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Harmonizing technology with interaction in blended problem-based learning

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ABSTRACT

This paper discusses the harmonizing role of technology and interaction in a qualitative study on blended problem-based learning within the context of academic development in higher education. Within this setting, and as both designers and tutors in blended PBL, it is important to seek best practices for how to combine instructional strategies in face-to-face and computer-mediated environments that take advantage of the strengths of each and avoid their weaknesses. A qualitative study of the lived experiences of 17 academic staff participants in a blended problem-based learning module was considered likely to provide a much-needed analysis of current thinking and practice on the potential of interaction in this form of professional academic development in higher education. Specific aspects of interaction (technical, peer, content and the learning experience) within blended problem-based learning tutorials are analysed to provide research-based information about the realities of delivering a PBL programme using technology. The study argues that the intersection of PBL and learning technologies can offer different ways of teaching and learning that require exploration and reflection of pedagogy and technology as in integrated approach that must work effectively together. The synergy from the collaborative blended PBL approach in this module could result in the coherent and comprehensive provision of training, support and research work throughout higher education institutions.

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1. Introduction

In higher education institutions (HEIs) in Ireland, as elsewhere, the use of online technologies has become an increasingly important challenge in academic staff development. As a field, e-learning has impacted on higher education in local, national and global contexts and is fast-changing, highly fragmented, but still rapidly growing. The Internet has made it impossible for HEIs to ignore technology in fulfilling their strategic mission and respond to the expectations of a diverse student body.

Informally, enthusiasm among academic staff for e-learning continues to grow and where explicit institutional policies are lacking, pressure on lecturers to engage with new technologies is coming from students and from their own peers. Alongside this, new pedagogical approaches emerge on the educational scene to support complex, flexible and integrated learning and the development of professional competencies. Although not new, problem-based learning (PBL) is one which appears to have captured the imagination and support of teachers; there has been a growing interest in the last few decades, particularly on the collaborative construction of knowledge through active learning and the importance of higher-order skills such as problem solving. Given our increasingly networked society, interest has grown in such new educational methods and in where and when to teach them. PBL is an educational strategy that involves the presentation of significant, complex and “real-world” problems to students that are structured in such a way that there is not one specific correct answer or predetermined outcome.

The promises of blended learning in the literature are extensive: increased learning, a reduction in the need for ‘brick and mortar’, increased engagement, collaboration and higher quality learning. However, there has been little examination or questioning of the interplay of new technologies and pedagogies in the context of higher education academic development. This qualitative study was designed to understand the complexities of delivering education in an age where information and communication technologies (ICTs) are constantly reshaping and redefining our accepted notions of what it means to teach and learn.

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2. Context

The institution in which the study took place is a large multi-campus, multi-discipline organization, with subjects offered within Applied Arts, Built Environment, Business, Engineering, Science and Tourism and Food. The current and emerging higher education environment in the Institute, as elsewhere, is seeking solutions to problems of changing paradigms of learning and the influx of learning technologies. The focus of the research reported here is a Postgraduate Diploma module in higher education learning and teaching entitled 'Designing eLearning' for academic staff. The programme was developed in 2001, and has over 100 graduates today. The 'Designing eLearning' module runs over a period of 10 weeks and carries 10 ECTS (European Credit Transfer and Accumulation System) credits.

It is suggested here that the need to encourage engagement amongst academic staff with regard to their e-learning and pedagogical professional development opportunities has never been greater. By so doing, participants would be enabled to experience, discuss and reflect on issues related to teaching and learning in a blended environment. This could thereby enable them to relate their understanding and practice to appropriate educational principles and key institutional policies. This study presents the opportunity to work with eager members of the teaching community in offering a novel approach to their academic development. As all participants on the module are self-selecting and choose to pursue this professional development opportunity themselves, arguably it is a situated reality that participants are motivated and keen to explore the blended PBL approach offered through the module.

The focus of the PBL approach was for each group of multidisciplinary participants to design an online or blended course of their own choosing. This problem they were to solve included stages of problem identification, deconstruction, seeking and using knowledge and experience, understanding, thinking, choosing a strategy, acting and then critically evaluating and reflecting on the action.

Whilst there is no specific recipe for mixing up the ingredients of the blend of problem-based learning adopted, with the amount of face-to-face, synchronous and self-directed work being prescribed by the learning outcomes of the module itself, Table 1 provides a breakdown of the ingredients in the blended PBL module and estimated time for completion of each activity.

