PROBLEM-BASED ELEARNING OF HTML IN ICT COURSE OF HIGHER SECONDARY LEVEL IN BANGLADESH

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Abstract- Problem-based learning (PBL) is a blended learning approach that engages students to self-directed learning and collaborative learning. Programming is the core course in Computer Science and Engineering and learning programming languages is difficult. In this paper, we have proposed a model integrating eLearning with PBL (PBeL) to make the learning and teaching of programming languages easy and effective and to support life-long learning. We have implemented the model initially for learning and teaching of Hyper Text Markup Language (HTML) in higher secondary level ICT course under the education board of Bangladesh. We have applied the system for both synchronous blended learning and asynchronous learning and found very satisfactory result in teaching and learning.

Index Terms- PBeL, eLearning, HTML, Problem-based.

I. INTRODUCTION

PBL is an effective instructional pedagogy that inherently engages students to self and meaningful learning which results deeper understanding and longer retention [1, 2, 3]. The effectiveness of PBL depends on the design of PBL problems that covers the content of a course. Woei Hung (2006) proposed a conceptual framework 3C3R for designing problems in PBL. He discussed theoretical basis and guidelines to design PBL problems in general [4]. These guidelines basically describe what should be an effective PBL problem.

This paper proposes a model titled Problem-based eLearning (PBeL) which describes the structure of the PBeL problems, the system architecture, the development of the problem-bank and learning and teaching in both synchronous and asynchronous mode. We have implemented the model for learning and teaching of HTML part of ICT course at Higher Secondary (HSC) level in Bangladesh. As per the model, we have designed a problem-bank covering the content of the course. The PBeL system was applied to the students of HSC level of different colleges. The result obtained is very much satisfactory and encourages us for the application of the model for other programming languages.

II. LITERATURE REVIEW

The benefit and success of PBL revealed in many articles [5, 6, 7, 8, 9]. PBL pedagogy applied on introductory programming course to accomplish performance evaluation and found PBL students results significantly better than traditional [10, 11]. Nuutila et al. applied seven steps method of PBL on an introductory programming course. The seven steps method is widely used in medical education [12]. 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. Kamaruddin et al. proposed some guidelines to design effective engineering problems for PBL in general [13]. Design of PBL problems have been discussed by a few researchers [14, 15, 16, 17, 18]. To design PBL problems, Hung [4] proposed a conceptual model 3C3R where he discussed the model in respect of its theoretical basis, component functions, and the techniques used. Mostly, their discussions are general or conceptual and, therefore not sufficient to physically design programming problems which meet up the intended learning goals, coverage of content, reduce teacher work load as well as students learning overhead.

III. PBEL SYSTEM ARCHITECTURE

PBeL system contains the following modules: problem design and management module, student learning module, teaching by instructor module, students' performance evaluation module, and user management and administrative module. PBeL system architecture is shown in Figure 1.

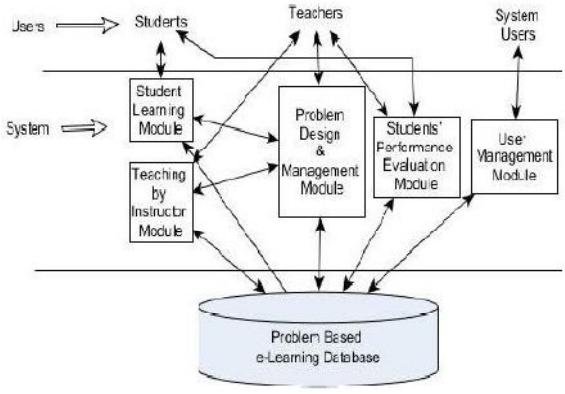

Figure 1: PBeL system architecture.

Problem design and management module: The main component of PBeL architecture is the problem design and management module. The purpose of this module is to create problems as per the model described in the following sections. After defining a problem, a standard solution is done by the teachers and both the problem and the solution are saved in the PBeL database. The detailed of the problem creation and solution development has been enumerated in the following sections.

