Interactive eLearning System (IeLS) for Learning and Teaching of ICT Coursein Higher Secondary Level in Bangladesh

Abu Sayed Md. Latiful Hoque, Golam Md. Muradul Bashir

Department of CSE, BUET, Dhaka, Bangladesh
asmlatifulhoque@cse.buet.ac.bd, murad98csekuet@yahoo.com

Received Date: 15 October 2017
Accepted Date: 29 December 2017

ABSTRACT

Introducing ICT course at higher secondary level has created new challenges for computer education in Bangladesh. The challenges are: the crisis of experienced teaching staffs, insufficient laboratory facilities, Internet accessibility and appropriate course materials. So it has become very difficult to provide proper ICT education at higher secondary level. If the ICT education cannot be achieved in these levels, it will have a negative impact to the study of Computer Science and Engineering (CSE) at tertiary level as well. Problem Based e-Learning (PBeL) is the integration of eLearning with Problem-Based Learning, a new paradigm of learning of programming languages and ICT education. In this paper, we have presented an Interactive eLearning System (IeLS) based on Problem-Based eLearning (PBeL) for learning and teaching of the ICT course. The system has been implemented as per syllabus of National Curriculum and Textbook Board of Bangladesh. There are two types of contents in the course: textual and programming. Students can learn the textual contents of the course interactively and measure the learning outcome by self-evaluation. The learning and evaluation process is continued iteratively until the learner is satisfied. The programming contents of the course are HTML, C programming and Database Management System. We have implemented the programming contents as per PBeL model. In the PBeL model, the main component is the problem-bank that has been designed in a hierarchical fashion such that the content coverage problem of traditional PBL is removed. So transition from traditional to PBL is easy. The system

has been used by the students and teachers of different colleges in higher secondary level. The result has been found to be very much satisfactory.

***Keywords**: PBeL, ICT Course in Higher Secondary Level, eLearning of HTML, Interactive eLearning, eLearning of C Programming, eLearning of Database*

INTRODUCTION

Introducing ICT course at higher secondary levels have created new challenges for computer education in Bangladesh. These challenges are the crisis of experienced teachingstaffs, insufficient laboratory facilities, Internet accessibility and appropriate course materials. So proper ICT education at higher secondary level is very difficult to achieve. If no proper ICT education can be provided in these levels, it will have a negative impact to the study of Computer Science and Engineering (CSE) education at tertiary level as well.

Problem Based e-Learning (PBeL) is the integration of eLearning with Problem-Based Learning, a new paradigm of learning of programming languages and ICT education in Bangladesh. It has been found that introducing Problem Based e-Learning (PBeL) in the learning of Database course in the Department of Computer Science and Engineering (CSE), Bangladesh University of Engineering and Technology (BUET) has been found to be quite effective [1]. With this experience, it is highly desirable that the same will be true in learning and teaching of ICT course in the higher secondary education and the challenges mentioned above can be solved.

In this paper, we have presented an Interactive eLearning system (IeLS) based on Problem-Based eLearning (PBeL) for learning and teaching of ICT course in higher secondary level. The use of this system removes the fear of the students to study the newly introduced ICT course in higher secondary level by the design and development of the course content in an interactive manner. This system has been implemented as per the syllabus of National Curriculum and Textbook Board [2] for ICT course content in HSC level. It makes the learning easy by developing the content in such a way that the students can get help instantly. The content has been organized in a cycle of learning and self-evaluation mode byintroducing e-evaluation

of different types. As a web-based system, it is easy for the teachers to grasp and a thorough understanding of the course content within a short period of time even for the teachers not studying computer science. So this will solve the instructor crisis problem of the country. The content and the problem-bank are accessible by using smart phones as well. Hence, Internet accessibility problem has been reduced to some extent.

A process has been proposed for continuous improvement of the system for better learning and teaching outcome by using a usage statistics and users feedback mechanism. The programming contents of the course are HTML, C programming and Database ManagementSystem. Problem-Based eLearning model [2, 3] has been implemented for the learning and teaching of the three programming parts. PBeL model has been implemented in three modes: solutions with hint, solution without hint and full solution. So students can learn self or with peers as pair-wise learning method having minimum interaction with the instructor. The effectiveness of the system has been measured by organizing workshops for the ICT course teachers and the ICT students. We have collected feedback from both teachers and students and found that the use of this system will solve the existing problems of learning and teaching of the course to a great extent.

