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Investigating ICT using problem-based learning in face-to-face and online learning environments

John Pearson *

Faculty of Education, The University of Hong Kong, Pokfulam Road, Hong Kong

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Abstract

This article reports on the design, implementation and evaluation of a module in the MED (Business) in the Faculty of Education at the University of Hong Kong in which an explicit problem-based learning (PBL) approach was used to investigate the challenges associated with the adoption and use of information and communication technologies (ICT) in Hong Kong secondary school classrooms. PBL influenced both the way the curriculum was developed and the process by which students ($n = 18$) investigated topics related to the integration of ICT in business studies classrooms. The evaluation was based on five evaluative questions dealing with the implementation of PBL, the extent to which PBL facilitated academic discourse, the extent of 'new' knowledge about ICT that had been created, the role of the tutor, and the online learning environment provided. The evaluation revealed that PBL provided a practical approach to investigating ICT in both face-to-face and online learning environments, leading to 'new' knowledge about challenges associated with the adoption and use of new technologies in various educational settings.

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* Tel.: +852 2859 2415; fax: +852 2858 5649.

E-mail address: jpearson@hkucc.hku.hk.

1. Problem-based learning

In the last 20 years, there have been many accounts of the adoption of problem-based learning (PBL) in professional education and training (Chen, Cowdroy, Kingsland, & Ostwald, 1994; Conway, Fisher, Sheridan-Burns, & Ryan, 1997; Little, Ostwald, & Ryan, 1995; Marsh, 1999; McPhee, 2002; Ostwald & Kingsland, 1994; Stokes, 2001). While different ‘models’ have been used, the basic premise is that PBL is ‘a way of constructing and teaching courses using problems as the stimulus and focus for student activity’ (Boud & Feletti, 1991, p. 14). When investigating ‘real-life’ problems, students work co-operatively in a small group, usually with the assistance of a tutor and with access to other resources to: (a) clarify the problem; (b) identify learning needs to address the problem; (c) undertake individual reading/study; and, (d) apply newly acquired insights and understandings to re-address the problem. The aim is that students acquire ‘knowledge and skills through a staged sequence of problems presented in context’ (Boud & Feletti, 1991, p. 14).

Interest in this approach to learning has been maintained because fundamental ideas underlying PBL have related directly to constructivist ideas about teaching and learning, and to ongoing debate about the nature of professional practice. By framing courses around ‘real’ problems in the context of ‘real’ practice, PBL has presented a coherent and practical approach to learning which incorporates ‘active’ rather than ‘passive’ approaches to the development of critical thinking skills, experiential and social learning in the form of collaborative inquiry based on engaging with authentic problems, and more dynamic interactions between teachers and learners based on respect for students’ prior learning and experience (Hendry, Frommer, & Walker, 1999; McPhee, 2002). And, in conceptualising problems in terms of ‘real’ practice, PBL has also incorporated notions of ‘reflective practice’ and ‘life long learning’ into a coherent view of professional education and training for both novice and experienced practitioners.

While PBL has been widely adopted, there are relatively few published case studies of PBL in teacher education and, specifically about the use of PBL to investigate the challenges associated with the integration of new technology in schools. In the studies identified, the adoption of PBL in specific modules (subjects) in educational psychology, science education and social studies education in initial (pre-service) primary and secondary teacher education programmes (courses) has been considered to be successful (Casey & Howson, 1993; Gibson, 2002; McPhee, 2002; Murray-Harvey & Slee, 2000; Steinkuehler, Derry, Hmelo-Silver, & DelMarcelle; Pearson, Kwan, & Wong, 2003; Peterson, 1993, 1997; Peterson & Treagust, 1997), although caveats about the difficulties of writing educational problems, the need for tutors in teacher education programmes to model interactive approaches, and issues to do with assessment in collaborative learning settings have been noted.

PBL has also been used in modules in teacher education programmes which focus on ICT in schools. At the University of Southern Queensland, an interactive multimedia package based on PBL principles was developed to assist pre-service teachers investigate problems related to the integration of technology into teaching (Albion & Gibson, 2000; Gibson & Albion, 1997). Students were reported to be ‘strongly positive’ about the software, and reported that they ‘had gained fresh insights into aspects of teaching referenced in the materials they had used’ (Albion & Gibson, 2000, p. 323). Multimedia resources (video and audio), print-based materials and on-line discussion forums have also been used at the University of Melbourne in several modules in the initial teacher education programme dealing with the integration of new technology in

1815 primary school classrooms (Chambers, 2002; Chambers & Boyle, 2001). Students' evaluations were reported to be 'very positive' regarding the 'problem based nature of the course'.