Student learning module: Students are the main beneficiaries of the PBeL system. They use the student learning module through Web interface. This module serves the student to select a problem of choice, supporting materials to solve the problem, submit the solution of the problem and appear in online examination for self evaluation or evaluation by the teachers.

Teaching by instructor module: One of the objectives of the PBeL system is to reduce the teacher workload. This is achieved by careful design of the problem-bank and reusing the problems. Teacher can select some problem for teaching and make their access open for the students for practice and some problems can be used for evaluation purpose. In PBL teaching, usually an ill-structured problem is assigned to a group of students and teacher acts as facilitator. In PBeL, instructor has a number of options for teaching. The structured part of the problem-bank can be used as a blended learning in an interactive mode. This option is closer to conventional teaching and learning in terms of content coverage. The semi-structured or ill-structured part of the problem-bank can be used for experienced learner group to develop the real-life problem solving skill of the students.

Students' performance evaluation module: Using the students' performance evaluation module, teachers can create online assignments or tests and allocate the assignments to the students. Students have to solve the assignment in a specified time and submit the solution. All submissions of the students are saved in PBeL database for evaluation and future reference purpose. The evaluation of programming problems are done automatically and the design problems are done by using the evaluation support system. To reduce the teacher workload in this system, a standard solution of the problem is saved in the system and the student submission is compared with standard solution usually in two windows side by side.

User management and administrative module: User management module is used to create user and assign privileges to the users. These are some administrative jobs to maintain the systems like database administration, problem-bank management, administration, and similar others tasks. These are maintained in this module.

IV. PBEL PROBLEM BANK DEVELOPMENT

In PBeL design model, we follow the following rules:

Rule 1: The union of all of the problems in any level covers the total content of the course under PBeL and hence confirms factual knowledge acquisition.

Rule 2: By bottom up synthesis, the lower level problems form a tree structure (Figure 2) and each parent problem must be the integration of more than one child problems considering degree of contextualization of the specific level. Different level are appropriate for different levels of students which are set considering human cognitive architecture. According to Hung, over-contextualized PBL problems may enwrap the students with redundant information or considerations, on the other hand under-contextualized problems may cause the learners to fail to consider issues that are implicit but critical in that particular setting [4]. As a result, problem integration must be with appropriate level of contextualization.

Rule 3: A child problem can be included in one or more than one parent problem (Multiple Inheritance). Sometimes multiple inheritance is required to ensure a real life context.

Rule 4: The construction of the tree stops to the root problem.

Rule 5: Every leaf problem carries one and only one concept which can be referred as an atomic problem and represent lowest degree of contextualization.

Rule 6: The complexity as well as degree of contextualization of the problems increase with the increase of level from bottom to up.

Traditional text books are organized as chapters, sections, subsections, topics/contents. The lowest level is the topic or concept. If a problem is designed covering a single topic/concept, we have defined it as an atomic problem. The lowest level of problem construction is level 1. Let P_1 is an atomic problem in level 1. All problems in level 1 are atomic problems. After solving any problem in level 1, a student will learn a single concept of the course. The construction of problem starts from developing all atomic problems. Let a course C has m topics/concepts in PBeL. Several researches claim about the lacking of factual knowledge acquisition of PBL students. In PBeL problem design model, problems have been constructed from each single concept of traditional text book content in level 1. As a result, there are no chances of un-coverage of content inclusion here. These level 1 problems are used to construct level 2 problems and continue to the highest level (Figure 2). Lower level problems represent lower degree of

contextualization whereas gradually higher level problems represent higher degree of contextualization. The domain and human cognitive architecture are considered to set appropriate level for specific level of students. The following sections describe the construction process of problems from lower to higher level.