RELATED WORK

Problem-based eLearning of HTML in ICT course of Higher Secondary level in Bangladesh has been described by Abu Sayed and Golam (2016). In this paper, the effectiveness of PBeL has been shown in part of the ICT course. The details about the PBeL model have been given in Golam and Abu Sayed's paper 2016a). In this paper, it has been described how can the PBL be integrated with eLearning to solve the content coverage problem and instructor workload problem of PBL be solved. PBeL has been applied in learning and teaching of PHP (Golam & Abu Sayed, 2016b) and SQL programming (Abu Sayed et al., 2012). The benefit and success of PBL revealed in many articles (Gallagher &Stepien, 1996; Hung, Bailey &Jonassen, 2003; Norman & Schmidt, 1992; Hung, 2006). PBL pedagogy applied on introductory programming course to accomplish performance evaluation and found PBL students results significantly better than traditional (Looi&Seyal, 2014, Soares, Fonseca & Martin, N.A.). Nuutila et al. (2005)

applied seven steps method of PBL on an introductory programming course. The seven steps method is widely used in medical education (Barrows, 1986; Schultz-Ross & Kline, 1999). The cognitive and affective requirements as well as contextual validity of programming problems and medical education are not similar. As a result, precisely application of seven steps method is less adapted with the programming problems types. However, the issues adjacent to the physical design of problems seem to have received little concentration. The PBL has been applied many other courses e.g., Analogue Electronics (Mantri, Dutt, Gupta &Chitkara, 2008), Software Engineering (Qiu& Chen, 2010), Signal Processing (Bhatti & McClellan, 2011) and the study of Microprocessor (Kim, 2012). These systems do not provide any guidelines how can the transition from traditional to PBL be done smoothly, the traditional contents can be covered in PBL and the reduction of instructor workload.

SYSTEM ARCHITECTURE

We have divided the content of the course to six modules as per the syllabus provided by NCTB (N.A.). The modules are as follows:

1. Information and communication technology: World and Bangladesh Perspective
2. Communication System and Networking
3. Number System and Digital Devices
4. Introduction to Web Design and HTML
5. Programming Language
6. Database Management System

Analysis and Design of Content

The content has been analyzed and decomposed in such a way that support the development of the system. Figure 1 shows the detailed decomposition diagram of the system. In the decomposition diagram, it is shown that the first three modules, there are texts, graphics and Multiple Choice Questions (MCQ). The learning process starts with earning the contextual knowledge by studying the content. After acquiring a certain amount of contextual knowledge, students go through an MCQ to judge his knowledge, to remove the fatigue and monotony and increase students' participation in learning. The learning process runs iteratively as shown in Figure 2.In the decomposition diagram, it is shown that the last three modules contain the PBeLas the components of IeLS. In these modules, there are programming parts and for learning and teaching of programming, PBeLs have been incorporated in the IeLS.

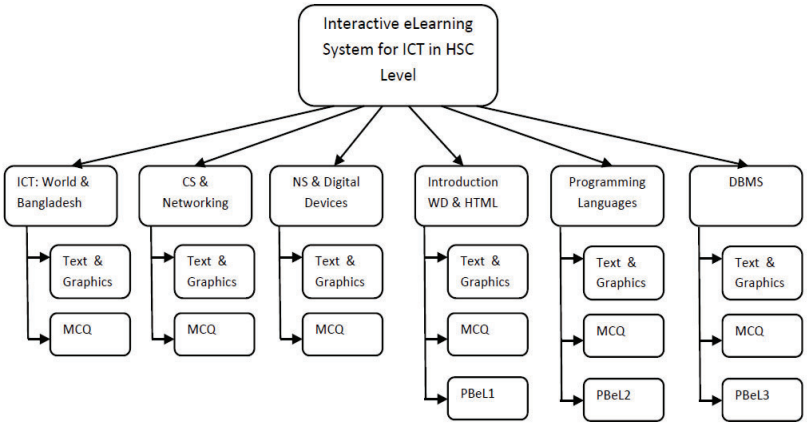

Figure 1: Decomposition Diagram of Interactive eLearning System for ICT Course in HSC Level

