The Conceptual Framework of Online Problem-Based Learning Towards Problem-Solving Ability and Programming Skills

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***Abstract*—Computer programming is a tough course that involved complex activity. The most important activity for students while learning programming is to learn how to create their own programs. Even though there are few learning approaches that have been proposed to assist students especially novice students in learning programming, few researchers believe that students face such difficulties due to their lack of ability to analyze problems. Due to that matter, we have intended to propose a conceptual framework of problem-based learning or PBL with the aim to improve students' problem-solving ability and programming skills. Besides, through the increase development of technology in recent years, the PBL tasks will be conducted via online learning setting. The aim of this paper is to develop a conceptual framework of online problem-based learning towards students' problem-solving ability and programming skills. The input-process-output (IPO) model was used in describing the conceptual framework of this study. Inputs lead to processes that in turn lead to outcomes. The proposed conceptual framework will be useful for guiding the online instructors to effectively organize and design teaching tasks and materials for the online PBL to take place in order to assist students' problem-solving ability and computer programming skills.**

Keywords—computer programming, online problem-based learning, problem-solving ability, programming skills

I. INTRODUCTION

Novice students lack the knowledge and skills needed for programming, such as coding and debugging; these skills are essential to computer-related fields of study [1 - 4]. Most freshmen students taking programming courses face difficulties due to a lack of ability to analyse problems [5], [6]. In addition, learning of problem solving and programming design are among the beneficial outcomes of Problem-Based Learning (PBL) sessions. Usually, the problems are analysed from various perspectives in the PBL group. Through the effort that students make in explaining the problem or proposing designs to each other, they usually come up with more abstractions. Consequently, their learning of problem-solving and program design improve in order to solve specific problems [7]. This study aims to examine problem solving ability (PSA) in order to improve coding and debugging skills among secondary school students using PBL tasks via Facebook. It will focus on secondary school students in Saudi Arabia who are studying the Computer and Information Technology 1 (CIT1) curriculum.

II. LITERATURE REVIEW

A. Problem-Based Learning

PBL is entrenched in constructivist principles, which uphold the conception that learners actively construct knowledge during the learning process. Similarly, online PBL is related to social constructivist learning theory. PBL methods pose problems so that the learners discover what they know, what they do not know, and what they need to learn before they can solve the problem [8]. Today's society requires graduates to be able to solve complex problems efficiently. The claims made for PBL promise an important improvement in outcomes for higher education as well as basic education. The results of studies examining the effects of PBL are conclusive regarding students' problem-solving ability [9].

B. Problem-Solving Ability

Problem solving is a useful concept that describes the conscious effort in controlled information processing that is aimed at identifying, discovering, or inventing a solution to a problem [10]. McCracken et al. [2] defined problem-solving as an iterative five-step process: (1) Abstract the problem from its description, (2) Generate sub-problems, (3) Transform sub-problems into sub-solutions, (4) Re-compose, and (5) Evaluate and iterate. Indeed, To succeed in the field of Computer Programming, learners needs to have knowledge and to master a variety of skills, including problem solving [11]. Bachu and Bernard [12] reported that lack of problem-solving skills has been identified as the major cause of students' failure in introductory programming courses. Pillay and Jugoo [13] investigated the impact of students' problem-solving ability on their performance on a programming course, and showed that having taken previous courses in problem-solving significantly and positively affected performance.

C. Programming Skills

Programming skills (PS) are vital for anyone studying programming courses. In this paper, PS refer to coding and debugging. Learners are required to have these skills to write a program (coding) in any programming language. McCracken et al. [2] An expected outcome of a student's education in programming courses is PS, which includes

understanding a problem, writing the required computer program, and debugging coding errors.

Coding is a statement written by a programmer that follows the syntax rules specified by the programming language [11]. Whereas, debugging is fixing any incorrect code that is found after running the programming test. Thereby, it is necessary to debug the code in any application to verify its runtime behaviour and to fix any issues that occur [12].

III. Conceptual Framework

The input-process-output (IPO) model was used in describing the conceptual framework of the study. As shown in Figure 1, the researcher constructed this figure to represent the relationship among the variables in the current study. This framework has a powerful influence on recent empirical research, much of which either explicitly or implicitly invokes the IPO model [16]. The conceptual framework consists of three dimensions: input, process, and output. Inputs lead to processes that in turn lead to outcomes.

