded teaching and assessment techniques not to mention rote memorization. For the sake of improvement of apprenticeship and contribution rates.

Educational opportunities are still unequal with the better learning institutions only being open to those who are able to afford it or who are politically connected. Nowadays teaching and examination trends in Pakistan are getting considerably transformed and in line with the global practice, it also shifted from a 10+2 to 12+4+2 system (Hunter, 2020).

The Secondary education System of Pakistan is mainly based on taking Exams and memorization only. They don't pay much attention to the learning process. There are two main categories SSC (consists of 9th and 10th grade education) and HSSC (two years of education consisting of FSC, FCS, Arts, and Science group). For HSSC, the student needs to clear an examination of SSC and for Bachelor, the students have to pass the HSSC Examination. From an overall number of students, hardly one-fourth of the strength get pass for 11th grade. In 2017, a UNESCO survey revealed that the overall upper-secondary Net Enrollment Rate (NER) in Pakistan was 23 percent in 2017, compared with 46 percent in Bangladesh and 38 percent in Nepal (Hunter, 2020).

Intermediate education is divided into four categories from which students choose their field of interest. The groups are pre-medical, pre-engineering, humanities, and general science. Urdu, Islamic studies, Ethics (in the case of non-Muslim), English and Pakistan studies are mandatory courses for all the mentioned groups in addition to their respective required elective subjects. For instance, Arts students choose Islamic elective, Arabic and Civics whereas students in the general science group will choose Mathematics, Physics and Computer Science.

1.2 Motivation

In the advanced field of Computer Science, scientists and expert researchers have played a major role in making the learning process more interactive and fruitful over the last decade. Like automated problem-solving by taking assessments (Hsiao et al., 2010; Ihantola et al., 2010; Ihantola and Karavirta, 2011), intelligent tutoring systems (Mitrovic, 2003; Kumar, 2005), interactive algorithm animation and program visualization (Shaffer et al., 2007; Sorva et al., 2013), and adaptive electronic textbooks (Weber and Brusilovsky, 2001; Kavcic, 2004; Davidovic et al., 2003). Brusilovsky et al. (2014) referred to these types of content as “smart content” in many of their publications because of individual feedback and guidance, offered by these smart contents similar to the one provided traditionally by the tutors. Smart contents

designed for lab and classroom studies have shown many positive results for students learning (Mitrovic, 2003; Davidovic et al., 2003; Kumar, 2005; Hsiao et al., 2010; Hosseini et al., 2016). However, the practical aspects of these systems have turned out slightly lower than expected in the learning process (Naps et al., 2002). This is perhaps slightly lower than would have been expected due to the design of the smart content usage to be non-mandatory or not graded at all and mainly for practice outside the classroom. In other words, most of the smart content was developed to support students in learning new content after teaching, to check how advanced their knowledge was, or to prepare students for the implementation of the tasks that would actually be evaluated.

Integration of mobile technology into the curriculum of computer science (Thelma et al., 2024), particularly for Intermediate education, offers more advantages for the students with respect to their diverse backgrounds, learning interests, and higher education prospects. Many of the already published research has shown that students feel more inspired and motivated when course content is related to their interests (Eliza et al., 2024; Davis, 2009). There are some challenges in integration of mobile learning technologies as discussed by (Quraishi et al., 2024). Mobile applications are the main source which have the power to attract users from different age groups; and students are found to be utilizing and enjoying these applications more than the others (Nielsen, 2014). Students have naturally more motivation to learn and use emergent technologies in their daily life. Therefore, it can be stated that computer topics among the students of intermediate education are learnt with both natural curiosity for learning and with the intent of developing skills to acquire better jobs in the future. Hence, they require and expect higher education institutions to help them learn computer science better. Considering these objectives and needs, there is no reason to doubt that anyone who has to go through programming-related topics can expect this new generation of students to complete the degree with an increased level of drive for the topic at hand.

In addition to the innate curiosity in advancing technologies, students have unique learning strategies, and varied interests and are from various cultures and societies. Another aspect that has been learned from the use of mobile phone technology is to address these differing students. Due to the fact that teaching strategies have developed in a way that corresponds to the requirements of this set of students, we will be able to use the advantage of diversity in educational institutions and create a positive and exciting experience for learning. The application of mobile phone technology applies the principle of educational strategies for enhancing the learning process of students of this diverse population.