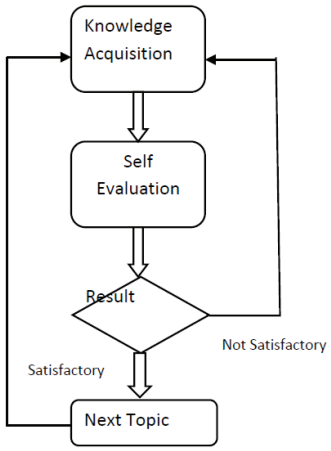

Figure 2: Knowledge Acquisition Cycle for Acquiring Contextual Knowledge System Architecture for IeLS

Figure 3 shows the system architecture for IeLS for ICT course at HSC level. There are six system modules for the management of interactive contents of six chapters, the problems and solutions management for blended synchronous learning covering the content and supporting lifelong learning. In a classroom in blended learning environment, the progresses of all of the students are not the same. The progresses of some students are very fast and the progresses of some students are very slow. It is a challenging problem for the teaching and learning community to maintain the class room environment attractive, interactive and interesting for all levels of students as mentioned.

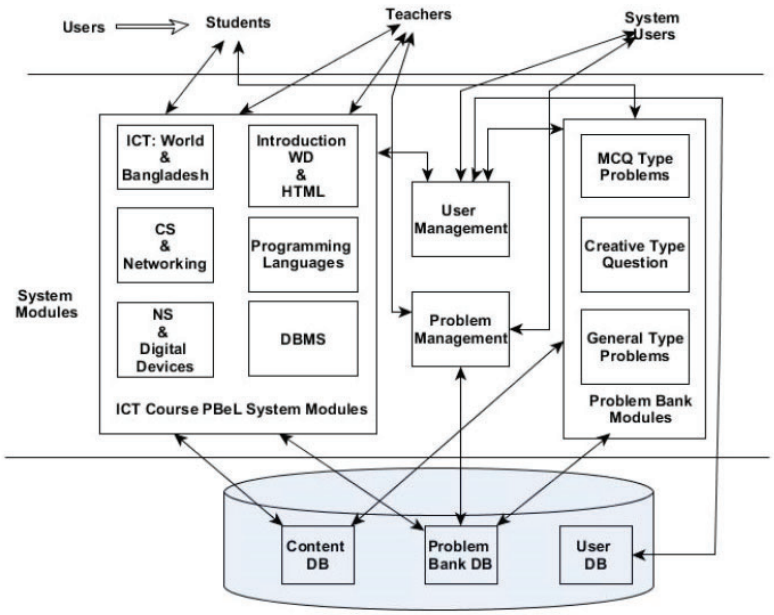

Figure 3: System Architecture for IeLS for ICT Course at HSC Level

In this system, this challenge has been addressed by designing the problem bank in a hierarchical fashion as discussed by Golam and Abu Sayed (2016a). Each problem is a part of a big real-life problem. The higher the level of the problem, the difficulty of the problem is also higher. The lowest level problems are designed in such a way that they cover the entire content of the course. The users of the system are students, teachers and system users. The students interact with six modules of ICT course PBeL system for learning purpose in different mode. The students also interact with problem-bank modules for appearing online examinations for self-evaluationor evaluation by the instructor. The teachers interact with the PBeL system modules for inserting the content into content database as per design of the content database, updating the content as per necessity and insert problem to the problem-bank integrating the content with the problem.

In the problem-bank module, there are three types of problems as suggested by NCTB (N.A.) and the course experts. These are the different

types of Multiple Choice Questions (MCQ), Creative Type Questions (CTQ) and General Type of Questions (GTQ). Problem-bank is used for multiple purposes e.g., learning and teaching in PBeLenvironment, self-learning, self-evaluation and the evaluation by the instructors. There are examinations held in different times for different levels of students in all colleges. The teachers can prepare the question-set of all types from the problem-bank. Question set can be prepared by selecting different questions by the teacher or it can be prepared by running question-set preparation algorithm.