3. Literature review

The role of blended learning within a pedagogical approach such as problem-based learning (PBL) has been gaining international recognition among practitioners and academic educators alike. Research into the concepts, tools and methodologies of both e-learning and PBL have increased momentum in recent years. However, contemporary commentators have voiced concerns with the speed at which technology has been proceeding at the expense of pedagogical advances. Within the specific field of blended learning, Jones (2006) has concluded that the practice of blended learning has outpaced the research, due, in part, to the rapid increase in both the quantity in use and the sophistication of technology.

Issues related to the design and implementation of blended learning environments have increasingly surfaced in recent years, as technological advances continue to blur the lines between distributed learning and traditional campus-based learning. This has raised questions about advances in technology during that last decade that have brought challenges and opportunities to the ways in which individuals are educated and trained, in particular through online instruction. McConnell (2006, p. 25) suggests that a major motivating factor in the uptake of e-learning in organisations is "the professional development of trainers, course developers and teachers in the new form of learning provision". This echoes the sentiments of other researchers in the field (Segrave, Holt, & Farmer, 2005), and forms the core of many institutions' e-learning strategies.

Acknowledging that there is a growing research-base in the area (Donnelly, 2004; Koschmann, 2002; Uden, 2005), it is fair to say that less is still known about the use of PBL in the electronic-based distance-education "virtual classroom", or equally, as the focus of this study, in the increasingly popular "blended" classroom (Bonk & Graham, 2006). McShane (2006) has called for further research into academics' perceptions of what it is to teach in a student-centred manner in a blended environment. Similarly, Lycke, Strømsø, and Grøttum (2002) advocate in their ongoing project on PBL and ICTs in Norwegian higher education that up-close studies are needed to answer vital questions such as how academic teachers can promote effective e-learning strategies among their students.

There is a qualitative difference between 'teaching online' and merely 'putting a course online'; a central feature of academic staff development involves conveying the difference between using technology as a delivery mechanism and using it as a communications medium. The impetus for blended learning depends partly on a growing acceptance that higher educational and training programmes should be student-centred and partly on the need to develop enhanced efficiency in the provision of teaching.

This study is taking cognisance of the need for strong and effective interaction between pedagogy and technology to ensure that both are used to best effect in implementing PBL in a virtual environment. Gredler (2005) in his consideration of learning and instruction, suggests that the role of technology in learning remains an issue for theory development and research. Specifically, yet to be developed are learning principles that address teacher-student interactions, student-to-student communication and student-to-subject-matter interactions for various uses of computer technology. There seems to be much evidence in the literature that as Internet-based teaching and learning have proliferated, researchers, theoreticians and pedagogues have recognised that an educationally-viable environment requires students to interact with content and with each other.

Table 1
Activities in the blended PBL module.

Features of a blended PBL environment	Duration of activity
Face-to-face PBL tutorials	10 × 3 h
Between tutorials: researching, reading, planning, designing ideas	Over 10 weeks
Online reflective journal entries	1 per week × 10 weeks
Video conferencing session	3 × 1 h
Asynchronous discussions	5 per week × 10 weeks
Synchronous chat sessions	10 × 30–60 min
International guest tutor collaboration	3 × 1 week

Table 2
Blended learning interactions central to this study.

Variable	Attributes	Function	Contribution of my study: theory into practice
Interactions as transactions	Learner collaboration	Is the degree and quality of engagement with others	<ul style="list-style-type: none">– Creation and sharing of ideas– Critiquing ideas– Deciding and agreeing to collaborate on an issue
Interactions as outcomes	Interaction for participation	Provides learners with a means of engaging with one another	Articulating one's interest in assuming leadership responsibilities in a group
	Interaction for communication	Offers the ability to share information and opinions or to influence intentionally the opinions or beliefs of others	Teaching others in the group
	Interaction for negotiation	Involves the willingness of another individual to engage in a dialogue, come to consensus or agree to conform to terms of an agreement	<ul style="list-style-type: none">– Initiate dialogue with peers or the tutor– Dialogue on how they will agree on an issue
	Interaction for teambuilding	This is necessary to ensure that individual members of a team/group actively support the goals of the group	<ul style="list-style-type: none">– Recognition and acceptance of individual differences– Expression of respect for the group as well as for its members– Effective listening– Shared sense of responsibility– Confirmation of expectations within the group

The research surrounding this module is based on the hypothesis that interaction between participants in the PBL group is the key element to a successful blended learning experience for all involved. The hypothesis is based on a sociological understanding of one of the dimensions of interaction for describing groups, coined by Wagner (2006) as 'interactions as transactions'.

