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Synchronous Problem-Based e-Learning (ePBL) in Interprofessional Health Science Education

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Abstract

Health Science teams are increasingly interprofessional and often require use of information communication technology. These shifts result in a need for health science students to learn online interprofessional teamwork skills early in their training. In response, one interprofessional communication skills course was remodelled from traditional Problem-based learning (PBL) to include learning in an online collaborative (team-based) environment (Elluminate). This study evaluates the types of interactions facilitated by an interprofessional *e-problem-based learning* (ePBL) activity. A qualitative analysis of recorded discussions in Elluminate yielded two major categories of results. First, the online learning environment was shown to facilitate small-group collaborative interactions by updating older tools, in terms of offering intuitive, accurate, and multiple communication tools, and enabling novel forms of interaction. Second, the online learning environment prompted discussion of technology-facilitated communication difficulties in a way that led to the remediation of these difficulties. These results suggest that, while there is a need for further research on the relationship between online synchronous (real-time) learning environments and collaborative learning, ePBL can enable positive and novel forms of student interaction and facilitate student learning.

Introduction

Technology in Healthcare Teams/Training

Modern health science workplaces are interprofessional, complex problem-solving, and technology infused environments. In the reform of health service delivery, the focus is increasingly on teamwork and collaboration. Online computer-mediated technologies will also be used to enable health care teams to work together at a distance (Iedema, Meyerkort & White, 2005; Valaitis, Sword, Jones & Hodges, 2005). Therefore, health professionals must possess discipline specific clinical skills, interprofessional team skills, and fluency with information technology. Accordingly, health science education now emphasizes interprofessional group problem solving (Cook, 2005). Students who learn these skills in a technology infused learning environment are at an advantage when entering the workplace.

Research indicates that computer-mediated online learning environments and face-to-face learning environments often result in similar learning outcomes when variables such as learner styles, gender, group dynamics and task complexity are taken into account (Bernard et al, 2004; Tallent-Runnels, et al., 2006; Luppicini, 2007). The emphasis on group problem solving has also necessitated a shift to using *problem-based learning* (PBL) strategies. In response to an increased emphasis on technology and problem based work environments, this paper proposes *electronic problem-based learning* (ePBL) as an innovative training method in the context of interprofessional health teams. These team-based interprofessional health science ePBL activities use an actor referred to as a *standardized patient* (SP). A synchronous (real-time) peer-to-peer desktop virtual classroom learning environment, *Elluminate Live*® was used as the online computer-mediated communication delivery platform for the PBL scenarios.

Investigation of e-learning has shifted from the question of whether such learning environments are "as good" as face-to-face learning environments (Cook, 2005), to specifying factors that affect computer mediated learning (Luppicini, 2007), course environments (Tallent-Runnels, et al., 2006), and online group learning dynamics and collaboration (Graham, 2005; Harvard, Du, & Xu, 2008). In the study reported in this paper, these factors are explored within the context of an interprofessional health sciences course. The study was based on the understanding that learning occurs as a process of constructing knowledge within a social and environmental context. The purpose was to explore how participants used the synchronous technology to learn interprofessional team skills in the context of an ePBL scenario involving a standardized patient. We focused the inquiry on identifying themes of technology use. The study used qualitative methods to answer the questions: In what ways did the Elluminate learning environment facilitate or interfere with students learning interprofessional collaboration skills in clinical scenarios? Insights gleaned from this study provide specific recommendations for training and future research in workplace e-learning of interprofessional health science teams.

Rationale and Background

Traditional interprofessional health sciences course. The context for the study is an interprofessional Health Sciences course. Approximately 800 students are enrolled in over 20 sections and the course is required for nine Health Science programs: Nutrition, Medicine, Dentistry, Dental Hygiene, Nursing, Pharmacy, Physical Therapy, Occupational Therapy, and Medical Laboratory Science. It is optional for students in the Faculty of Physical Education and Recreation, and Human Ecology. Each team includes no more than one member of each discipline (six to eight students). Within each classroom, six interprofessional teams are overseen by at least two facilitators from different professions (one faculty member and one clinical practitioner). See Figure 1 for an example of three typical teams and one facilitator. The role of the facilitators is to guide the students through the activities, providing feedback and assistance.

