STUDENTS' PERCEPTIONS OF PROBLEM-BASED LEARNING SUPPORTED BY A WEB-BASED SYSTEM

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ABSTRACT

This paper reports students' perceptions towards learning Systems Analysis through problem-based learning (PBL) with a Web-based system in the fall of 1999. Problem-based learning is a promising recent development in tertiary education that uses problem cases to enable students to acquire critical thinking and problem-solving skills. This learning approach promotes student-centred and collaborative learning. A Web-based system has been developed with the functionality to support the various stages of the problem-based learning /teaching strategy. The technological support assists collaborative learning through the sharing of resources, and to enhance the communication of students. The questionnaire survey feedback of 53 students yielded some interesting results. This paper presents the students' perceptions of the PBL approach to learning, including the time spent in the PBL processes, the problems that they encountered in the PBL processes, and their comments on PBL.

INTRODUCTION

The author has taught the subject Information Systems Analysis for a number of years. It has been observed that students in the past did not prepare or read sufficiently. The majority of our undergraduate students do not have work experience and therefore are not easy to teach. The PBL approach was introduced for the first time to teach Information Systems Analysis to the year-2 students in the Higher Diploma in Information Systems programme. It was the only subject in the programme that used the PBL approach, and students had not had exposure to PBL experience before. However, it was envisaged that students would learn better with the PBL approach, which enables them to engage in collaborative learning.

Problem-based learning is a recent promising development in tertiary education that provides students with problem solving, self-directed learning and collaborative learning skills. The amount of direct instruction is reduced in problem-based learning as students assume greater responsibility for their own learning, with the teacher taking the role of facilitator of learning [1,2]. Students normally work in teams. Students are given ill-structured problems through which they develop high-order thinking and problem-solving skills. The shift in the teaching and learning process is more student-centred than teacher-centred. The teacher as knowledge provider becomes less important as students learn from other students, the WWW, and from other information resources.

PBL has become an increasingly popular method of learning and teaching in many professional education areas such as medicine and law.

It has become increasingly popular for universities to use the World Wide Web (WWW) in direct support of teaching and learning [3,4]. The use of the Web as a teaching resource can benefit students [5,6]. Students can learn better when the pedagogical process of PBL is supported by technology to foster teaching and learning. A Web-based system has been developed to support PBL. The technology provides facilities to both teacher and students to facilitate learning and teaching. These include easy downloading of teaching resources from the Web, a discussion area for brainstorming, a facility for project planning and monitoring, a private area for group discussion, a facility for the submission of individual and group work, and a posting area to display good work to motivate students. The teacher is able to monitor the progress of the students, and timely feedback can be given to them via the system. This paper reports the students' perceptions of learning effectiveness using the PBL approach, the problems that they encountered in the PBL processes, and their comments on PBL.

STUDENTS' PERCEPTIONS OF EFFECTIVE LEARNING USING THE PBL APPROACH

<u>Students' preparations for problem case</u>

A hybrid PBL approach was taken in which students receive two hours of lectures and a one hour tutorial per week for 14 weeks. They are given seven problem cases that are linked to the learning objectives of the subject. Both well-structured and ill-structured problems are used, as the well-structured problems tend to develop knowledge acquisition and train specific skills. Ill-structured problems can enable students to develop critical thinking, creativity and problem-solving skills. More importantly, they should be able to realise that a problem can be resolved using different perspectives. At the conclusion of each problem case, each project team is required to submit a report of not more than seven pages and a presentation file for the problem case using PowerPoint. Students are able to understand the collected information and have the skills to summarise a short and concise report. For the first and last problem case, each team is required to make a presentation of not more than 20 minutes.

Given a problem case, students need to identify the problems in the problem situation. They can document the important issues in the problem analysis area of the Web, to indicate what problems they need to solve. They need to identify the learning issues for problem-solving and the information that needs to be explored. A group project plan is to be formulated with the task sequence, task description, schedule and date of completion. This exercise enables students to learn some project management skills, in which a problem is decomposed into its components. The assignment of individuals to each of the tasks is determined by the team leader or the team members themselves to ensure that every member has an even share of the work. Later on, the project plan can be updated once the individual has completed the tasks. Such a simple tool permits students to learn project planning and controlling skills. More importantly, they need to train themselves to produce quality results on time, as the completion time of each task is marked. The teacher only intervenes when a team is found to be not working in harmony. Their work plan is put on the Web,

and the teacher can provide feedback via the Web or in tutorial sessions. Thus, students practise project management through planning and controlling by viewing all activities on the Web.