This article is a contribution to the limited case study literature about the use of PBL in the professional education of teachers in the context of a graduate studies module about the integration of ICT in teaching/learning activities in Hong Kong schools. The design and implementation of the module is briefly described, and data about students in the module are presented. In the final section, the efficacy of using PBL as a strategy to investigate issues associated with the integration of ICT in schools is briefly discussed.

2. ICT in Hong kong schools

In relation to the content of the module, it was decided (by the author, who was responsible for designing, teaching and assessing this module) that an attempt should be made to problematise ICT and the ways in which it was currently used in many Hong Kong secondary schools. The reasons for doing so are now briefly described.

In 1998, a *Five Year Strategy* (Education & Manpower Bureau, 1998) outlined new initiatives for information technology in education (ITE) in Hong Kong schools. Substantial amounts of money were allocated for infrastructure, equipment and training. The *Five Year Strategy* also presented a 'vision' for ITE which involved a 'paradigm shift' in schools – teaching/learning activities were expected to change 'from a largely textbook-based teacher-centred approach to a more interactive and learner-centred approach'. It was also thought that new technology could play 'a catalyst role in the transformation of school education', helping to turn 'schools into dynamic and innovative learning institutions where students can become motivated, inquisitive and creative learners' (Education & Manpower Bureau, 1998, p. 1).

Other reports on education by the Education Commission (2000) and the Curriculum Development Council (2000), as well as a number of curriculum guidelines also emphasised changes in curriculum and pedagogy. The Education Commission report (pp. 60–62) recommended 'a new culture of learning and teaching' in schools including inter alia shifting from the 'transmission of knowledge to learning how to learn'; from 'compartmentalised subjects to integrated learning'; from 'textbooks to diversified learning to teaching materials'; and from 'traditional time-tabling to an integrated and flexible arrangement of learning time'. A Curriculum Development Council report, which advocated school-based curriculum development based around eight key learning areas, also promoted changes in the 'culture of teaching and learning' by 'infusing generic skills' such as information technology in teaching and learning activities (Curriculum Development Council, 2000, p. 28).

These reports have provided a comprehensive policy framework for curriculum reforms and the ways in which ICT might be used to support learning activities in Hong Kong schools (Pearson, 2001). Some schools have accepted the challenges involved in integrating ICT in teaching/learning activities (Law et al., 2000). However, there has not been widespread adoption of the proposals presented in the *Five Year Strategy* (CITE, 2001; Coniam, 2002). There are many reasons, including the difficulties imposed by building designs (multi-story buildings and small classrooms), the general conditions of teachers (large classes, heavy teaching loads), and the expectations held by teachers, students and parents about the need to 'cover the content' if students are to be prepared

for examinations designed to assess knowledge of content (Dimmock, 2000). In secondary school classrooms, the dominant use of ICT has been the display of PowerPoint presentations (Ki, 2000; Pearson, 2003; Yuen & Lee, 2000), an attempt to ‘technologize’ (CITE, 2001, p. ii) existing ‘transmission of content’ methods of teaching rather than fundamentally change teaching/learning approaches along the lines envisaged in the *Five Year Strategy* and other curriculum reform documents.

There are no ‘easy answers’ to the challenges associated with using ICT in many secondary school classrooms in Hong Kong. The aims of using ICT, and why these have been selected, need to be examined critically so that the implications for teaching, learning, content and assessment can be clarified and ideas about new directions in which to proceed can be elaborated. At the same time, many practical matters associated with the management of ICT resources have to be considered. Given these challenges, it was considered that the adoption of an explicit PBL pedagogy would be an appropriate way in which students could critically examine recent policy initiatives in ICT (and curriculum reforms outlined in other policy documents) and, at the same time grapple with the difficulties which often arise when attempts are made to translate new initiatives into practice in the school setting. Presenting the mature age teachers enrolled in this MEd module with an opportunity to discuss ICT in a structured way also raised the possibility that new knowledge/insights about using ICT in schools might be generated which was considered to be less likely to occur when only a tutor’s perspective was under consideration and evaluation. Hence, the module was designed around genuine problems in an attempt to create ‘new’ knowledge about ICT in the business curriculum.

3. Design of the module

Many models of PBL appear in the literature (Barrows & Tamblyn, 1980; Boud & Feletti, 1991; Charlin, Mann & Hansen, 1998; Hendry et al., 1999; Margetson, 1998). However, the following definition encapsulated two key ideas that influenced the curriculum design of the module.

PBL is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem-solving proficiency, self-directed learning strategies and team participation skills. The process replicates the commonly used systemic approaches to resolving problems or meeting challenges that are encountered in life and career. (attributed to Barrows & Kelson in Ayres, 2002, p. 20)

The design and implementation of the model was an adaptation of other models – presented by the Faculty of Medicine at the University of Lindberg (nd) and Ayres (2002) – that had been used successfully in another programme with a group of mature age students in the preceding semester (Pearson et al., 2003). Eight steps for students to follow were identified (Table 1).