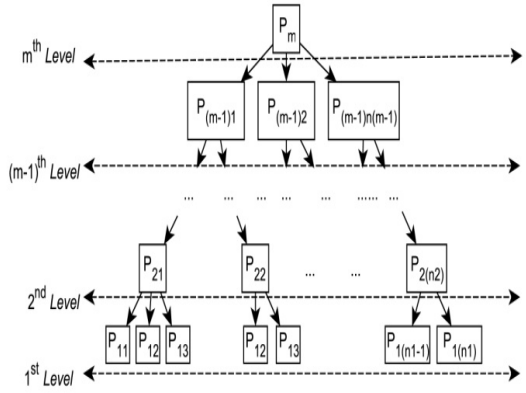

Figure 2: Level-wise synthesis of problem

Problem design for ICT of Higher Secondary (HSC) level: We have applied the level-wise problem construction method for the development of problem-bank for HTML part of ICT course in HSC level of Bangladesh. A real-life problem to develop a curriculum vitae (CV) using a HTML has been considered for this purpose. One person uses curriculum vitae to explain oneself for different purposes. A person normally wants to develop curriculum vitae as much attractive as possible for job purpose or any other purpose. We use the curriculum vitae to explain the problem construction process from traditional to PBeL problem. Figure 3 shows the part of output of the CV problem with a level wise decomposition as P_{11}, P_{12}, …. To higher levels.

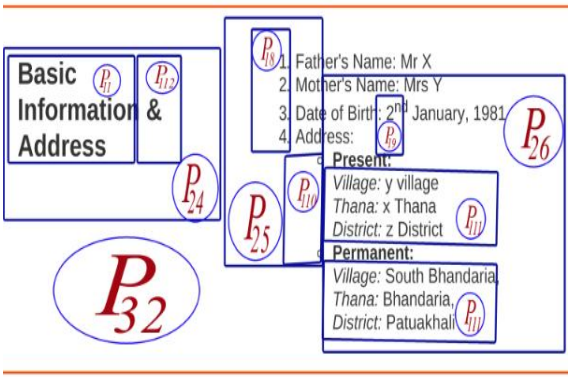

Figure 3: Part of CV problem

The tree representation of the partial CV problem is given in Figure 4. The lowest level problem parts are P_{11}, P_{18}, P_{19}, P_{110}, P_{111} and P_{112}. The second level problem parts are P_{24}, P_{25} and P_{26} and three second level problems form one third level problem P_{32}.

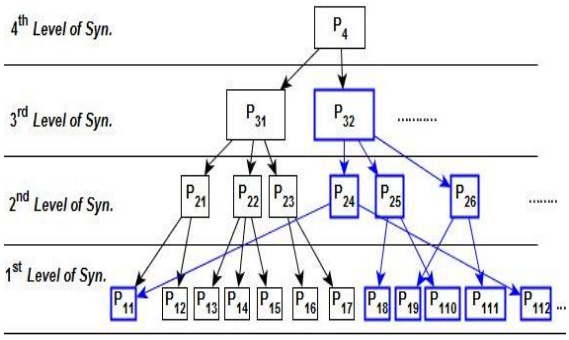

Figure 4: Tree representation of CV problem

Same problem can be used in different manner such as structured, semi-structured or ill-structured problem. As for example, if we approached the CV problem with ill-structured manner then no standard output (sample of CV) is provided to develop the CV. The students are asked to design CV as best as possible. In that case, CV is an ill-structured problem as one's developed CV is better than others' CV in different perspective. Here the initial state, goal and constraints all remain undefined. In this manner of problem design, there is no assurance of expected contents' coverage according to a number of researchers [19, 20, 21]. The same problem we can be used as structured manner. In this manner, the students are given a sample of a CV and asked to design a CV as same as the given standard output of CV code. In this case, the required contents are supplied with the problem which reduces the random searching time as well as problem of intended factual knowledge acquisition. In fact, this sample (here CV) is constructed considering content coverage of a specific area of a language. We consider Hyper Text Markup Language (HTML) domain for illustration of our problem construction process.