A. Input

The inputs are a requirement from the environment, which consist of human resources (such as the facilitator) and material (as PBL task) that represent the flow of resources into the process from the outside. Inputs include scenario development for the PBL task and the facilitator roles in online PBL. Figure 1 shows the scenario development for PBL tasks by Albion and Gibson [17]; this scenario contains the following elements:

i. Concepts: development starts when the identification of key concepts from the content domain are identified.

ii. Context: a typical context for the use of concepts. A description of the context, including environmental elements and the problem is created.

iii. Artefacts: the problem is divided into number of sub-problems to make scaffolding easier by assessing the types of artifacts- typically documents of different types- that could be produced in in order to deal with step-by-step solution to the problem situation. Thus, artefacts are gathered through the problem-solving process into their cognitive structures as though they are products of authentic experience.

iv. Storyline: building a storyline around a problem may assist in drawing the user out of exploration mode, into and through the problem.

v. Scenario: the scenario is completed by creating a storyline describing the progress of the problem solver from the initial encounter with the problem to its possible resolution and offering the user with the motivation.

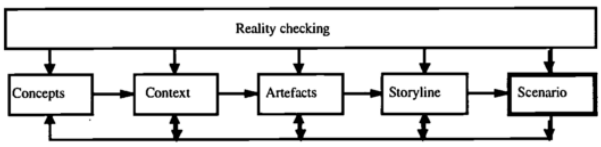

Fig. 1. Scenario Development for PBL Tasks (Albion and Gibson, 1998)

At each phase, an effort is made to apply reality checks to ensure that the overall scenario, and each element thereof, is credible and flows naturally by user choice. The process is more likely to be repeated than linear.

On the other hand, the second input in the conceptual framework is the facilitator roles in online PBL. Facilitators often encounter great challenges when transitioning from traditional instructional methods to online PBL. These challenges are associated with all aspects of online PBL, including changes in facilitator roles. Figure 2 shows the conceptual framework inputs. According to Albion [18], [19], the facilitator roles in online PBL include: a guide the development of learners' higher order thinking skills (HOTs) in group discussions and promotes their independence by providing less information. Furthermore, facilitators helps student for evolving them thinking as metacognitive guides. As well as aiming to promoting students' lifelong learning skills, that they can construct knowledge. Finally, the facilitators in online PBL environment not a knowledge provider, but resources. PBL Facilitators do not serve as dispensers of knowledge. Rather, they serve as resources to the group and provide guidance and direction if the group solicits assistance or becomes bogged down. Such a stance is clearly consistent with the requirements of 21st century learning. [19]

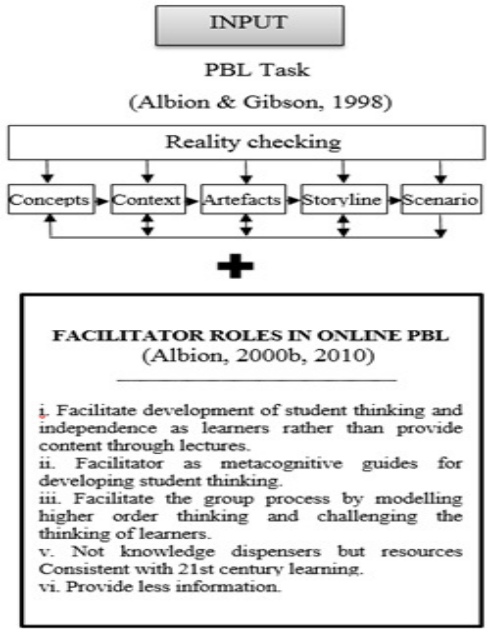

Fig. 2. The conceptual framework inputs

B. Process

Processes are operations and activities that mediate the relationship between the input factors and the outcomes. Albion [20] created a set of nine principles for processing tasks in an online PBL learning. The first one is beginning with an authentic problem. Online PBL should is initiate by an authentic, ill-structured problem, which is genuinely problematic for the student. The second principle is included relevant cases. Learning from cases was found to be effective

in developing expertise, especially when accompanied by explanations, and was recommended as an approach to changing beliefs. The third principle is representing multiple viewpoints. Alternative viewpoints should challenge learners to examine their own knowledge and beliefs. Ill-structured problems are characterized by the fact that there is no single correct solution. The fourth principle is stimulating the activation and development of knowledge. Activating prior knowledge to facilitate connection with new learning and developing new knowledge through immediate application are key PBL principles. The fifth principle is scaffold learner performance. Scaffolding in standard PBL is given by a tutor who can adjust the advice or aid given in accordance with the conditions. The sixth principle is providing a strong narrative line. It can create coherence and support learning by providing a strong and explicit narrative structure. The seventh principle is providing access to relevant information. It may include links or references to external resources depending on the design of the environment. The eighth principle is encouraging self-evaluation. Self-evaluation while using online PBL materials, self-assessment is encouraged by providing solutions that enable users to compare their own responses. The ninth principle is support individual and collaborative learning. PBL groups have been shown to achieve learning through knowledge activation and development. "Expert" evaluators agreed that online PBL material design was consistent with its use to support individual and collaborative learning.