Interaction has been and continues to be one of the most hotly debated constructs in the realms of distance and e-learning, instructional design and academic transformation to name but three. For the purposes of this study, interactions are defined as reciprocal events that require at least two objects and two actions. Interactions occur when the objects and events mutually influence one another. A number of schools of thought have emerged in the last two decades that explore interaction in the context of technology-mediated learning. Wagner (2005) contends that there are two commonly held beliefs. Firstly that the perceived quality of a learning experience is directly proportional to and positively correlated with the degree to which that experience is seen as interactive. Secondly, if technology-mediated learning designs are to have any significant impact on current and future pedagogical practices, then learning design decisions need to maximize the benefit of interaction.

The ability to interact – with tutors, students, content interfaces, features, code, channels and environments – can be argued to be analogous to being connected. Whilst this may appear simplistic, for technology-mediated learning, interaction is undoubtedly a key value proposition. It continues to be perceived as the defining attribute for quality and value in a blended learning experience. Interactivity is the core of learning, and is evident at all levels of engagement. However, the term *interactivity* is used so loosely that in the fields of e-learning and blended learning, it has become almost synonymous with the notion of learning itself. This study proposes that by bringing the concept into sharper focus, real insight will be gained into the nature of blended PBL. Interaction in the context of this study will be explored at three levels: interaction with concepts, tasks and people (peer learners and tutors). These three levels have been previously represented in a popular framework for interactive learning by Mayes and Fowler (1999). However, it is suggested that a case can be made for proposing a new dimension of interaction that focuses on the blended PBL interaction activity experience. The decision for this was based upon recognition that blended PBL is a complex process of interaction between people, the tools they use and the context in which they are embedded.

Interaction in education is a complex phenomenon. The literature identifies several taxonomies that classify various types of online interactions; however, Moore's (1989) seems to be the most well known taxonomy in the field of online education where he described three types of interaction: *learner-content*, *learner-instructor*, and *learner-learner*, which were later extended by Hillman, Willis, and Gunawardena (1994) to include *learner-interface* interaction. Many other definitions of interaction exist (Carlson & Reepman, 1999; Hirumi, 2002; Merrill, Li, & Jones, 1990; Sims, 2003; Wagner, 1994; Weller, 1988; Yun, 2005) and all provide a variety of reasons why interactivity in an online course is important. Wagner (2006) has discussed the concept of interaction in relation to blended learning and it is considered that this adequately serves as a demonstration of the breadth and vitality of the field. He contends that interaction should be viewed less as a theoretical construct and more as a variable that needed to be exploited, accommodated, leveraged or managed when crafting blended learning designs. Interactions have been researched in terms of four dimensions: transactions (interpersonal, academic, collaborative), outcomes, social presence and experience.

Each of the four dimensions of interaction provide very different views on the value that interaction brings to a learning experience. They also share a number of similarities. Firstly, each perspective is shaped by some degree of technology-mediated learning and is looking for a way to transcend distance. Secondly, each assumes some degree of self-regulation and independence on the part of the learner. Thirdly, each acknowledges the value of facilitation by a tutor. In the context of this present study, this suggests that interaction strategies, regardless of their theoretical bases, can help improve the relevancy of blended PBL experiences for the participant. Table 2 depicts the variables of blended learning interactions which informed this study in terms of their attributes and function; they have been considered for the work as they are central to the social and communal constructivist approach adopted in the module.

4. Research study

This study recognises that there is still confusion about the models, media and environments used to support PBL that use technology in some way, and is particularly concerned with illuminating current knowledge on PBL group-oriented interaction. Central to this aim is the need for a better system for delivering education and training for academic staff which Hameed, Hameed, and Clements (2006) have recommended is paramount in the context of the move to a knowledge economy.

Table 3
Sample for the study.

Number	Attribute
17	Part-time postgraduate learners in total
9	Had completed a PBL module previously
5	Had prior experience of blended learning
8	Males
9	Females
15	Subject disciplines in higher education represented: Group 1 (Psychology, Social Science, Culinary Arts, Information Literacy, Adult Literacy); Group 2 (Biology, Apprentice Plumbing, Apprentice Joinery, Apprentice Metalwork, Adult Literacy); Group 3 (Architecture, Marketing, Culinary Arts, Refrigeration, Printing, Fine Art, Chemistry).

