Design of Scaffoldy: A Mobile Editor for Programming in C++ for Novice Learners

Ali Raza
Department of Computer Science
University of Management and Technology
Lahore, Pakistan
aliirazii@gmail.com

Dr.Muhammad Shoaib Farooq
Department of Computer Science
University of Management and Technology
Lahore, Pakistan
Shoaib.farooq@umt.edu.pk

Dr.Adnan Abid
Department of Computer Science
University of Management and Technology
Lahore, Pakistan
Adnan.abid@umt.edu.pk

Ashfaq Ahmad
Department of Computer Science
University of Management and Technology
Lahore, Pakistan
Ashfaq.ahmed024@gmail.com

Abstract— Scaffolding is required by novice learners of programming. The omnipresence of the smartphone has provided a significant opportunity for helping novice learners of programming on the smartphone. For supporting the construction of programs and encourage learning any time requires scaffolding techniques on the smartphone should be incorporated. In this paper, the design of scaffolding techniques that can be provided on the smartphone is discussed based on a scaffolding framework. This paper also paves the way for the researchers to explore more new scaffolding techniques which can be embedded into handheld devices.

Keywords—Scaffolding; Design; Fading;Smartphone;Learning

I. INTRODUCTION

Learning programming can be challenging especially in a resource constraint environment of Pakistan where means to program on Laptops and PCs are minimized due to electric failures and poverty rate [21]. To overcome this obstacle in the learning of programming, the omnipresence of the smartphone can be used as a platform for learning to program. In order to support learning at the smartphone, scaffolding (support) should be provided in the environment for novice learners in order to program effectively. Studies have shown that in developing countries, use of the smartphone can play a critical role in the learning of students in higher education [1] [2]. Learning on the smartphone has been provided to students with the help of the camera, sensors and accelerometers [3] [4] [5]. Scaffolding (Support) is needed by learner while they learn to program. The implication of the scaffolding varies in the form of guidance required from the students. Scaffolding

is similarly provided on handheld devices for the learner that can help them facilitate in learning [6]. The term scaffolding refers back to the work done by the L. Vygotsky in the 1930s [7]. Mobile phones not only have been used from learning perspective instead they are also being used for teaching purpose where a pedagogical framework for mobile learning is proposed [8].

In this paper, we are going to discuss the proposed design of an application named "Scaffoldy". The prototype of this system is built on a theoretical framework based on literature. The design of this application focuses on learner centered designed as proposed by Quintana et al. [9] because this design suits the needs of the novice learners.

II. RELATED WORK

In this section, mobile applications are discussed which are used for learning purpose by the novice learner not only in programming but other fields also.

In a study conducted, the use of smartphone among the medical students was found to be increasing and demands for another medical application on the smartphone for learning purpose was found [10]. Another study explains the use of the smartphone as promising in learning of medicine and other medical relevant studies. The study also suggests that the use of the smartphone in learning is significant [11].

Smartphones can be used as a ubiquitous learning tool rather than just a communicational tool. These results regarding smartphone as a possible enabler of ubiquitous learning obtained from usage technology model and modified unified theory of acceptance [12]. In [13] it is explained a novel programming environment named TouchDevelop on which

students can program on the mobile phones. It proposes that computer programming should be directly done on the mobile phone instead of PCs and Laptop, another advantage of programming on mobile phone is that students can show their projects any time to their friends and families.

A course is designed specifically for teaching Object oriented java software to C/C++ students on the android mobile platform and results showed that android platform incorporation in teaching as a tool showed effective results [14]. Guidelines for the design of applications on handheld devices for the educational purpose are built on the learner centered approach are being explained by the [15], in which decomposition of the tasks is elaborated as an essential part of learning for novice learners. In another paper, universal instructional design principles are applied to the design of mobile learning. Whereas problems and opportunities for learning on mobile are also discussed [16]. Guidelines are also proposed in [17] where learner's response on the object design possibilities are explained, this study also proposes the guidelines for the better utilization of handheld devices for learning purposes.

III. SEVEN LEVEL SCAFFOLDED FRAMEWORK FOR PROVIDING SCAFFOLDING ON SMARTPHONE

In this section, seven-level framework is being proposed for providing scaffolding to novice learners on the smartphone. The four guidelines in designing this framework are taken from Quintana et al.[18] which are i) difficulties experienced by novices ii) learning challenges which are concerned with the cognitive type iii) guidelines provided for specifying scaffolding iv) Methodology on how to implement the guidelines. The two guidelines are taken into account from Jackson et al. [19] so that categorization and selection of the scaffolding techniques are done with concern to relevant challenge that is faced by the learner. The last guideline is taken from Newell & Rosenbloom [20] power law of practice, which indicates the speed of task is enhanced if the power of the number of time the task is performed.
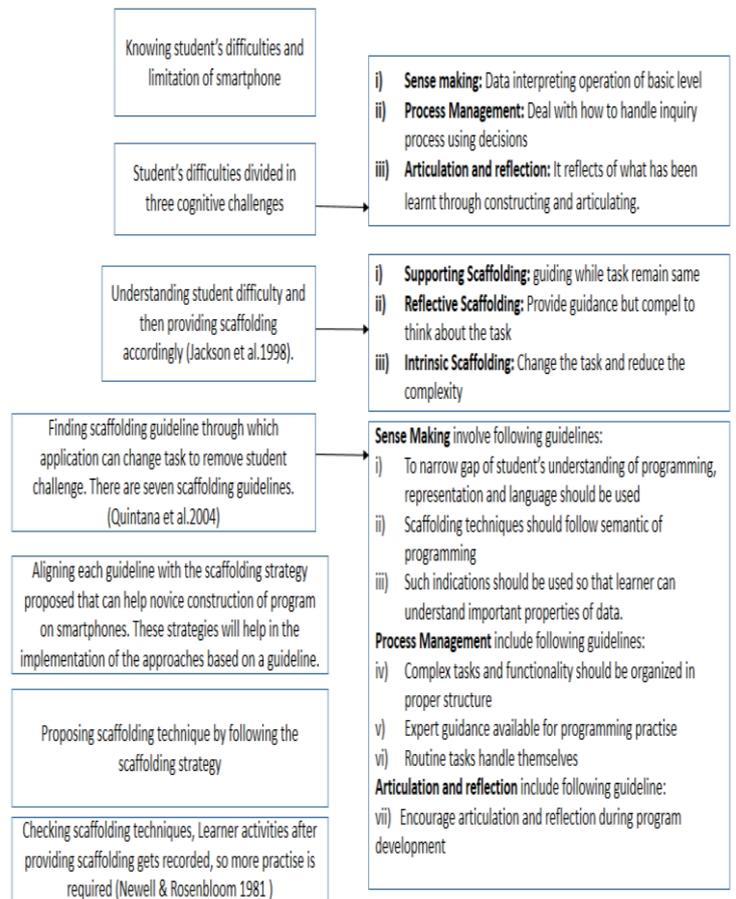