The above principles that stated earlier will be used in an online social learning environment (Facebook). The purpose of these principles is to guide the application of online PBL. The facilitator will use these principles as the underlying framework for educational design. Figure 3 shows the conceptual framework process.

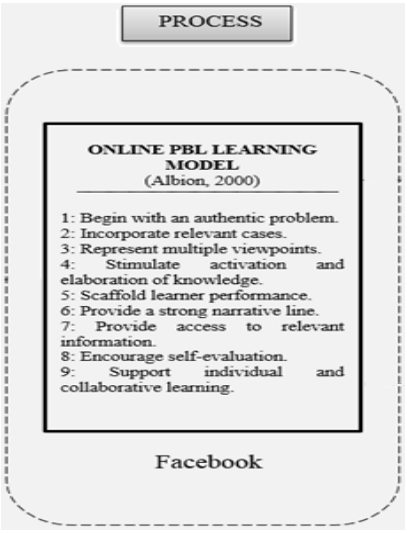

Fig. 3. The Conceptual Framework process

C. Output

Outputs are the consequences of the process actions or activities. The expected results from the conceptual framework are that both PSA and PS (coding and debugging) will be enhanced. In order to achieve these outputs, the researcher will use the Problem Solving Inventory (PSI) for the purpose of measuring PSA among secondary school students following the CIT1 curriculum, while higher order thinking will be used to reflect the appropriate level of coding and debugging that learners achieve. At the end of the conceptual framework, the researcher will create a framework that can be used to support facilitators in increasing coding and debugging skills in secondary school students by using online PBL through Facebook. Figure 4 shows the conceptual framework outputs.

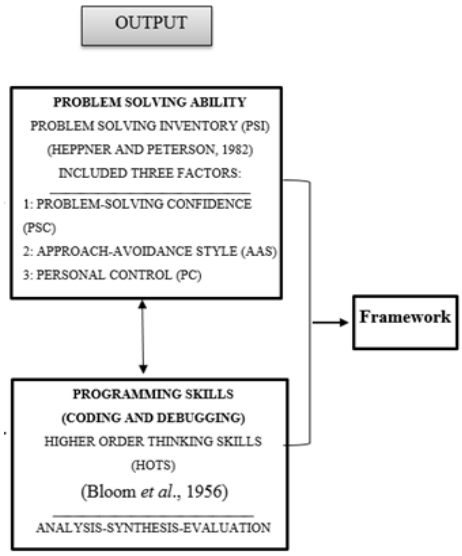

Fig. 4. The conceptual framework outputs

IV. Discussion and Conclusion

The benefits of this conceptual framework is to examine the potentiality of PSA in improving coding and debugging skills among secondary school students by using online PBL tasks through Facebook. This study is important for all people who are involved in the process of teaching and learning. They are:

A. Learners

The findings from this study will inform students on how to perform better in learning pr

ogramming, especially coding and debugging skills, and foster their problem-solving skills through online PBL by using Facebook as a platform for interaction and participation in online discussion with facilitators and peers.

B. Facilitators

At the results of this framework, facilitators, particularly those who teach programming, will be able to design teaching tasks and materials for the online PBL environment through Facebook that will enhance PSA and PS among students.

C. Ministry of Education (MOE)

The MOE in Saudi Arabia seeks to integrate technology into the teaching and learning environment. The information gathered from this conceptual framework could help the MOE

in developing new computer science curricula such as CIT1, CIT2, and CIT3, as the outcome of this framework can be used as a guideline to integrate online PBL with these curriculums. Thus, learners would be able to learn effectively and foster their PSA and PS. Many researchers developed frameworks in order to help students gain PS [4], [21]–[25]. However, these studies on PS are still lacking in the aspect of the potentiality of online learning environments that support interaction between the facilitator and learners.

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