The objective for this study was to establish, in a tutorial setting, the factors that govern the success of interaction in blended problem-based learning; As the affordances of technology are not yet fully understood in the context of academic development, this in turn can limit how they may best be utilised within the PBL tutorial. Today, educators have more choice than ever when it comes to selecting types of interactions to include in their blended courses; unfortunately they often do not even know the potential of the tools that are available to them or how to use them effectively. To further confound the situation, the use of interactive technologies alone does not ensure meaningful interactions will occur in a blended course. All decisions regarding types of interaction in a blended course should be driven by pedagogical principles and grounded in research.

A naturalistic, interpretative, qualitative approach was used to analyse the data collected for this study. The open-ended, exploratory, qualitative approach taken in this present study can help document how learners in real PBL situations and contexts, addressing both broad themes and micro-issues helps us understand the complexity of learning and teaching in blended PBL environments and offers insights that can be useful in developing our practice as academic developers. As a research approach, it has presented a series of “slice-of-life” episodes during the blended PBL tutorial process and afterwards, revealing the range of applications and use of the knowledge in professional teaching practice.

The research methods employed to collect face-to-face and online observational data from three PBL groups in this two year study on a blended PBL module were participant observation, online discussion logs, open-ended focus group interview and self-reflective papers to capture the participant's own thoughts and experiences of the blended PBL approach. Each method was chosen for the opportunity it could offer to explore interactions which were central to this study.

The sample for this study was the total population (17 participants) of blended PBL groups undertaking the PBL module in the two years the data was collected in order to explore the lived experience of a heterogeneous population of academic staff in Irish higher education; there were three PBL groups in this study (See Table 3). In each focus group interview there were between five to seven individuals and each were held immediately after a face-to-face PBL tutorial session, in the same room where the observation video recording facilities were still in place. The immediacy of the focus group session was designed to keep the sense that the participants felt that they were in the PBL classroom rather than in a different research territory.

The participants named their own groups as part of an induction activity: Group 1: ‘The Apprentices’ [5 in the group]; Group 2: ‘CPD Challengers’ [5 in the group], and Group 3: ‘Cyber Club Seven’ [7 in the group].

The approach taken to the collection of data of blended PBL groups was multi-faceted. A main concern has been to provide meaningful and accessible insights into the practice of blended PBL based on the analysis of real-life situations. There were two levels taken to the analysis of the data. Level One was descriptive in nature and through video observations explored the interactions between the peers, the tutors and the content of the blended PBL tutorial. Level Two was a thematic analysis of interactions in blended PBL and through a combination of online logs, focus group interviews and participant self-reflective papers, categories and themes emerged to inform the findings of the study and implications for practice. Being engaged with the events as they happened in the field and attempting to bring holistic attention to the practices as constitutive of a distinct culture was important to this study. As suggested by Hine (2000, p. 20), this study has examined those enduring practices through which the blended PBL groups have become meaningful and perceptible to participants.

While the WebCT system which was used in the module technically organized the online environment of the PBL groups, actual interactions took place through the actions and reactions of the participants to the PBL learning setting, module materials and activities, to tutor and guest tutor directions and to peers' ideas and actions.

5. Discussion of findings

The use of direct quotes is used in this section to provide evidence of both the shared enthusiasm for the blended PBL process and also some real concerns voiced by the participants. Whenever possible by using the words of the participants themselves, key issues will be highlighted.

For inclusion of all participant quotes, the following applies:

FG = focus group interview (either indicated by 1 or 2 for the first or second interview)

RP = reflective paper (numbered 1–17 for each participant)

PO = participant observation (the date of each observation is provided)

F2F = face-to-face (abbreviation used in participant quotes)

Two main interlocking themes are apparent within interactions in the blended PBL tutorials: harmonization in blended PBL interactions and technology supporting interactions.

5.1. Harmonization in blended PBL interactions

Blended learning requires that students change learning environments frequently, which may cause confusion regarding the learning outcomes and make students unable to select and use appropriate cognitive activities. From a pedagogical perspective, it is important to be aware that teaching and learning in blended learning environments can be highly unstable and fluctuating and consideration of the relevance of continuity between the face-to-face and online environments is crucial. It is in this sense that 'harmonization' is used to bring together the online and f2f environments in a seamless manner for the PBL groups.