The system users interact with the user management module and the problem management module. Student users have only one role of learning and evaluation. The teacher's roles are submission of questions as question setter, moderation of questions and preparation of question-set for different examinations.

IMPLEMENTATION OFIELS

The open source web programming language PHP has been used for the development of the web-based system and MySQL has been used for the database. A problem-based eLearning (PBeL) System for structured programming language C for Higher Secondary level has been shown in Figure 4. Using this module, the students can learn the content of C programming language as per NCTB (N.A.) syllabus. They can also write C programs, execute it and see the results interactively.

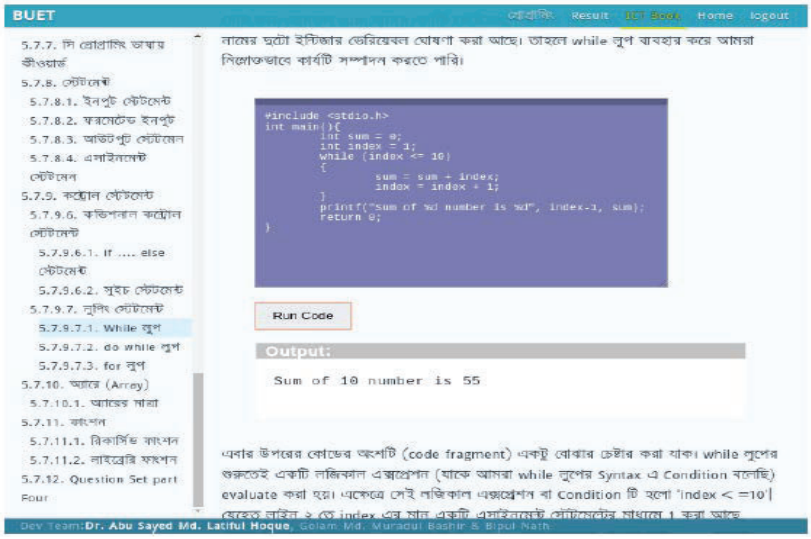

Figure 4: Interface for Interactive Learning Module for C Programming Language

We have developed a PBeL module for the learning of web development and HTML. Figure 5 shows a sample interface for this module. In this module, real life problems like the home page of ICT Division, government of Bangladesh, CV of a famous person etc. have been used for the interactive learning purpose. We have considered three options for learning: learning from the scratch, learning with hint and learning with example (complete solution). There are different levels of problems. The top level (root) problem is the full real-life problem. The root level problem has been decomposed into lower level smaller problems. Level 1 problems are mostly atomic problems those covers a single topic or concept of traditional course content.

Figure 5: Interface for Interactive Learning Module for HTML

The interface for the PBeL system for learning and teaching of DBMS part of ICT course has been given in Figure 6. The theory part can be learnt according to the learning cycle described in previous section. For the PBeL part, several database schemas have been given and on the basis of schema, SQL problems are set.

Figure 6: Interface for Interactive Module for Database Management System

RESULT AND DISCUSSION

Table 1 shows the questionnaire for the evaluation of IeLS. For the evaluation of the system, we have considered seven aspects: personal satisfaction, personal belief, desire, technological, learning, problem solving and student engagement. The participants were 48 students of one leading college, Dhaka College.

Figure 7 shows the performance evaluation by HSC students of medium type college. The evaluation question Q4 is grading the system according tolikert scale for the statement “the addition of the system with traditional class will improve the HSC student’s understanding level”. It

shows that almost 100% strongly agreed the statement. Figure 8 shows the evaluation result after using the system by HSC students of a leading College. Q10 was grading the system according to likert scale for the statement “the practical componentsof HSC level ICT course should be learnt in an interactive mode like the shown Problem based e-learning system”. It was also strongly agreed by almost 100% students.