Based on these ideas about PBL as curriculum and process, a number of objectives relating to the content of the module were developed. These focused on the: (a) aims and rationale(s) for using ICT in secondary schools; (b) the use of ICT to enhance learning activities in business classes; and (c) practical issues to do with access to and management of ICT resources. Other

Table 1
Model of PBL adopted

1	Clarify terms in the problem
2	Define the problem to seek initial understanding
3	Analyse the problem – give possible explanations to reveal prior knowledge
4	Summarize the major points of problem analysis
5	Formulate learning objectives for the problem in the form of issues or questions
6	Independent research based on Step 5
7	Group discussion
8	Group presentations

objectives about problem-based learning and computer-mediated communication were also developed.

These objectives were then used to develop the case study that students would investigate. This case study described the ICT resources and personal skills of teachers, the ways in which ICT was currently used, and the impediments that might impact on the wider adoption of ICT in classroom learning activities in a typical government secondary school in Hong Kong. The case study presented a scenario in which the head of the business panel encouraged teachers to do more to support student learning activities with ICT by investigating and discussing three topics ('problems') based on the objectives developed for the module. The development of one topic over a period of three weeks, and the activities students were asked to complete during this time are shown in Table 2.

Table 2
Development of a problem

Week 5 (1.5 hours)	<p>Topic 2: Ways of using ICT to enhance learning activities in business classes</p> <ul style="list-style-type: none"> ● Identification of issues to be investigated ● Clarification of concepts/terms ● Tentative plan of structure and content of group presentation ● Allocate responsibilities for research on topic ● Allocate responsibilities for final report <p>Following this session, participants will commence research on aspects of the topic they have selected</p>
Week 6 (1.5 hours)	<ul style="list-style-type: none"> ● Continuation of research on components of topic ● Contribute findings to online forums ● Respond to requests for advice/assistance in online forums ● Prepare group report <p>Participants are expected to have developed their group presentation by the time of the next f2f meeting</p>
Week 7 (1.5 hours)	<ul style="list-style-type: none"> ● Presentation of group reports ● Discussion of findings and issues arising in group reports ● Post group reports in online forum <p>A few days after this session, participants are expected to write a short reflective statement and upload this (anonymously if they wish) to the relevant online forum</p>

4. Implementation

The two-year part time MEd (Business) programme consists of 11 coursework modules and a dissertation (five modules equivalent). The module titled *eLearning in the Business Classroom* consisted of 15 contact hours and was scheduled in the first year of the programme. The students ($n = 18$) undertaking the programme were teachers in secondary schools ($n = 13$) or with the Vocational Training Council. Most ($n = 13$) had 5–10 years teaching experience (range 1–20 years). All had enrolled in the programme to increase knowledge of curriculum and improve teaching skills in business education, with several also hopeful that attainment of the degree would improve job security. Only three students had previous experience with case studies in their undergraduate degree. Only one student had previously participated in online discussions.

On-campus classes were initially held on one evening each week. In the first class, students were given an outline of the module, and watched a video recording (University of Limburg, nd) of one way in which PBL can be used to investigate a problem. They were also given a transcript of the narration from this video, and suggested readings about PBL for private study and online discussion.

The planned implementation of the eight steps in the PBL model for each topic (problem) in the PBL model adopted are shown in Table 3.

At the beginning of the module, students self-selected into three groups. For each topic, students were asked to nominate a leader (to ensure investigations kept on task and on time), a recorder (to summarise and record discussions) and presenters (to prepare face-to-face and online presentations). With the onset of Sars (severe acute respiratory syndrome) and the suspension of on-campus classes immediately following the presentations for Topic 2, students were advised to use the same model, and adopt the same roles and responsibilities to complete Topic 3 totally online.

There were no tutor-led activities (such as lectures or group discussions) about the content of the module. For each problem, students were referred to the case study, given printed copies of required readings, and suggestions for further reading about the topic. Students were expected to investigate the content of the module by examining the case study (as three topics) in on-campus classes and online discussion forums. The role of the tutor – in class and online – revolved around the clarification of terms/concepts, assistance with additional resources requested by particular groups and, most importantly, the facilitation of group investigations/discussions when help of this kind was needed, rather than tutor-led discussions about the case study or the provision of additional content about the ways in which ICT might be used in schools. The adoption of the role of facilitator – rather than content provider and/or class manager – is consistent with the

Table 3
Implementation of a PBL topic (Topics 1 and 2)

Steps	Class time (hours)	Online	Learning activities
Steps 1–5	1.5	–	Clarification of the problem
Step 6	–	?	Self-directed research with reference to the issues/questions identified in Step 5
Step 7	1.5	? hours	Group discussion of the topic and preparation for group presentation
Step 8	1.5	–	Group presentation/discussion

literature about the role of tutors in a PBL strategy (Charlin et al., 1998). Additional comments about the role of the tutor are included later in this article.