Self-directed learning

When students select sources of information, they use the WWW, which is an excellent tool for searching and offers access to quite a number of search engines. To ensure that students read and understand the newly acquired information that they locate from a number of sites, they are required to write up to a short paragraph or two in length, representing their summaries or impressions of the information presented at the site. This enables the students to understand the topic, to practice their writing skills, and also to reflect on the work done. The work of a student can be shared among the team members. When the work is to be submitted electronically, there is no constraint that it be submitted during office hours, and this provides more flexibility to students. Students in the process of the information search often encounter two problems. First, some initially do not know how to search for information on the Web. Second, they encounter an information overload problem. However, they have been reminded to select the relevant information rather than all the information. They should also learn how to make group decisions based on the information available. More importantly, they should acquire skills and knowledge in the use of the various WWW search engines and in employing efficient search strategies in information-seeking.

Collaborative learning

Small group discussions enable students to exchange experience through communication skills, and to learn the experience of other team members. This approach to learning facilitates the development of students' interpersonal communication and social skills. The Web offers opportunities for students to experience many aspects of social interaction when communicating with people [7]. It is common to find students who are shy and less out-spoken. Also, students reluctant to speak out have the opportunity to express their views and ideas in writing. These students generally benefit from group learning. It has also been found that some of these students possess leadership potential as they can make good plans and can organise team members to complete the project work. Teamwork experience can be developed in a small group of students. Table 1 shows the time spent, on average, by students on the PBL processes in a problem case.

Table 1
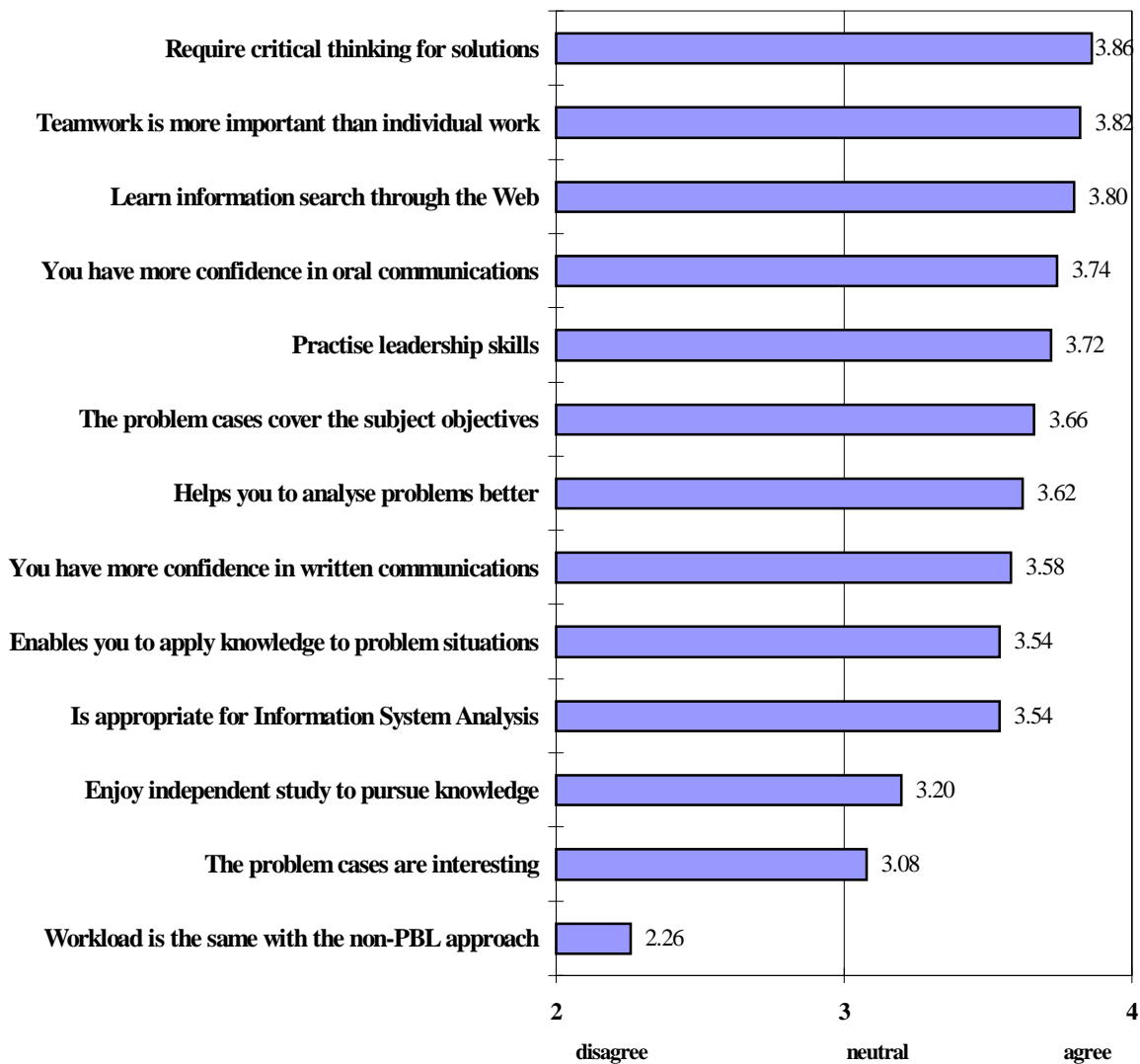**Time spent on the PBL process per problem case**