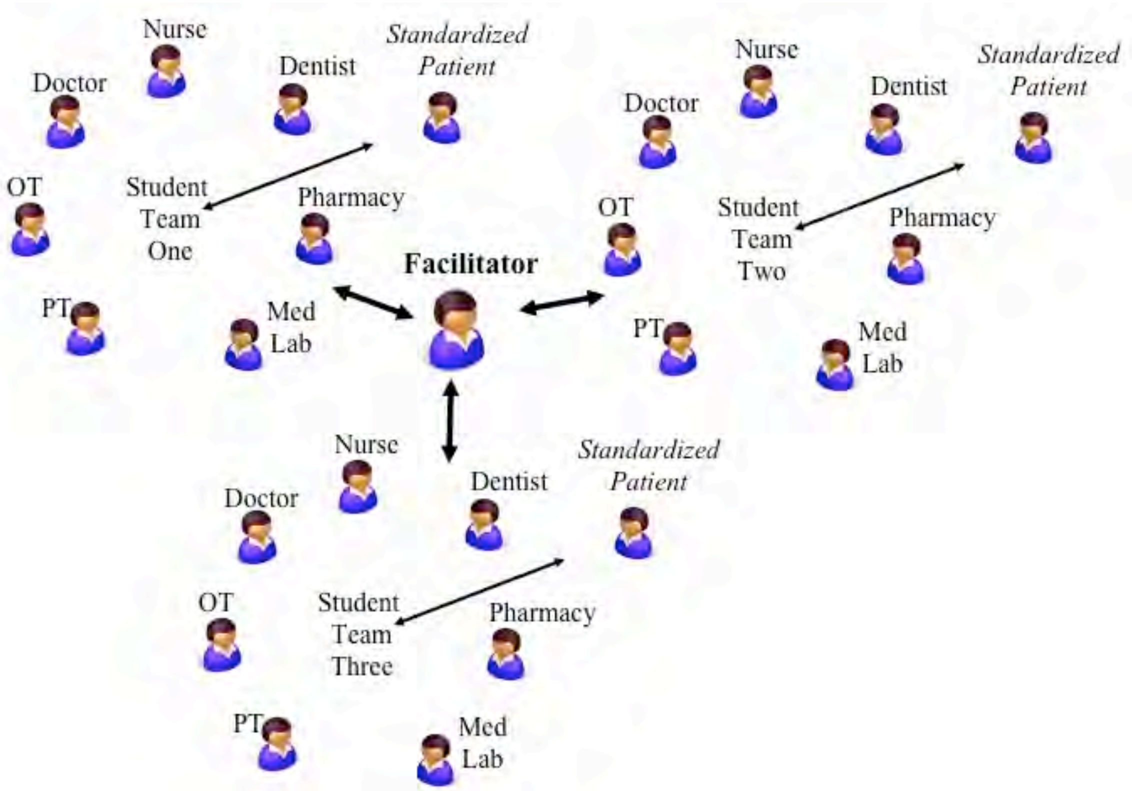

Figure 1. Online Classroom Network

The goal of the course is to develop interprofessional communication and teamwork skills that facilitate group problem solving and planning. There are five key concepts covered in the course: personal and team reflection, giving and receiving feedback, consensus decision making, conflict resolution, and team roles. The interprofessional team interacts with a Standardized Patient (SP) to create a treatment plan using the interprofessional communication skills highlighted in the course material.

SP is a person trained to simulate an actual patient by performing the history, body language, physical findings and emotional/personality characteristics of a patient. SPs have been used for over 40 years to provide effective, safe and supportive learning environments in health care education (Cantrell & Deloney, 2007; Heard et al., 1995). An SP is used for safe and supportive instruction, assessment, or examination of skills of a health care provider. Students' appreciation for each profession's role in patient care increased as a result of completing interprofessional SP interviews and developing a patient care plan (Westberg, Adams, Thiede, Stratton & Bumgardner, 2006). In the traditional course, SPs interacted with student teams with respect to an ethical dilemma and provided feedback to the student teams regarding team process and communication skills.

Problem-based learning in the traditional interprofessional education. The interprofessional team interacts with the SP in order to provide a more realistic interaction than a paper based scenario can provide. The team determines if all or a portion of the team will interact with the standardized patient. Any team members not participating will act as observers to provide feedback to the team. The SP will also provide feedback to the team. The team has the option of using a 'time out' in order to discuss strategies for the interview and then a 'time in' to continue with the interview.

The PBL scenarios emphasize a student-driven learning process within the context of small student groups who share knowledge and ideas to collaborate on solutions to ill-structured problems. Because PBL scenarios often require less structure, they allow a collaborative group to naturally evolve into various solution states. Students in PBL environments are focused on meaning-making rather than fact-collecting. Group dynamics are often a critical part of the PBL experience and involve students developing communication and social skills. Theoretical models of PBL suggest that students learn content and problem-solving strategies when engaged in authentic PBL (Hmelo-Silver, 2004; Taylor et al., 2004).