The nature of the blend involved the transition from the face-to-face PBL tutorial to online interaction. Blended learning within PBL cannot be regarded simply as a type of technology-intensive activity that replaces the functions of the classroom-based tutorial. Instead, those effectively incorporating blended learning must think about how it might enhance, extend or transform the face-to-face PBL tutorial experience, not simply replace it. Participants in each of the groups discussed this harmonization:

If we highlighted an issue or problem online then we sorted out some of our problems at the next f2f meeting.
(Michael, FG2)

The f2f elements were essential. I felt this blended approach with the online activities/ tasks, online reflection, video conferencing, people from abroad coming in – all was important. The blended approach visibly promoted collaboration and interaction in our group.
(Ronan, FG2)

The beauty of the mix between f2f and online is that you would never reach that on your own. Even in 10 weeks, you would never acquire that amount of knowledge as an individual in a lecture situation.
(Declan, FG2)

In the online environment learners need to get over the barrier of admitting they need help. I think where the strength of PBL comes into play is that the help can come freely from peers f2f too.
(Michael, FG2)

F2f was good for delegating and organizing, and the discussion forums were good for following that up and backing it up, as were the online chats as well.
(Ryan, FG2)

Building up a sense of community was an important aspect for each group. Results from a recent study by Dawson (2006) on online forum discussions reported that mere quantity of discussion postings is not an indicator of community development; a significant relationship is observed when contributions are codified into various discussion interaction types (learner–learner; learner–content). Earlier research by Harasim (1987) also endorsed the categorisation of forum interactions and suggested that these types of interactions were the most important for enhancing the learning process. Similarly in this study, the online discussion forums provided the participants with an opportunity to enhance community building in their PBL group and extend the collaborative dialogue from the face-to-face PBL tutorials.

Community building was judged to have been enhanced by utilising the variables identified earlier from the literature 'interaction for negotiation' and 'interaction for teambuilding'. These were evidenced in this study by examples of dialogue within each group on how they will agree on an issue, expressions of respect for the group as well as for its members, a shared sense of responsibility and confirmations of expectations within each group.

The shared sense of responsibility extended into recognition of the importance of critical discourse amongst peers. This was evidenced both by online postings seeking critique of each others' individual contributions in the PBL group and quotes from the focus group interviews and reflective papers. Critiquing ideas amongst the participants was an important feature of their group work.

Honesty has a lot to do with it. I had no problem saying, I do not understand this, have you any ideas, or if you want to change anything that I have put up on that posting, just change it, or what do other people think, will we just leave it out. I don't think anyone was precious about their own work.
(Lóirín, FG2)

In two of the three groups in the study, all members felt comfortable not to post online if they had nothing to say because they knew each other face-to-face first and that imbued a sense of respect for each other:

I think you also need to be able to say I can make a mistake without feeling stupid. Anyone can make a mistake. I love coming into the f2f class and Padraig saying he encountered the same online problem the night before, and I feel great, it's not just me, and being confident to admit that to one another.
(Lóirín, FG2)

People can read a posting and accept it yet do not feel like responding "that's great" at that time; it may have been a great contribution, but it is yet another message saying very little of depth but could be important for peer reassurance online.
(Maeve, FG2)

However, the participants' perception of how they were regarded by others and how others actually perceived them resulted in disengagement by some and online dominance by others. There was a case of conflicting social identities between for example, Declan and Ryan in Group 3.

I was concerned that I may have been perceived as pushing ahead too fast for some others in the group at one stage; so it was really a concern about how I was being perceived online as opposed to my f2f persona, and wondering how the others were going to react.

(Ryan, Participant Verification Session, 05/02/07)

Articulateness and ability to synthesise information online was generally not as forthcoming as the literature on e-learning would suggest. The difference in expressiveness of ideas online in this study contrasts with the research by Ranno, Diers, & Birk, 2005 who found that students in their blended course reported positive benefits of online discussion in terms of coherence of discussion reached compared to the face-to-face setting. Similarly, in a study based on a technology course for teacher development, Yeotis (2005) reported that each time participants contributed to the online discussion their responses showed a more fluent understanding of the content area.