5. Evaluative questions (EQ) investigated

Since an explicit PBL strategy had been adopted in the design of the module, it was decided to evaluate the extent to which the adoption of PBL as ‘curriculum’ and ‘process’ had been implemented successfully. Four evaluative questions (EQs) were initially framed to guide this evaluation.

EQ1: *Was an explicit PBL strategy followed – in face-to-face (Topic 2) and online discussions (Topic 3) – when topics (problems) were investigated?*

The question was initially posed to focus on the adoption of PBL in face-to-face classes, and then extended to online discussions following the decision to investigate Topic 3 totally online following the suspension of classes due to Sars. The question was examined to determine the extent to which an explicit PBL strategy had actually been followed in face-to-face classes, and whether the same strategy was transferable to an online learning environment. If this was found to be the case, PBL could be added to the repertoire of activities (Paulsen, 1995) that might be used in online learning environments.

EQ2: *Did an academic discourse develop when topics (problems) were investigated?*

This question was designed to focus attention on the nature of the discussions in face-to-face and online activities. Were discussions of an ‘academic’ nature – did students support answers with arguments, add new dimensions/questions, and provide/seek clarification (Jones, Scanlon, & Blake, 2000) – and focus on important issues associated with the case study presented? The question was also designed to focus attention on collaboration – an essential feature of ‘academic discourse’ and, hence a necessary component of a PBL strategy.

EQ3: *Was ‘new’ knowledge created about problems associated with the adoption and use of ICT?*

This question was developed to focus attention on ‘what’ was learned. Was ‘new’ knowledge – such as the clarification of current policies and practices, and the development of well-supported practical solutions to perceived problems – an outcome of students’ discussions about each topic (problem)? It was considered to be important to address this question to ensure that content acquired was significant and relevant, and that the processes by which that knowledge had been acquired was not the only thing which was considered important in the adoption of a PBL strategy.

EQ4: *Did the role adopted by the tutor facilitate the process by which topics (problems) were investigated and the knowledge outcomes reached?*

As a strategy to foster self-directed student learning, PBL requires specific behaviours from tutors in relation to the nature and timing of interventions on group-based learning activities. Tutors must adopt a position on the margin of the group(s) as problems are investigated, yet intervene decisively as needed when problems have not been appropriately addressed and procedures need to be clarified. The extent to which the tutor could accomplish these roles when the face-to-face discussions in three groups could not be constantly monitored added to the importance of investigating this question. When students worked online (Topic 3), it was also considered to be important to further consider the tutor’s role in providing guidance and support for learning activities in what was a novel situation to adopt a PBL approach.

A fifth evaluative question was added following the suspension of classes due to Sars and the decision to investigate Topic 3 totally online.

EQ5: *Did the online learning environment match the learning preferences of students?*

In Topics 1 and 2, online discussions had only been used as an adjunct to face-to-face classes each week (Table 1). The decision (by the tutor) to use online discussions to investigate Topic 3 meant that one-third of the module would involve working totally online. Hence, it was decided that student’s preferences for a mode of learning that differed from previous practice in this, and other modules in the programme, should be investigated more fully.

6. Data collection and analysis

A variety of data were collected to evaluate the use of PBL on this MEd module (see Table 4).

While the intention had been to video record discussions of one group per topic, technical problems with the video recording, and the suspension of classes due to Sars meant that discussions (two sessions in Topic 2) for only one group (*n* = 6) were available for analysis.

The analysis of face-to-face and online discussions was based on a close reading of the transcripts in terms of the evaluative questions (EQ1–EQ4) that had been framed to guide the evaluation. This enabled campus-based and online discussions and events to be interpreted in light of the ideas about ‘curriculum’ and ‘process’ that had been influential in the design of the module.