The evaluation result shown in Figures 7 and 8 were taken during the early stages of the development of the IeLS where only the HTML part was completed.

Table 1: List of Questions for the Evaluation of IeLS

Q. No.	Question Title
1	The practical components of ICT course should be learnt in an interactive mode like the shown e-learning system.
2	You cannot concentrate your attention to traditional class of the college
3	You feel boring to learn in the traditional teaching method of the college
4	You are satisfied to use the shown system as learning assisted tool
5	You are satisfied to use the functions of the shown system
6	You are satisfied to use the learning contents of the shown system
7	You are satisfied with the instructions of the shown system
8	You are satisfied with interactive facilities of the shown system
9	You believe the contents of the shown system are sufficiently informative
10	You believe the shown system is a useful learning tool
11	You believe the contents of the shown system are useful
12	You intend to use the shown system for the HSC level
13	You intend to use the shown system as a self learning tool for the HSC level
14	The environment of the shown system will enhance students' problem-solving skills for the HSC level
15	The environment of the shown system will be more fruitful than the traditional system of learning/teaching of the HSC level
16	The system will be an attractive solution to motivate the students to self-learning for the HSC level
17	The addition of the system can improve the students understanding in class room learning for the HSC level.
18	The addition of the shown system can develop the problem solving capability of the students.
19	If you used the shown system in the HSC level, then you performed more HTML practical work
20	Addition of similar e-learning system for programming language will help more than traditional way of learning
21	Learning by problem solving like the shown system has developed your HTML knowledge more than traditional HSC level learning
22	The shown system will engage students for self learning than that of traditional learning.
23	Problem solving of the system inspired you for more learning
24	You feel confident using the given system.
25	You feel confident operating the functions of the system
26	The environment of the given system improves your thinking skills.
27	The environment of the given system enhances you problem-solving skills.

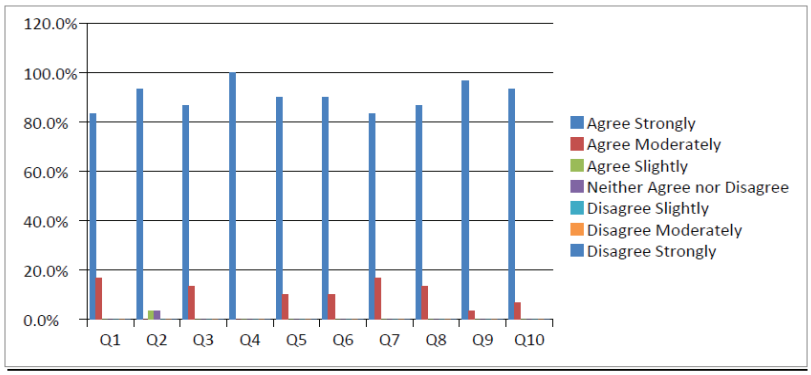

Figure 7: Performance Evaluation by HSC Students of Medium Type College

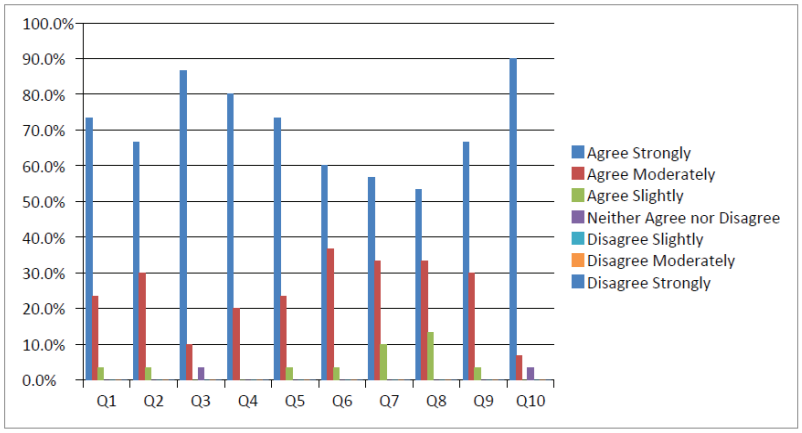

Figure 8: Performance Evaluation by HSC Students of Leading College

Figure 9 and 10 show the evaluation result after completion of the full IeLS system. There are 27 questions as givenin Table 1. As per Figure 9, question 12 "You intend to use the shown system for the HSC level" has the highest value of strongly agree. This shows the very positive impact of the system that can be used for learning and teaching. Out of 27 questions, there are 17 questions having "strongly agree" opinion more than 60 percent. These reflect the effectiveness of the system in learning and teaching.