V. PBEL IMPLEMENTATION

Primarily, the proposed PBeL problem model has been applied to design problems of Hyper Text Markup Language (HTML) part of ICT course of HSC level. In the level 1 (Figure 5), all single concepts of html have been included to form lowest level problems as per problem design model described in the previous sections. In this Figure, the marked `1' represents level selection option. Users are free to select any level from the system. After selecting level 1, students or teachers get the atomic problems marked by `2'. The problems are set as like text books' contents though users are free to select any problem. Students can write their code in Figure 5 (3a) and see the output of the code in Figure 5 (3b). The standard output of the selected problem is given to Figure 5 (3c). There are three options to write code to perform the learning/teaching using the problem. Default option is `No hints' which is shown by Figure 5 (4a). In this option the users see only used text of the problem with basic <html>and <body>tag only. The users have to write appropriate tag in Figure 5 (3a) to get the same standard output of

Figure 5 (3c). The second option is `Blank Tag' option that can be called as 'partial hint'. Here the users only have to write appropriate character or word of the tag. The students need not to consider where to put the tag and no need to write opening and closing tags. The third option is `With Tag' option where the exact code of the standard output has been given to users for learning/teaching by the observation of the code. It is an issue to find out which option is more useful to users for learning or teaching perspective. The usage mannerisms of the users have been recorded. From this recorded navigation, it can be found out which option is more useful to set as default option. The scenarios of the problems based on context are given in Figure 5 (5). Degree of contextualization varies with the level covering the contents. Figure 5 (6) represents the supporting materials which cover the contents of the specific problem. These contents help users to proceed for solution of the problem.

Figure 5: The implementation of PBeL for HTML of ICT course in HSC level of Bangladesh

VI. RESULT AND DISCUSSION

Several sessions were organized to introduce and practice the PBeL system developed for HTML learning and teaching for Higher Secondary Level students. We have taken HSC students of medium type colleges for the performance evaluation of the system as a test case. In Bangladesh, most of the students are enrolled in medium type colleges. Thirty three (33) students who studied HTML content in traditional environment were called for the session along with their ICT course teachers. Both the students and their teachers have been cognized PBeL theoretically by the presentation of the domain expert and practically by using the system. The students performed the online learning and practice using the system. They practiced different levels of problems in problem-based e-learning environment. Male students were twenty seven and female students were six. They were from different groups. The demographic information of the program is outlined in Table 1.

Table 1: Demographic information of the program

	Frequency	Percentage (%)
Gender		
Female	6	18.18
Male	27	81.82
Group		
Arts	5	15.15
Commerce	4	12.12
Science	24	72.73

All students were assigned HTML problems individually by the system. These problems trigger them for self-learning. They practice until they become confident themselves about the answers to the specific problem. At last, a set of survey questions was served to the students for performance study of HTML system. The survey questionnaires were designed in 7-point Likert scale (ranging from 7 which means agree strongly to 1 which means disagree strongly). The students were ensured to retain confidentiality and any primary key information to trace any of the students' opinion was not recorded. As a result, they gave their opinion independently. The set of questionnaire that were given for the performance study are given in Table 2.

The students were very much positive about the system environment. Most of the students have given their opinion in scale of 'Agree'. This is because they have got themselves engaged with learning with enjoyment. The detail of the students' opinion has been shown in Figure 6. From the survey result it has been seen that for the question 'Q4: The addition of the system with traditional class will improve the HSC student's understanding level' opinion is hundred percent. As students were experienced with traditional learning system and practiced in the PBeL environment in the organized sessions, they were confident to give this opinion. For the questions Q1 & Q_7 the results were comparatively less than other questions. These two questions were about problem-solving skills. As the students were new to learn by problem solving, they give their opinion with higher variety.

The corresponding mean and standard deviation of the result are given in Figure 7. From the figure it has been seen that for the question 'Q_2: The environment of the shown system will be more fruitful than the traditional system of learning/teaching of the HSC level', the standard deviation is more than other opinion. Since the question was a predictive type question with comparison between conventional traditional system

and proposed system, the students were more diverse about this.