7. Results

EQ1: *Was an explicit PBL strategy followed – in face-to-face (Topic 2) and online discussions (Topic 3) – when topics (problems) were investigated?*

An analysis (Table 5) of the transcripts of face-to-face discussions for one group (Topic 2, Weeks 1 and 2) revealed that this group followed closely the suggested ‘model’ (Tables 2 and 3) introduced at the beginning of the module. This is evident in comments at various times during the discussion:

(Leader) I think, first of all we have to define several terms

Table 4
Data collected in relation to evaluative questions (EQs)

Data sources	Evaluative questions (EQs) investigated				
	EQ1	EQ2	EQ3	EQ4	EQ5
Videos & transcripts of f2f sessions	✓	✓	✓	✓	
Statistics on f2f discussions	✓				
Statistics on online discussions		✓		✓	
Transcripts of online discussions	✓	✓	✓	✓	
Students’ reflective statements	✓	✓	✓	✓	
Group presentations			✓		
Online Learning Environment Survey					✓

Table 5
Time spent in face-to-face sessions on each stage of PBL

Stage in PBL model (see Table 2) Session 1 (62 min)	Percentage of time
1. Clarification of terms	12
2. Definition of problem	6
3. Analysis of problem	30
4. Summary of problem	6
5. Formulation of objectives	8
6. Individual study	–
Session 2 (57 min)	
7.1 Report on self-directed research	47
7.2 Group discussion about content of final report	39
7.3 Further discussion of final report	14
8. Group presentations	Session 3

We have clarified all the terms;

OK. Let me summarise what we have discussed.

(Leader) I think in today's meeting we should let individual members report on what they have done in the last week.

The analysis also revealed that the suggested PBL model (Table 1) was followed sequentially – firstly, students clarified terms (Step 1), then defined the problem (Step 2), and then moved to other steps. Once they had moved to another step, they did not return to a previous step to re-examine issues discussed or decisions taken. The 'steps' provided the leader and other members of the group with specific guidance about how the investigation of a topic should proceed, and how discussions could be brought back 'on track' when comments were not relevant to the topic. Hence, PBL provided a practical strategy for participants to structure discussions in scheduled face-to-face sessions.

However, the adoption of PBL involves more than simply following a sequence of 'steps'. As a strategy for self-directed learning, PBL involves a willingness amongst participants to contribute ideas to discussions and work collaboratively to investigate problems. The extent to which this occurred can be revealed by quantifying the contributions of participants at each stage of the investigation of a topic. This showed that student contributions to discussions varied greatly, ranging from 36% to 6% (mean = 18.2; SD = 9.8) in session one, and from 29% to 6% (mean = 14.3; SD = 8.05) in session two. While these variations may be due to lack of familiarity with content discussed, they may also be due to: (a) confidence with English as a second language; (b) the assigned roles of leader and recorder/presenter; and (c) the lack of awareness by the leader of the need to encourage all group members to contribute. While the differences in participation did not appear to impact on the outcomes of the group on these occasions, their existence suggests that there is a need to outline the expectations of leaders rather than assume – as in this case – that leaders have sufficient knowledge and experience to manage groups efficiently.

An analysis was also completed of the online discussion to examine the extent to which participants contributed messages and worked collaboratively to investigate Topic 3. This was done by compiling a ‘message map’ (Levin, Kim, & Riel, 1990) to show the linkages between messages at each stage of the discussion (Table 6). The number of messages, and the number and percentage of words contributed by each participant were also calculated.

The ‘message map’ (Table 6) reveals many linkages between messages at various stages in the investigation of the topic, indicative of collaborative interaction between members of the group. Interestingly, a strictly linear sequence was not followed (as in the face-to-face discussion) with participants often referring to messages at previous steps as the investigation of the topic proceeded. This may have resulted because messages were always available and could be re-examined at any stage throughout the discussion. Variation is also evident (as in face-to-face discussions) in the extent to which members contributed to the online discussion, with assigned roles (Student F as leader, and Student E as recorder/presenter) again appearing to be influential in participation.

Tables 5 and 6 reveal that participants followed an explicit PBL strategy when investigating topics, following the steps in the model presented (Table 1) and working collaboratively (sharing ideas) when topics were investigated. Hence, PBL provided a practical strategy by which topics in the module could be examined in both face-to-face and online discussions.

EQ2: Did an academic discourse develop when topics (problems) were investigated?

The transcripts of face-to-face and online discussions, and students’ reflective statements written at the end of this topic, were analysed for examples of ‘academic discourse’ using criteria developed by Jones et al. (2000). Illustrative examples from face-to-face sessions were:

provides/seeks clarification

First of all we have to define several terms. (introductory remark by Leader)

adds new dimension/question

You can find some useful web sites as long as you use the Chinese version of the search engine.

draws on personal experience

When I gave them a project in commerce, they searched on their own, then simply used cut and paste to produce PowerPoint slides.