Figure 1: Seven level scaffolding framework

In the next section, these seven steps are being followed and scaffolding technique is provided to a specific challenge of learner while programming.

IV. APPLYING SCAFFOLDING TECHNIQUES AGAINST SPECIFIC CHALLENGE OF LEARNER

Step 1: Issue in syntax rules of programming in C++
Step 2: Understanding the cognitive challenge faced by the learner.
The learner in this case of having trouble with the syntax of programming face cognitive challenge sense making. The learner is making sense of the program by looking at the parts of the program.
Step 3: Understanding which type of scaffolding is needed by the learner
In this case, the learner requires supportive scaffolding, because the task is going to remain the same and help will be

provided to the learner. Reflective scaffolding can also be provided as the learner will be pushed to think about the task.

Step 4: Identifying scaffolding guideline that helps in removing learners challenge

As learner is facing sense making challenge so language and representation should be used in narrowing the gap of learning face by the learner. This guideline is embedded in the scaffolding strategy, which is shown in next step.

Step 5: Aligning scaffolding guideline with the scaffolding strategy designed

To provide support to learner with language and representation, the following strategies were chosen:

    i)   Giving systematic hints to help develop the mental model

    ii)   Allowing learner to visualize different examples

The first scaffolding strategy helps learner in the development of the mental model in which a systematic approach of giving examples to the learner is followed. Whereas the second strategy focus on the exploration of the learner, where it is allowed to move in different sections and forced to think about the task [18].

Step 6: Scaffolding technique designed on smartphone against scaffolding strategies

Giving systematic hints to help develop the mental model.

The scaffolding technique against this strategy is offered by providing instructions which are related to syntax rules and from these examples, a learner can develop the mental model for resolving their real challenges. Systematic hints are given to learner in Figure 3 below. Whereas example is shown to the learner in Figure 2 below, allowing the learner to visualize different examples.

Step 7: Checking scaffolding technique

When the learner has completed the task overcoming the challenges with the help of scaffolding techniques provided to the learner in the smartphone. Learner will be given a prompt on the screen which asks learners to resolve errors, these errors were recorded when learner committed mistakes. The technique is applied in Figure 4, where user is practicing to find and correct errors.

Figure 3: Hints given to learner

Figure 2: Example given to learner

Figure 4: Error practicing for learner

V. SCAFFOLDING TECHNIQUES PROVIDED TO LEARNERS ON SMARTPHONE

Three type of scaffolding should be provided to learners:

    i)   Static: which remains same e.g. Parts of programs

    ii)   Automatics: Learner is provided automatic support e.g. sequence completion, guidance, hints, default code

    iii)   User initiated: Learner itself initiated the required scaffolding e.g. Full view program, example of program

And it each scaffolding techniques should have fading ability or not. It depends totally on the technique provided.

Table 1: Scaffolding types for novice learners of programming

Scaffolding Technique	Type	Fading ability
C++ program showing in parts: Header files, imports, main method, body	Static	None
Completion of program in sequence	Automatic	The restrictions are lifted after three successful tasks
Step by step guidance	Automatic	The guidance is removed after three successful tasks
Prompt on errors	Automatic	None
Full program view	User Initiated	None

Example shown to learner	User Initiated	None
Giving option to select default code	Automatic	None
Showing hints to learner while he is doing task	Automatic	None
Learner creates program in parts, one at a time	Static	None
Expert Guidance	User Initiated	None

A prototype of the main interface and menu option is shown in Figure 4, 5 below. Options regarding Drawer menu will come separately by clicking the button on the left side of execute button. Thus keeping the main interface neat and clean.
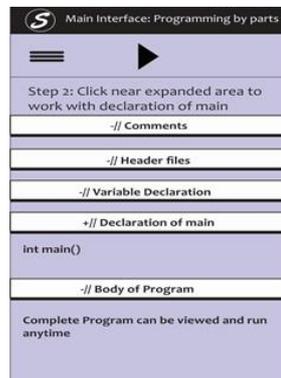

Figure 6: Drawer Menu

Figure 5: Main Interface Showing In Parts

VI. CONCLUSION

Scaffolding provides support and learning to novice learner and it is evident from the literature review. The Omnipresence of smartphones has led to the incorporation of such scaffolding techniques on the smartphone. Designing such scaffolding techniques on the smartphone certainly benefit novice learners of programming. More such supportive techniques can be incorporated for learning on the smartphone that can help novice programmers.

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