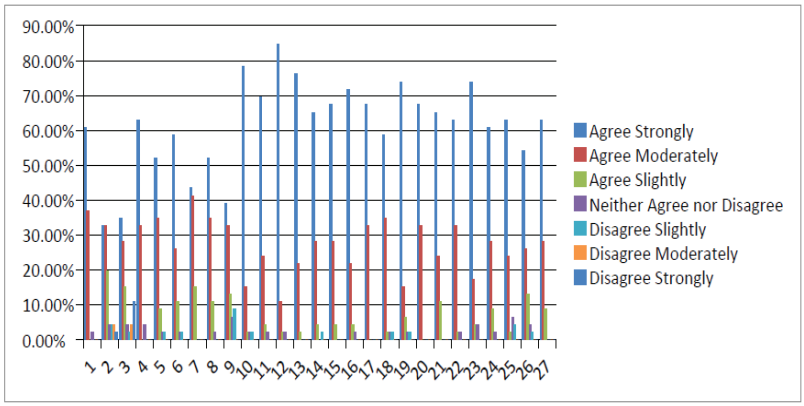

Figure 9: Students' Response about IeLS by HSC Students of a Leading College

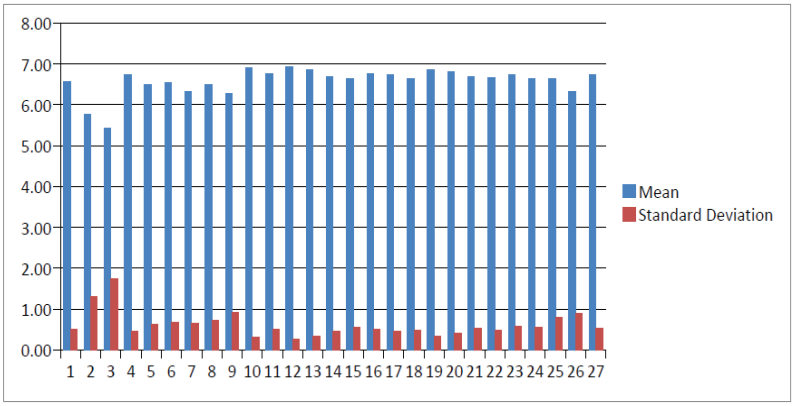

Figure 10: Mean and Standard Deviation of Student Response about IeLS

CONCLUSION

The problems and challenges for learning and teaching of ICT course in Higher Secondary level in Bangladesh are: the crisis of experienced teaching staffs, insufficient laboratory facilities, Internet accessibility and appropriate course materials. This research is an attempt to solve these problems by the

integration of eLearning with Problem-Based Learning, a new paradigm of learning and teaching.

In this paper, we have presented an Interactive eLearning system (IeLS) based on Problem-Based eLearning (PBeL) for learning and teaching of ICT course in higher secondary level. This system has been implemented as per the syllabus of National Curriculum and Textbook Board of Bangladesh for ICT course content in HSC level. There are six system modules as per the decomposition of the course content. We have presented a system architecture showing the interconnections of the modules, the content database and the problem-bank.

The programming contents of the course are HTML, C programming and Database Management System. Problem-Based eLearning model has been implemented for the learning and teaching of the three programming parts. The effectiveness of the system has been measured by the application of the system in a blended learning environment for ICT students. We have collected feed-back from both teachers and students and found that the use of this system will minimize the above mentioned problems for learning and teaching of this course. There are some scopes of improvement of the system as suggested by the participants of the workshops. These are the use of video, animation and graphics in contents that can be implemented in the future work.