Mapping problem-based learning into an e-learning environment. Developing individual and team roles and interaction skills in an interprofessional context is challenging offline, and can be even more challenging online (Jennings, 2006; McConnell, 2002). When designing online learning activities, one must carefully match the goals of the activity with the learning environment (Luppicini, 2007). The medium interacts with the course design so that specific technologies support specific types of learning (Bernard et al., 2004; Veermans & Cesareni, 2005). For example, students often encounter difficulty establishing their identity in asynchronous textually based online environments (Rourke, Anderson, Garrison & Archer, 1999). Students in a PBL online environment often perceive synchronous discussions as critical for group decision-making and to clarify their understanding of information. (Beaumount & Cheng, 2006; Valaitis et al., 2005).

In an online context, developing individual and team roles and interaction skills can be even more challenging (Jennings, 2006; McConnell, 2002). The communication technology to support PBL online should provide a platform for exchange, organization, and processing of students' ideas and knowledge (Beaumont & Cheng, 2006). As Harvard, Du, and Xu (2008) indicate, selecting an appropriate delivery format becomes even more pronounced when the students are engaged online in a collaborative learning environment that requires a real-time interchange of ideas.

Strijbos, Martins, and Jochems (2004) suggested six steps when designing instruction for an interactive online group-based learning environment. These steps provided the framework that guided our design of interactions and activities in an online setting (see Appendix 1.).

In mapping the traditional version of the course to the online implementation it became readily apparent that some steps in Appendix 1 were much simpler to map than others. Implementing the PBL activities and selecting the right delivery format were the most challenging aspects of the design process. The following describes the resulting ePBL model for the Interprofessional Health Sciences course.

Blended version of the Interprofessional Health Sciences Course. The blended delivery format encompassed a combination of traditional face-to-face and online (asynchronous and synchronous) interactions. Three out of the 10 class periods were identified to remain face-to-face. The remaining seven classes were redesigned for an online synchronous delivery format. The same objectives and PBL scenarios were discussed as in the traditional course delivery.

The synchronous online classes used the Elluminate desktop virtual classroom environment as their delivery format. Elluminate allows participants, (students, facilitators, and SP) to communicate peer-to-peer online in real-time through a combination of voice, video, interactive white board and instant messaging. Elluminate enables a virtual classroom modelled around the group/team configurations used in traditional class settings for this course. It is important to maintain these team configurations because the pedagogical strategy using a group dynamics educational model is well established and effective in the traditional course (Carbonaro et al., 2008).

Elluminate was configured so one person could speak at a time but at any time a student could virtually “raise their hand” and their request to speak would be logged in ascending order. Figure 2 shows a typical Elluminate interactive session for the course. On the left hand side, in the participant information box, an individual student would have access to the microphone, instant messaging, and both writing on and viewing the whiteboard. The whiteboard can be used to display PowerPoint slides, Websites, or for the instructor and students to write information to share with the class.