Table 2: Served Questionnaires for Performance Evaluation of the Model

Question ID	Detail Question
Q1	The environment of the shown system will enhance students' problem-solving skills for the HSC level
Q2	The environment of the shown system will be more fruitful than the traditional system of learning/teaching of the HSC level
Q3	The system will be attractive to motivate HSC students for self-learning
Q4	The addition of the system with traditional class will improve the HSC student's understanding level
Q5	If you used the shown system in the HSC level, then you could perform more HTML practical work
Q6	Addition of similar e-learning system for programming language will help to learn more than traditional way of learning for HSC level
Q7	Learning by problem solving like the shown system will develop HSC students' HTML knowledge more than traditional HSC level learning
Q8	The shown system will engage HSC students for self learning than that of traditional learning
Q9	Problem solving of the shown system will inspire HSC students for learning more than traditional learning
Q10	The practical components of HSC level ICT course should be learnt in an interactive mode like the shown Problem-based e-learning system

Most of the students agreed to choose Problem-based eLearning of HTML in ICT course of Higher Secondary Level as their learning strategy, since they perceived themselves as self-learner with high motivation and freedom. Most of the students agreed that the system enhanced their knowledge with real life problem solving than that of traditional learning system.

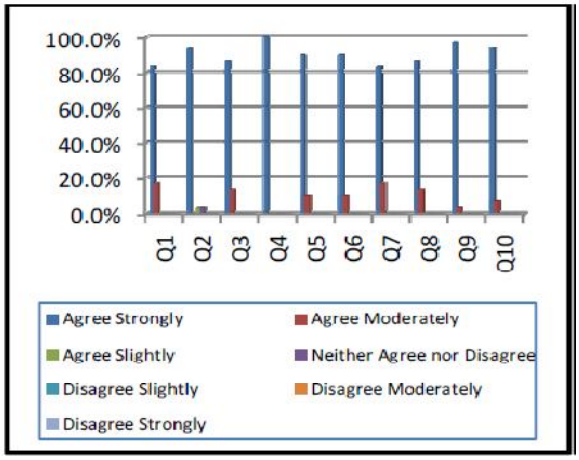

Figure 6: Performance Evaluation by HSC students of Medium Type College

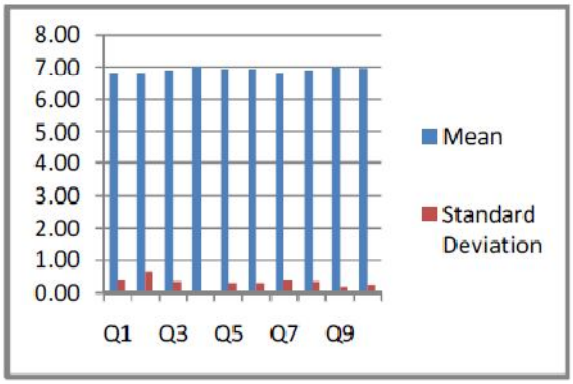

Figure 7: Performance Evaluation by HSC students of Medium Type College (Mean and Standard Deviation)

CONCLUSION

Programming is the core course in Computer Science and Engineering and learning programming languages is difficult. PBL is an effective instructional pedagogy that inherently engages students to self and meaningful learning which results deeper understanding and longer retention.

In this paper, we have proposed a model integrating eLearning with PBL (PBeL) to engage the students in effective learning in blended learning environment and life-long learning. It also supports the instructors in teaching of programming languages with reduced workload in PBL environment. We have implemented the model initially for learning and teaching of Hyper Text Markup Language (HTML) in higher secondary level ICT course under the education board of Bangladesh. A problem-bank has been developed as per PBeL model that support life-long learning of the students.

We have applied the system for both synchronous blended learning and asynchronous learning and found very satisfactory result in teaching and learning. The result shows the positive impact to apply the model for other programming languages.

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.

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