PBL processes	Hour	Mins
Understanding the issues in the problem case	2	19
Formulating a project plan with your team	2	31
Information search through the WWW	6	29
Information search through the library	3	5
Working individually (reading, thinking, writing, etc.)	7	14
Teamwork (discussion, report writing, etc.)	7	14
Total	28	52

This indicates that they tend to prefer using the WWW for their information search rather than using the resources in the library. Some students reported that they could search for information on the Web more systemically than before. They spent equal amounts of time working individually and in groups. The total number of hours per case was about 29 hours, which is longer than expected. Students tend to spend more time working on this subject.

Perception of PBL approach to learning & teaching

There are a number of tasks that students are required to undertake in using the PBL approach. They need to work individually and be compatible with their team members. Table 2 shows the students' perceptions of using the PBL approach to learning.

Table 2
Students' perceptions of effectiveness learning using the PBL approach

Statement	Value
Require critical thinking for solutions	3.86
Teamwork is more important than individual work	3.82
Learn information search through the Web	3.80
You have more confidence in oral communications	3.74
Practise leadership skills	3.72
The problem cases cover the subject objectives	3.66
Helps you to analyse problems better	3.62
You have more confidence in written communications	3.58
Enables you to apply knowledge to problem situations	3.54
Is appropriate for Information System Analysis	3.54
Enjoy independent study to pursue knowledge	3.20
The problem cases are interesting	3.08
Workload is the same with the non-PBL approach	2.26

2 — disagree   3 — neutral   4 — agree

The findings are that students perceive that problem cases require them to exercise critical thinking for solutions to the problems. This is due to the minimum number of hints given to them, which encourages critical thinking. Students, in general, may not appreciate this teaching approach. Without much assistance, they are encouraged to discuss their ideas/findings with their group members, and to come up with some solutions. Students often remark that the teacher provides no guidance in their work. This may have a negative impact on the teacher's performance evaluation. As such, the work of each group needs to be monitored and feedback given to them.

They value teamwork more than individual work for several reasons: the workload can become lighter as the entire project work is to be shared among team members; the results are better in a shorter period of time; they enjoy working with their friends and making new friends, and they value the importance of leadership to organise activities, to coordinate things and to solve problems. They realise that more up-to-date information can be obtained on the Web than from gathering information in the library despite the initial problems of information search with the WWW. They have more confidence in oral communications as they have been requested to prepare a presentation file using PowerPoint to support their report work. Their presentations have been videotaped for feedback and they have an opportunity to self-evaluate as well as receiving feedback from both the teacher and other students. They value the opportunity to practise their leadership skills as each student is expected to play a role as the leader, with the responsibility to manage the work of the team. However, they found the workload to be extremely heavy for several reasons: First, they had no experience of using PBL before. Second, they lacked teamwork experience. Third, they had problems in the information search initially – information overloading and also trying to search for all information on the Web, rather than just for the relevant information. Fourth, they lacked report-writing skills.

Assessment of students using the PBL approach

The assessment of students using the PBL approach is purely based on coursework, without examinations or tests. Each student is assessed by individual contribution, group work as a whole and peer evaluation by students themselves. The individual performance includes presentation, tutorial contribution, and individual work (quality of contribution in discussion via the Web and individual work submission). The group work includes the project plan, team report, presentation and teamwork. Individual and group marks are given equal weight. The peer evaluation is designed with the intention that every student contributes positively in a teamwork situation. Students evaluate their team members on both contribution and quality of work. The peer evaluation of students relies on the judgment and honesty of the students to make such evaluations. In general, students have been fair in their peer evaluation assessments, since the assessment of students is different from the traditional approach where examinations have been included. Without examination results for comparison, there is no evidence that students perform better using the PBL approach. However, students have been found to have improved in their learning activities, including reading, researching, and writing, were much higher than when traditional teaching was applied to the same course. The level of interaction among students was much higher, and this can been seen via the Web with their discussion records.