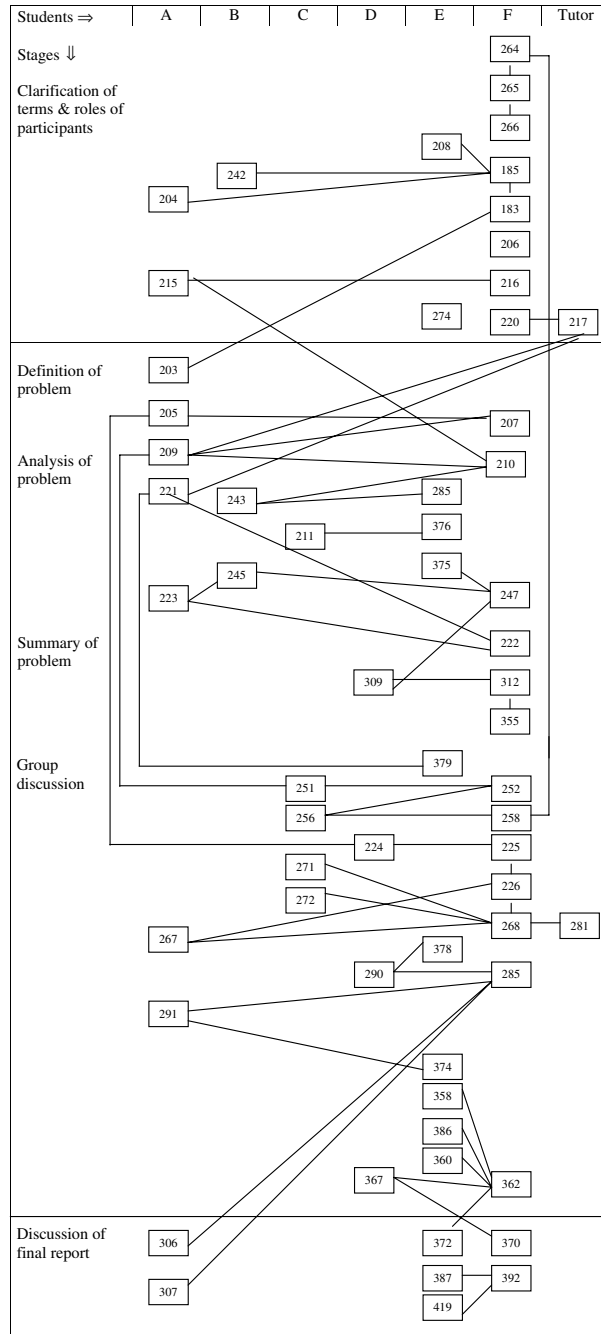
supports responses with references/readings

I visited the site of the Consumer Council and downloaded some pages about consumers’ rights and . . .

acknowledges others contributions

I think your ideas are very interesting, because we can see the differences in using ICT with different groups of students.

Table 6
Contributions of students and tutor to the online discussion



N of messages (62)	11	3	5	5	13	23	2
N of words (6207)	1404	325	1317	424	1081	1441	215
%	23	5	21	7	17	23	4

In the face-to-face discussions, these comments were typically short, made in the ‘flow’ of conversation. However, much of the ‘richness’ of ‘academic discourse’ is lost since large passages from transcripts of interactions between several participants cannot be quoted here. In contrast, online transcripts have more of a ‘standalone’ quality. For example:

provides/seeks clarification

I would like to answer your second question first. Our school does not have any computers that can be borrowed by students for ‘home use’ as we are not part of the Digital Bridge programme, but there are 10 laptops that can be borrowed by students for use on campus.

supports comments with argument/experience

In the IT policy proposed by government, it sets a standard for teachers to achieve at least 25% of class time in using ICT. In order to achieve this target, many teachers just use computers as an electronic blackboard (as Emily has mentioned). I think the criteria should also deal with the effectiveness of ICT to improve learning outcomes.

In these examples from online discussions, the additional time available to think about and compile responses may have contributed to more detailed responses than in face-to-face discussions where many comments had to be made on the spur of the moment.

The responses to two specific questions in the ‘reflective statements’ students were asked to complete at the end of each problem also contributed interesting data on ‘academic discourse’. Many students commented on the ‘active participation’ of others, and the ‘active sharing of ideas’ in group discussions.

We all did our job contributing views, reading and searching for materials within a limited time as part-time students and full-time teachers.

I really appreciated my team mates’ contributions to the forum especially on the last few days before the presentation. It was better for each of us to contribute a little rather than one person prepare the whole response. My peers have actively participated in the group discussions, evaluating alternatives and choosing the best solutions.

In this regard, the specific roles of ‘leader’, ‘recorder’, and ‘presenter’ assigned to members of the group facilitated ‘academic discourse’.

I logged into WebCT regularly and participated in group discussions trying to figure out suggestions to the questions. Also, Eva and I summed up all the points in the discussion and prepared the summary.

They were actively involved in the discussions in class and on WebCT. I appreciate that they finished things very efficiently and contributed some useful ideas to the group.