According to Vygotsky's social development theory, learning does not happen in isolation. A number of respected scholars including Ramsden (1988), Garrison (1990), Entwistle and Entwistle (1991) and Wagner (1994) have reported that increased levels of interaction have been shown to increase motivation, positive attitudes toward learning, higher satisfaction with instruction, deeper, more meaningful learning and higher achievement. Owsten et al. (2006) believe "sustained interaction between and amongst tutor and students leading to knowledge construction and validation requires an opportunity to share and test ideas in a secure environment and with a manageable number of students" (p. 339). ICTs used in this study have both the capability of supporting and enhancing this engagement and the capacity to extend the learning experience to critically consider the technology itself and critically access and evaluate the wealth of information available in a virtual learning environment.

From a constructivist viewpoint, studies on web-based learning environments have shown that a critical component to interaction online is an interpersonal, social component; this occurs when learners receive feedback from the instructor or peers and colleagues in the form of personal encouragement and motivational assistance. Social interaction can contribute to learner satisfaction and frequency of interaction in an online learning environment. Indeed, Grabinger and Dunlap (2000) have reported that without the opportunity actively to interact and exchange ideas with each other and the instructor, learners' social as well as cognitive involvement in the learning environment is diminished.

However, the participant observation of the face-to-face PBL tutorial also suggested a degree of conflict between the theory and practice of blended interaction for those who felt that the blend of online and face-to-face PBL was not always in harmony:

I had an expectation that the f2f and online would almost go hand-in-hand and complement each other, and I feel it didn't. Even though I have been reading on this over the last couple of weeks, it now seems that the f2f and the online together can actually complicate things because the way we do things f2f and how we communicate is very different from how we communicate online, and it is very difficult to bring the two elements together.

(Sorcha, PO, 08/02/05)

This was also experienced in an online discussion board posting with the same PBL group where difficulty was identified in linking what is covered in the f2f PBL tutorial to asynchronous online discussions.

Message No. 1013 [Branch from No. 1010]

Posted by Eimear on Tuesday, January 25, 2005 9:23pm

Subject: Re: Linking the F2F Tutorial to our Online Groupwork

Just a quick word to Dervla and Caitlin – sorry you missed today's tutorial – hope everything is okay.

..... today in class was good but it is very difficult to convey here online what we covered. Much of it was subjective and there were many different opinions and 'piggy-backing' on each other's ideas. There is no way that I can capture the spontaneity of it for you here in this posting, which is very frustrating. I guess we could try an online chat but if you can't make that, I'll bring you up to speed at the start of next week's class.

We have three more Tuesday tutorials before the last class..... we left today with the sense that there is a lot of time left, although I personally think its going to be difficult to keep a balance between the f2f and on-line work. Looking forward to hearing from you both.

This triangulated with the data from the second focus group interview when a different participant from a different PBL group discussed their experience in relation to the synchronization between the f2f and online tutorials:

I think it is a weakness of eLearning that in many cases it relies on written communication because although people can misinterpret things in any form of communication, when you are online, it is much more complex and intricate to re-explain what I mean than what I can do in the f2f tutorial.

(Aine, FG2)

Tensions existed within the groups and these tensions and how they were resolved (or aggravated) provided continuous interactions and the development of new practices. Contradictions arose when new ways of thinking or doing came in conflict with traditional or currently accepted ways of thinking and doing and occurred within each of the participants and among activities, resulting in tensions within the system. There was only one case of an exaggerated contradiction where one group almost reached crisis proportions and it almost led to a breakdown of the PBL group itself.

Our group suffered severely for several weeks from misunderstandings and a complete disagreement on our concepts and ideas of how to move things forward; this was the storming phase, and when one of the others in the group highlighted in an online posting the tension that had developed in the face-to-face tutorial, well that really set me off.

(Sorcha, FG2)

Very often, in the course of everyday activities, tensions or breakdowns in the groupwork were negotiated and repaired to an extent, but not all tensions or contradictions were obvious to the participants engaged in the given activity. Furthermore, the participants in some of

the groups did not share consistent motivations or conceptions, despite their participation in the same activity. Tensions that occurred in the group learning setting led to a changing in the division of roles between the participants in the group:

There was a competition for ongoing control of the discussions which added to confusion in the disorganized periods. I felt I did not have a great influence on our group work f2f, because some of the others wanted to take the development of our work in a different direction from what was uniformly agreed; at times they seemed oblivious to the fact that they were blatantly doing this; but after each tutorial I waited to see what would pan out in the subsequent online discussions.