The reason for this is that programming has become an interesting subject for students of different origins since the development of AI technologies such as ChatGPT and Midjourney. Today there are thousands of applications for mobile phones; every student has several of them as their favorite ones and uses them every day. Including topics related to programming in the class lectures can help to capture the attention of students with different backgrounds at the same time. A further aspect of the use of mobile phone technology for learning is the fact that it enhances learning among diverse students. This thesis is relevant for the students with need for experientially oriented learning (Kolb, 2014). The active teaching method can be considered a suitable variant for the mobile programming approach application. Active doing can be met by allowing the students to experience first-hand involvement in programming topics they have been taught, where they are tasked with using programming topics to develop a program.

1.2.1 Survey

To better understand the problem and expected solution, a survey was conducted in the form of a questionnaire to the computer science students in 2nd year at Govt. Graduate College G.T. Road Jhelum. At the start of the regular session of 2020-21, a total of 121 students were enrolled in the class and 120 of them completed the survey. The questionnaire included basic questions about their experience with any programming language at the high school level and if they used any medium outside the classroom to enhance their learning. 86% of students (104=Yes, 16=No) said that they have studied computer science as a subject in Matriculation.

The next set of questions was related to only those who had answered 'Yes' to the previous question. 82 students said they had studied 'BASIC' as a programming language but only 13% well learnt the basic concepts. However, 90 students said they never used any tool/medium outside the classroom to enhance the learning of programming.

The next set of questions was about understanding the tools or gadgets students have and use mostly. Every student (100%; N=120) owned a smartphone while 76% (N=91) also owned either a Desktop PC or Laptop. Smartphones are the most used gadget by 82% (N=98) of the students with only 45% (N=54) having access to the Internet. When asked about if they were interested in learning C programming language and using mediums other than textbook, more than 90 students responded with 'Yes'. Nearly 50% of the students responded with mobile phone application as their preferred medium and the other 50% were in favor of any kind of application i.e., mobile phone, desktop, and web. Survey questions and complete response

charts are given in Appendix A.

This questionnaire helped in identifying two important components of the research. The first component is that when students are taught programming language without using any medium other than textbook, their level of understanding basic concepts remains at low. Which highlights the need for and importance of educational tools and mediums to enhance learning. The other component of the research identified through the survey was that almost every student has a smartphone along with a Desktop PC or Laptop and a smartphone was also their most used device. They were also interested in using a mobile app to enhance their learning of C programming. However, not everyone had access to the Internet.

Therefore, based on the results of the survey and importance of educational tools/apps highlighted in previous paragraphs, it can be concluded that any medium preferably a mobile app which does not require Internet access to present its content to the students that are required.

1.3 Research Questions

The primary research questions based on the discussion in the previous section are:

- **RQ1:** Can Flutter SDK be used to implement a platform-independent application that can help in understanding the C language more?
- **RQ2:** Can integrating a platform independent application with class lectures help in achieving better marks in C language?
- **RQ3:** Can one application developed with a single codebase run on multiple platforms including Web-browser, Mobile, and Desktop without loss in performance or change in UI?

The Research Question 1 and Research Question 2 are interrelated and serve practical purpose of knowing the impact of an assistive tool like a cross-platform application can have on academic performance of Intermediate students. The third Research Question is about identifying that if the proposed application can be developed using single code-base without loss in performance or distortion in User Interface. This is an important aspect to explore as students can switch from Desktop PC to Mac to iPhone to Android to a web application. Therefore, app should present a unique experience to all the platforms without any change in the layout of the app or speed degradation.

1.4 Research Objectives

- To review the literature published in the field of educational assistive tools.
- To design and develop a cross-platform educational application tailored to facilitate C programming language learning among college-level students.
- To evaluate the effectiveness of the implemented application in enhancing the academic performance of students, as measured by their grades and comprehension of C programming concepts.
- To contribute empirical evidence supporting the integration of technology-enhanced learning tools in college-level computer science education for improved student outcomes in C programming courses.

1.5 Structure of Thesis

The rest of the thesis is divided into the following chapters:

- Chapter 2 presents a comprehensive literature review regarding the integration and evaluation of smart content in the course curriculum, the use of mobile development as part of the curriculum, the evaluation of education applications, and a summary of cross-platform applications and their development tools.
- Chapter 3 presents the design and implementation of the application regarding the code snippets and screenshots
- Chapter 4 presents results and discussion using different graphs
- Chapter 5 summarizes the thesis and presents a future work guideline