ACKNOWLEDGEMENT

This research work has been performed in the Department of Computer Science and Engineering, Bangladesh University of Engineering and Technology under the research grant of ICT Division, Ministry of Post, Telecommunication and ICT, Government of Bangladesh.

REFERENCES

Abu Sayed Md. Latiful Hoque, & Golam Md. Muradul Bashir (2016). *Problem-Based Elearning of HTML in ICT Course of Higher Secondary Level in Bangladesh.* In Proceedings of ISERD International Conference, IRAJ, Mecca, Saudi Arabia, pp. 1-6.

Abu Sayed Md. Latiful Hoque, Mohammad Mahfuzul Islam, Md. Iqbal Hossain, & Md. Faysal Ahmed (2012). *Problem-Based e-Learning and Evaluation System for Database Design and Programming in SQL*. International Journal of e-Education, e-Business, e-Management and e-Learning, IACIST PRESS, 2(6), pp.537-541.

Barrows, H. S. (1986). *A Taxonomy of Problem-Based Learning Methods*. Medical Education 20 (6), pp.481-486.

Bhatti, P. T. & McClellan, J. H. (2011). *A Cochlear Implant Signal Processing Lab: Exploration of a Problem-Based Learning Exercise.* Education, IEEE Transactions on 54 (4), pp. 628-636.

Gallagher, S. A. & Stepien,W. J. (1996). *Content Acquisition in Problem-Based Learning: Depth versus Breadth in American Studies.* Journal for the Education of the Gifted 19 (3), pp.257-275.

Golam Md. Muradul Bashir, & Abu Sayed Md. Latiful Hoque (2016a). *An Effective Learning and Teaching Model for Programming Languages.* Journal of Computers in Education, Springer, 3(4), pp.413–437.

Golam Md. Muradul Bashir, & Abu Sayed Md. Latiful Hoque (2016b). *E-learning of PHP based on the Solutions of Real-life Problems.* Journal of Computers in Education, Springer Link, 3(1), pp. 105–129.

Hung, W., Harpole Bailey, J. & Jonassen, D. H. (2003). *Exploring the Tensions of Problem-Based Learning: Insights from Research*. New Directions for Teaching and Learning 2003 (95), pp. 13-23.

Hung, W. (2006). *The 3c3r Model: A Conceptual Framework for Designing Problems In Pbl*. Interdisciplinary Journal of Problem-based Learning 1 (1), pp. 55-77.

Kim, J. (2012). *An Ill-Structured Pbl-Based Microprocessor Course without Formal Laboratory*. Education, IEEE Transactions on 55 (1), pp.145-153.

Looi, H. C. & Seyal, A. H. (2014). *Problem-Based Learning: An Analysis of Its Application to the Teaching of Programming*. International Proceedings of Economics Development and Research 70, pp.68.

Mantri, A., Dutt, S. Gupta, J. & Chitkara, M. (2008). *Design and Evaluation of a Pblbased Course in Analog Electronics*. Education, IEEE Transactions on 51 (4), pp.432-438.

National Curriculum and Textbook Board (NCTB), http://www.nctb.gov.bd/

Norman, G. R., Schmidt, H. G. (1992). *The Psychological Basis of Problem-Based Learning: A Review of the Evidence*. Academic medicine 67 (9), pp.557-65.

Nuutila, E. Torma, S. & Malmi, L. (2005). *Pbl and Computer Programming the Seven Steps Method with Adaptations.* Computer Science Education 15 (2), pp.123-142.

Qiu, M. & Chen, L. (2010). *A Problem-Based Learning Approach to Teaching an Advanced Software Engineering Course*. In: Education Technology and Computer Science (ETCS).

Second International Workshop (2010). Vol. 3, IEEE, pp. 252-255.

Schultz-Ross, R. A. & Kline, A. E. (1999). *Using Problem-Based Learning to Teach Forensic Psychiatry*. Academic Psychiatry 23 (1), pp. 37-41.

Soares, A., Fonseca, F. & Martin, N. L. (N.A). *Teaching Introductory Programming with Game Design and Problem-Based Learning.* Issues in Information Systems 16 (3).