These data illustrate ‘academic discourse’ in both face-to-face and online discussions. In online discussions, responses were more detailed reflecting, perhaps, more time to research and think about responses than in the face-to-face discussions. The PBL model followed, and specific roles adopted also encouraged ‘academic’ behaviours like researching (reading), summarising, presenting and defending ideas in both face-to-face and online learning environments. The way in which

topics were examined (Table 2) provided a workable structure which facilitated ‘academic discourse’ as participants examined topics and compiled group presentations. PBL provided an effective strategy to promote ‘academic discourse’ about issues associated with the integration of ICT in the business curriculum

EQ3: *Was ‘new’ knowledge created about problems associated with the adoption and use of ICT?*

This question was examined using three sources of data: transcripts of face-to-face and online discussions, student’s reflective statements and group presentations. Identifying what was ‘new’ presented some difficulties since the prior understandings held by students was not known. However, ‘new’ knowledge about ICT was considered to be evident in relation to:

current policy on ICT

I have a deeper understanding of ITE policy in Hong Kong, the Five Year Strategy and the problems of using ITE in secondary schools. [reflective comment]

current practices in schools

After reading your message, I wonder why the MMLC [Multimedia Learning Centre] has become a language lab. Let’s see if other schools have this problem. [online discussion]

insights from theoretical perspectives

Thirdly, I’ve thought about constructivism; learning is dependent on the shared understandings learners negotiate with others and is dependent on the prior conceptions the learner brings to the experience. [reflective statement]

‘solutions’ to perceived problems

In Year 1 [in a Vocational Training College], students use mostly Word, Excel, PowerPoint and Access which creates no problems because every computer has these software installed. But, once they go into Year 2, they need more specialised software like databases, accounting software, Oracle, etc. These are very expensive . . . So, it is not only a matter of whether our students have a computer at home which I assume the majority have these days, but the availability of the software required in various subjects. [online discussion]

The PBL strategy adopted (Table 1) – which required students to clarify terms, define and analyse problems, read and discuss articles, summarise ideas, and present considered views to others – encouraged participants to adopt a ‘research’ focus to the material presented in the case study. Each topic in the case study became a ‘problem’ to investigate which, given the absence of any readily available ‘solutions’, could only be dealt with by considering ‘original’ insights and ‘solutions’. Hence, the strategy was instrumental in helping students acquire critical knowledge about the use of ICT in the business curriculum.

EQ4: *Did the role adopted by the tutor facilitate the process by which topics (problems) were investigated and the knowledge outcomes reached?*

In this module, the tutor’s time was divided between three face-to-face groups (Topics 1 and 2) and three online discussion groups (Topic 3). Hence, the time available to contribute to discussions, especially in face-to-face classes, was limited. In the *first face-to-face session*, the tutor intervened on five occasions with comments on: (a) designing learning activities involving ICT; (b)

clarifying the focus of the topic; (c) the role of the teacher in learning activities; (d) PBL strategy; and (e) a minor clarification regarding procedure. These comments amounted to 10% of total contributions of all participants in this session. In the *second face-to-face session*, the tutor commented on: (a) use of the Web in learning activities; and (b) advice on how to further investigate a topic. These amounted to 14% of all comments in this session.

In the *online discussion*, the tutor made two contributions (4% of all messages) dealing with: (a) an explanation of a term in one of the set readings and (b) clarifying the focus of the topic.

After reading and reflecting on the transcripts, these interventions were considered to be consistent with the role of the tutor outlined earlier in this article. Importantly, they were also considered to be appropriate by students who supported – in reflective comments – the idea of the tutor as ‘facilitator’, someone who ‘observed, listened and questioned’, ‘clarified concepts’, ‘clarified what we needed to do’, and ‘helped us to focus on important issues in the topic’. These comments indicate that students believe that a tutor needs to be supportive – rather than prominent – in group discussions, and that they can make key contributions that facilitate group outcomes.

A fifth evaluative question was added following the decision (as a result of class suspension due to Sars) to investigate Topic 3 totally online.

EQ5: *Did the online learning environment match the learning preferences of students?*

This question was investigated using the Online Learning Environment Survey (OLES), which has been designed to help educators assess e-learning environments (Trinidad, 2003; Trinidad, Aldridge, & Fraser, 2004). Items ($n = 67$) are grouped in nine categories (computer usage, teacher support, student interaction and collaboration, personal relevance, authentic learning, student autonomy, equity, enjoyment, accessibility and asynchronicity). For each item, respondents are asked to indicate – using ‘almost never’, ‘seldom’, ‘sometimes’, ‘often’, ‘almost always’ – the extent to which they perceive each practice actually occurred in online activities, and the extent to which they would have preferred each practice to occur. The software charts the ‘actual’ and ‘preferred’ responses. Students were asked to complete OLES four weeks after the presentation of group reports for Topic 3.