Students' comments on the PBL approach to learning

Students were invited to commend on the PBL approach to learning at the end of the semester. They made several comments. First, they suggested the number of problem cases should be reduced so that they can devote more time to do an even better job in each case. However, some students were also concerned about the coverage of the syllabus if fewer cases were to be given. Second, students remarked that PBL is a 'new and tough' approach, as final year students have heavy burdens in other subjects as well. However, it is a good approach for learning in the university environment, and it is very useful in some "descriptive subjects" such as Systems Analysis and Software Engineering. Third, The work schedule was tight as each case lasted for two weeks. The workload was heavy and the time spent was more than they expected. It was suggested to have more guidelines and information to be given for each problem case. Fourth, they appreciated the opportunity to do report writing and presentations, but they could fully utilize the information for which they had searched. Fifth, they learnt how to practise teamwork, which they perceive as important training for employment
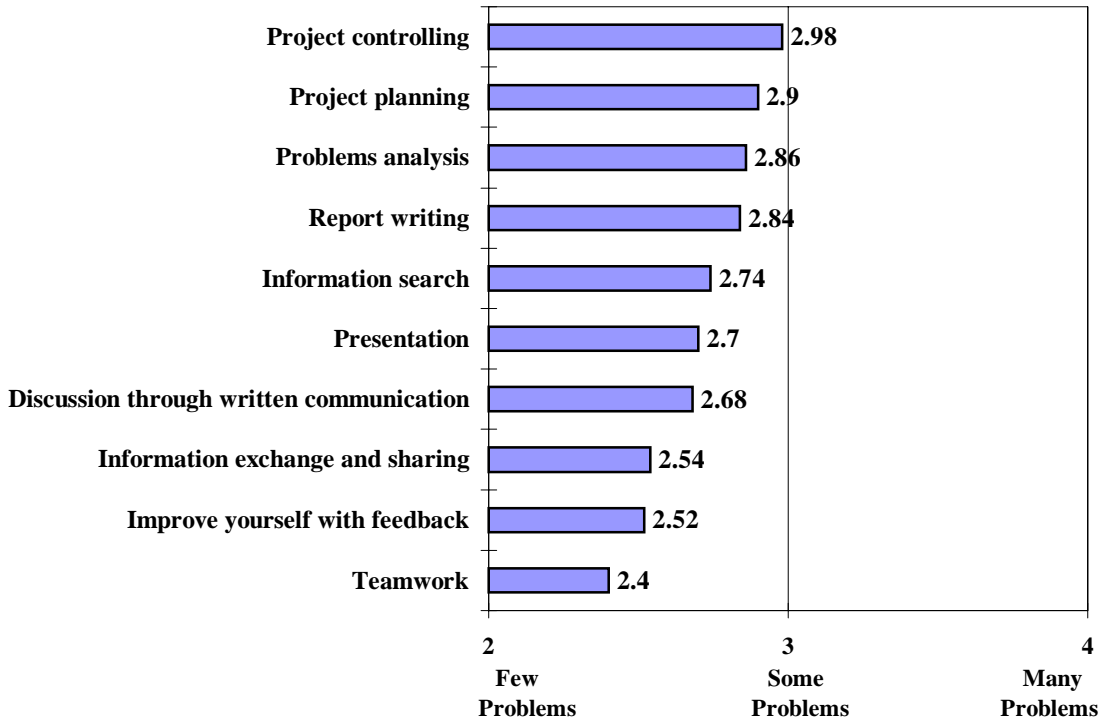
PROBLEMS ENCOUNTERED IN THE PBL PROCESSES

The problems that have been encountered by students provide useful feedback for future teaching strategy in adopting the PBL approach. Table 3 shows the problems in the PBL processes in descending order of significance. They rank project controlling, project planning and problem analysis as the most difficult PBL processes. They may have problems in project controlling for several reasons: students may have a lot of work to do in the final year of the programme; they have poor time management and do not know what the critical tasks are; they tend to spend more time on tasks that they like, e.g. learning web programming; some have part-time jobs which may prevent them from making a full contribution to their team, and some team members may not be cooperative in producing their work on time. Project planning is an important task in which students in general lack skill. Most have little concept of long-term and short-term planning. Thus, they require more practice before they can become proficient. Students have found problem analysis difficult, as they have intentionally been given ill-structured problems with little guidance, and they are not used to proposing possible solutions. Problem-solving requires an analytical mind and logical thinking. To alleviate this problem, students may need to be given more guidelines and also simpler problem cases to begin with.