(Aidan, RP1)

However, on reflection, the tensions and contradictions provided opportunities for expansive learning on the part of the academic staff on the module. Within this study, the theory of interactivity was informative for exploring tensions in blended PBL as it goes beyond individual knowledge and decision making to take a developmental view of minds in context. As the participants in blended PBL worked, thought about and solved problems together they demonstrated an accumulated set of habits and values. Learning was not an isolated act; rather it was situated in time and space and influenced by the surrounding actors, resources and behavioural constraints. As agents in the learning process, through their activities, the participants influenced the contexts in which such learning took place.

To implement a blended PBL module as an effective form of interactional pedagogy, there are a number of conditions suggested for its effectiveness by this study:

- The selection of authentic tasks within the PBL problem (by the tutor or the learners themselves) which demand a division of labour between the face-to-face and the online environments;
- The maintenance of common goals and motivation;
- The mutual expectations of learners and tutors;
- The awareness of the individual role and group leadership, and changes in these;
- The availability of appropriate communication tools.

Blending f2f tutorials with online support involves exploring the distribution of workload between the two for each individual participant; it is important to be explicit about the nature of the work (for example, is there something that needs a full unpacking in the f2f tutorial or can time be saved by completing it in 10 min online?) Some individuals were unsure when to do work, online or face-to-face; the findings have indicated how the technology facilitated this distribution, and the extension of the f2f tutorial let the participants achieve a greater level of knowledge and skill that they would have had in just the 3 h classroom.

So I think that what you produce together in PBL and with the support of the technology is definitely a greater product than what you would produce individually. There are one or two individuals who could do the whole thing on their own but the end product would be very much a different thing.

(Lairin, FG2)

Collis, Bruijstens, and van der Veen (2003) found that mastering the coherent use of online components often require a large amount of self-discipline on the part of the learners. The online context may direct attention more towards mastering a new technological medium than on the content of the PBL problem at hand. Further research would enlighten the extent participants regulate their use of learning strategy in accordance with changes in task and context, when they are entering the online learning environment.

People use the word blended very easily, but there are many aspects inherent with its design and use. When you get to a certain depth in the f2f tutorials then what else is WebCT being used for? Is it just a repository for information from week to week, so that you are not able to have the chance to actually have deeper conversations online? Instead you are having the deep conversations in the f2f tutorial, and you want to use WebCT to progress your product at the end also.

(Dervla, PO, 15/02/05)

How do I sustain the meaningful discussion about the problem from the f2f tutorial to online? I thought it was very interesting when the guest Australian tutors came into the module, and the deep level of discussion that took place that week, because it had to; they were at a distance and the engagement needed to happen, breaking issues down and exploring them was crucial.

(Eimear, PO, 15/02/05)

5.2. Technology supporting interactions

In this study, technology was integral and also supportive of the social processes of learning in PBL and through the enabling power of online asynchronous communication, the participants were able to actively engage in their own learning.

I found the online discussion forums suited me completely as they were in tune with my reflective and protracted way of thinking through a topic. I prefer to think about each comment I make and I would not have an opinion to express which I could not back up strongly. As a result I found others tend to control the situation in the f2f tutorials and topics that I felt important were not being discussed. Whereas online, I could partake in the discussions and lend my considered opinion to the conversations and this meant that my social relationship with my peers improved.

(Dervla, RP7)

Hanson and Clem (2006), Hofmann (2006), and Owston, Garrison, and Cook (2006) all provide evidence for learners supporting the preference for live interactions over those that are computer-mediated in a blended learning experience. It is suggested that these findings are credible because there is a pervasive argument in the literature that there is a synergy that is manifest in face-to-face contact that the computer cannot replicate. Donnelly (2006) has suggested that discussion forums, chat rooms and email are an adjunct to the PBL group experience.

rience by complementing the spontaneity and momentum achieved face-to-face in the classroom. However, in contrast to this, Offerman and Tassava (2006) make the claim from their research that the live components are unnecessary and primarily used for socialisation reasons. This begs the questions, when and why should academics be considering human interaction such as collaboration and learning communities, and how does live interaction versus what has been coined by Graham (2006) as *low-fidelity* (asynchronous) interaction affect the problem-based learning experience.