The responses ($n = 16$) of the students who completed OLES are shown in Fig. 1. The charts are very similar, indicating that the actual experience of students in this module closely matched their preferred learning environment. Using MANOVA for repeated measures, it was found that differences between actual and preferred scores on the nine OLES scales were not statistically significant ($p < 0.01$). Other studies have found that learners would prefer a learning environment more favourable than the one perceived as being present (Fraser, 1998, 2002) but in this case, the students’ actual and perceived environments were closely related showing student’s satisfaction with the learning environment experienced.

8. Concluding comments

In relation to the definition of PBL as ‘curriculum’ and ‘process’ which influenced the design and implementation of this module, and the questions (EQs) which shaped the evaluation of the work of one group of students, this module can be regarded as ‘successful’: an explicit PBL strategy was followed when topics were investigated; an academic discourse developed as these topics were analysed, researched and discussed; ‘new’ knowledge was evident in relation to issues, concerns and solutions about perceived ‘problems’; the role adopted by the tutor facilitated group

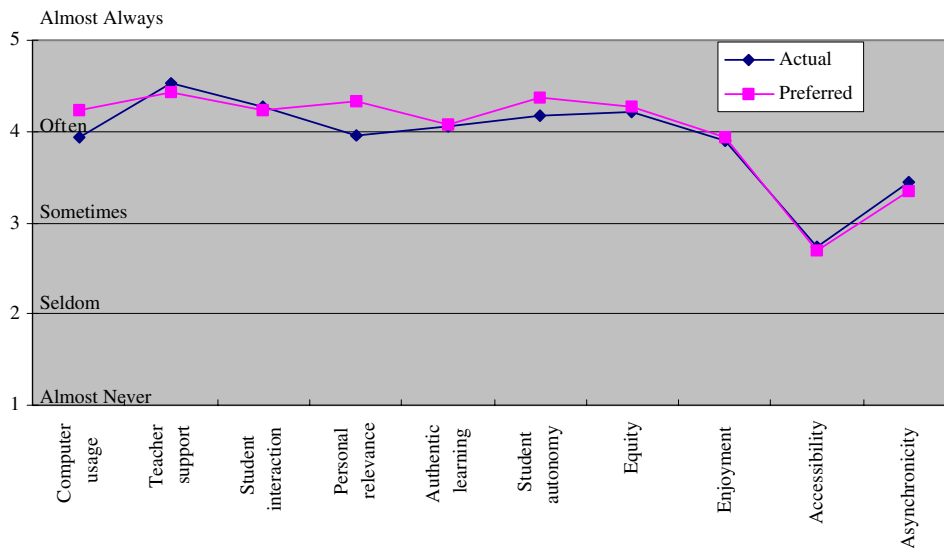


Fig. 1. Graphical representation of 'actual' and 'preferred' scores for students.

participation and outcomes; and the online learning context was consistent with features of students' 'preferred' learning environment. These outcomes indicate that PBL can be a viable strategy to investigate the challenges associated with the use of ICT in schools in both face-to-face and online learning situations in teacher education programmes.

An issue arising from this implementation of PBL concerns the origin of the problems which students investigated or, as Fenwick and Parsons (1998, p. 57) note, 'whose gaze has divined these problems and produced the cases?' In providing students with a detailed description about the school situation in which ICT was to be introduced, and the issues that were associated with doing so, an attempt was made to create a scenario in which students could *investigate* issues surrounding ICT in schools. However, the views attributed to the Head of Department in the case study – which represented the views of the tutor for the module – are prominent while other views about new technology, such as those of other teachers in the case study remain in the background. This tended to put students in the module in the role of 'problem solver' (how the Head of Department could get what she wanted) rather than 'problem investigator' (what views did teachers have about ICT and how could these impact on the adoption of new technology). On reflection, it was felt that other views should have been more prominent. As Fenwick and Parsons (1998, p. 11) note:

there may sometimes be pedagogical purposes best served through student analysis of pre-determined cases. But when descriptive situations are presented to students, they require a great deal of narrative and contextual detail, providing as many perspectives as possible. Rather than casting a student professional into the role of the omniscient solver in these cases, they might serve a better purpose as stories of how a particular person or group of people defined a situation and responded to it. Pre-service professionals could then spend time analysing how these problem cases selected for study have been constructed and what

assumptions about right practice and ways of viewing the world are embedded in their frameworks. Students can explore ways the problem-namer lives within the situation configured as problematic.

The challenge in introducing new technology in schools is to take account of all perspectives on the adoption and use of ICT. This needs to be recognised when PBL is adopted and ‘problems’ are written. If this is done, students will be better placed to recognise why the adoption of new technology in schools is so ‘patchy’, and why our agendas regarding ICT have proved to be so difficult to achieve.

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