Students reported teamwork, the ability to make improvements with feedback, and information exchange and sharing to be the least problematic areas. It is evident that they encountered very few problems in teamwork. This may be due to the way that the project teams were formed. Indeed, the formation of student teams has an impact on the learning outcomes. A class is divided into teams with six students per group. There are different ways of forming teams for students. First, the student teams can be formed based on the sequence number or name sequence in the class register. This results in all students within a group having the same last name. Second, the teams can be formed on a random basis. Third, students can self-select teams on their own. It is unlikely that students can choose their own team members in real-life working situations. Experience has shown that some members cannot form a team after several teams have been formed, and this has resulted in some bad feeling among the students when team formation is to be re-formulated. All these methods of team formation generally result in great variation of results, where some teams work successfully and others with disastrous results. The team formation strategy adapted was based on a

mixture of academic performance, gender and type of students (A-level or Technical Institution diploma graduates). It thus took several hours to fix the teams, but the result has been found to be quite successful as there has not been conflict reported except for with one student who has been suffering from mental illness. In mixed ability groups, the stronger students tend to encourage and motivate the weaker students to achieve better performance levels. At the same time, the stronger students can practise leadership skills and serve as consultants for their teammates. Another consideration is whether all of the team members live in the same vicinity so that team meetings can be arranged more easily. However, students should be adaptable to a new team situation, with people having different personalities and experiences. Teamwork can be enhanced with technological advances through better communication and electronic means of sharing information.

Table 3
Problems encountered in the PBL processes

Process	Value
Project controlling	2.98
Project planning	2.9
Problems analysis	2.86
Report writing	2.84
Information search	2.74
Presentation	2.7
Discussion through written communication	2.68
Information exchange and sharing	2.54
Improve yourself with feedback	2.52
Teamwork	2.4

2 — Few Problems   3 — Some Problems   4 — Many Problems

Students consider that their performance can be improved with feedback, and this is achieved through several mechanisms. First, the teacher makes use of the Web for timely feedback on their work, which is also monitored through the Web. Second, all of their presentations are videotaped for review and comments by the whole class. Third, their good work is posted on the Web so that their experience can be shared. Fourth, the teacher also provides them with feedback in tutorial sessions. The students' experiences and knowledge can be easily shared and exchanged with the facility provided by the Web, as each project team has a private area for teamwork development, and also the Web has the facility for on-line work submission.

STUDENTS' COMMENTS ON THE PBL PROCESSES

Students commented that the problems in the problem cases are difficult to identify. Sometimes, they misunderstood the problem and had to spend considerable time on discussion but were glad that team members could devote time to this activity. With ill-structured problem cases, they found the questions unclear and had difficulty in finding solutions in some areas. Some simple cases should be introduced first in the early stage. The Web has a large quantity of information, and they had the difficult task of selecting the right information, analysing and organising it. They spent considerable time studying the information on the Web, and only part of what they searched is included in the report. They found that 20 minutes was not sufficient for them to present all of the materials that they had prepared. In the teamwork situation, they sometimes had problems in reaching an agreement, as some of their team members were less cooperative.

CONCLUSION

This paper has described an approach to enhance the teaching of Information Systems Analysis to undergraduate students through PBL with the aid of technological advances. Students perceive that the PBL approach requires critical thinking for solutions. They realise that teamwork is more important than individual work in problem-solving. The Web has vast amounts of up-to-date information to assist them in learning. The workload using the PBL approach is much heavier than using the traditional way of teaching. The problems that they encountered are in the early stage of the PBL processes, including project controlling, project planning and problem analysis. They regard teamwork as the least problematic due to the team formation strategy of having students with mixed academic ability and mixed gender. They can improve themselves with timely feedback on their performance, and the use of the Web facilitates information exchange and sharing. Despite encountering some problems, students have remarked favourably on the use of PBL, mentioning: better problem analysis, understanding of how to formulate a project plan and subsequent control of their work, better written and oral communication, teamwork, practising leadership skills, and better information search via the Internet. They have been found to do more reading and engage themselves in problem-solving with problem cases. Although the effort required by the teacher is higher compared with traditional teaching, it is found that the learning and teaching experience is well worthwhile.

ACKNOWLEDGMENT

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