All three of the PBL groups successfully produced a collective end product of their work on the module, however, only two of the groups worked harmoniously; the third group exhibited anxiety and division and required extra resources from its members in order to sustain itself and produce its collective end product. Anxiety became a major focus for this group, which had the effect of diverting it from effective collaborative working. The findings show that the place of emotion can be central to the effective work of PBL groups in a blended environment. The difference between these groups with respect to this theme and categories is used as a point of departure in order to show how an understanding of the dynamics of blended PBL groups may be of benefit to teachers and students working in this new environment.

Questions 11 and 12 in the second focus group interview related to participants' preferred technologies on offer in the module. They were asked to distinguish the blended media for the module delivery that made a positive impact on them or hindered their learning where tools included video conferencing, asynchronous discussions, synchronous chat sessions, online reflective journaling, podcasting and face-to-face PBL tutorials. Table 4 shows the number of participants from each group who expressed their favourite three media experienced on the module.

Participants had strong feelings about their encounters of the different media blended on the module. The asynchronous discussion forums were seen as positive for supporting reflection but causing frustration in how peers used the threaded discussion structure and yielded information overload. In three instances only, podcasting was seen as more robust than video conferencing and the use of online reflective journals resulted in almost universal support and praise. The synchronous media in the form of video conferencing and chat rooms generated a mixed response on impact and perceived usefulness for practice. The face-to-face PBL tutorial emerged strongly in all groups as a delivery preference for learning. A selection of participant quotes illustrate the reasons for preference for a specific technology:

5.3. Podcasting

It was only after the event that I discovered how extremely important the voice recordings and podcasting were and saw this as an alternative to live chat and video conferencing. Replacing the typed word with voice recorded messages could make participation easier for some of my students, who can feel embarrassed by the type of difficulties they struggle to cope with such as literacy skills, slower mental processing, attention and organisational difficulties which can lead to internalized negative labels which can result in a lack of confidence.
(Declan, RP15)

5.4. Synchronous chat rooms

I have found that the use of chat rooms produced a sense of immediacy and connection.
(Sorcha, RP9)

You could not get into too deep a discussion on the chat but you could organize the group activities; I mean overall, we would not have survived on the problem without the chat.
(Declan, FG2)

The chat room experience was disappointing some times as I felt it did not further our direction a whole lot with regard to the problem. I feel they are more useful for brainstorming and social integration.
(Loirin, RP4)

Similarly, Graham (2006) offers up the role of such live interaction as relevant to designing any form of blended learning systems. Yoon (2003) suggests that online interactions which can be stored, retrieved and disseminated anytime, anywhere are still a relatively new phenomenon and awaits greater exploration and coordination.

5.5. Online Reflective Journals

Completing my reflective journal challenged me to think more deeply about the events on the module. I felt a personal connection to wider happenings in the group. I moved from a state of dependency on the tutor to one of inter-dependency and autonomy which involved learning how to learn from my own experience and from that of others in the PBL group.
(Sorcha, PO, 08/02/05)

Table 4
Preference for technologies in blended PBL.

Tools	Group 1 CPD challengers	Group 2 the apprentices	Group 3 Cyber Club Seven
Video conferencing	2	4	3
Discussion boards	3	3	4
Chat rooms	1	1	3
Online reflective journals	5	4	4
Podcasting	0	0	3
Face-to-face PBL tutorials	4	3	4

Interaction has long been regarded as the vital ingredient on which success matters in technology-related education. Research studies by Frankola (2001) and Charp (2002) on attrition rates in online courses has provided a rationale for the emphasis on promoting interaction and sound instructional strategies in online courses. More recently, Yun (2005) has concluded that there is evidence that instructional strategies which incorporate various types of interaction can be the key to teaching a high-quality online course that engages students.

6. Conclusion

Garrison and Anderson (2000) have suggested that technology can enhance and sustain dominant practices such as lecturing and student-centred pedagogies such as PBL or it can disrupt and transform them. Jones, Cook, Jones, and De Laat (2007) make a case that increasingly students experience an educational environment that is inter-penetrated with technology at all levels and it remains true that for some purposes face-to-face is the best option. Research, such as this study, are needed to provide a basis for the right choice of when to use different technologies and how to use them to achieve particular ends.

The combined use of interactive media and problem-based learning is complicated, since on their own each demand that staff and students possess a complex array of different teaching and learning capabilities. Together they can be seen as a formidable combination and this study has shown that they are approaches to learning that are complementary rather than collide. An attitude of ongoing enhancement is what is most important in academic development in this field of higher education today. Indeed a truism of effective academic professional development for the future is that it should mirror the approaches teachers are being asked to enact with their own students.

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