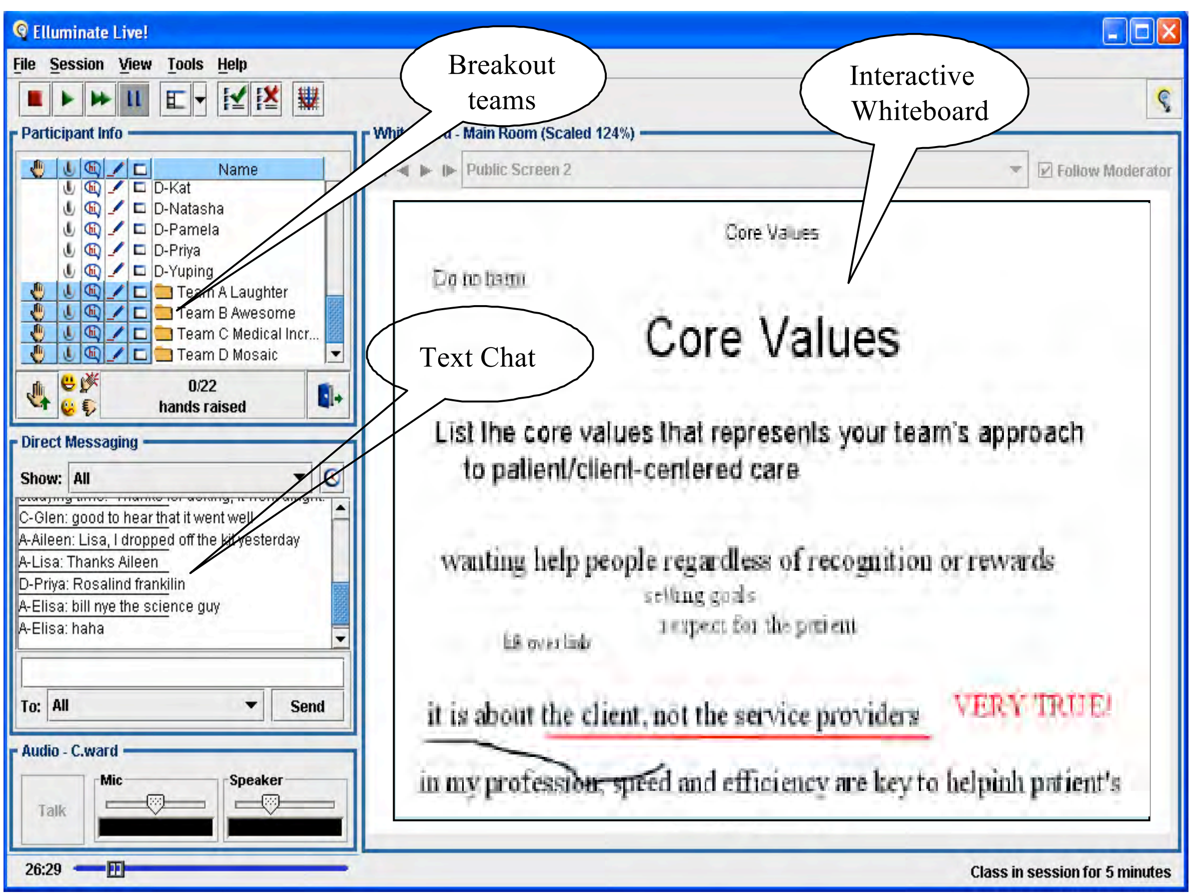

Figure 2. Elluminate Screen Caption

The online classes began in the main room, where the facilitator introduced the activity. The facilitator then sent the small groups into the breakout rooms, where only team members can communicate with each other using the virtual classroom features. The groups planned for the SP interview in the breakout rooms and when the group indicated readiness, the SP joined the breakout room. Following the interview, the SP left and the group discussed the interview and created a treatment plan. The SP then returned to the breakout room to provide the team with feedback.

Being able to create these virtual breakout rooms was a critical interactive feature because it allowed course designers to maintain the team-based configurations during PBL activity. For example, Figure 2 shows a team interacting during a PBL activity on core values. Students interacted with the SP to refine their team process skills to resolve patient care issues.

Method

Given that ePBL in Interprofessional Health Sciences Education is a novel instructional approach and that technological tools that support learning delivery formats are rapidly changing, qualitative research can define processes and variables that result in new hypotheses (Tallent-Runnels et al., 2006). In areas of emerging instructional models, qualitative research methods are best suited to provide the breadth of analysis that identifies trends and variables that form the basis of future research. This study specifically explored the interactions between the social context (group PBL) and the environmental context (the Elluminate environment). The data for this analysis were the contents from the transcripts of the online communication and interactions of the 20 students in 4 independent class sessions in the online component of the interprofessional Health Science course. Content analysis was used in this study to identify concepts and patterns within the text that provide insight regarding the study questions (Stemler, 2001). Content analysis is a method of describing a large body of data into themes (content categories) based on explicit rules of coding (Stemler, 2001). For this project, categories were established following a preliminary examination of the data. This process is known as emergent coding (Stemler, 2001). Two researchers read the text and combined their notes to establish rules of coding with which to categorize key themes. These rules were applied to the text with the assistance of the QSR NVivo™ qualitative data analysis program to organize the text and summarize the results. Coding units were defined by the natural end of meaning unit. Most of the data in this project was text based (either transcribed verbal statements or typed textual statements), but some of the units of meaning were diagrams or typed work on the Elluminate whiteboard. In the case of text, the coding units were complete paragraphs. In the case of the whiteboard content, the completed unit of representation was taken as one unit of coding. Reliability (95% agreement) was established between two raters using the same set of rules to identify codes. The instances of coding were then summarized using quantitative methods to describe the relative frequencies of occurrences of each coded theme.

Procedure

Camtasia (a recording software program) was used to record four online classes via continuous screen capture. The recordings were transferred into a textual representation by transcribing the verbal data, copying the text-based data, and describing the visual data. The final transcripts were checked for accuracy by comparing them to the original recordings by a second researcher.

The transcripts were read initially and themes were identified based on units of analysis (words, events, images, occurrences). These themes were discussed and revised by the team of researchers and rules of coding were established. Two separate researchers then initially coded part of the text. The researchers discussed inconsistencies and the text was recoded until the coding was consistently agreed upon between the researchers. The rest of the text was coded on paper by a single researcher. A second researcher then transferred the codes into NVivo and checked the coding for consistency. Code reports were printed and used to facilitate qualitative descriptions of the themes and quantitative information regarding the relative frequency of the themes. One of the themes emerged as particularly important to answering the research questions, so researchers returned to the original texts and recordings to elaborate the description.

Results

Two overarching themes emerged from the data as distinct from each other: *discussion of technology-facilitated communication difficulties* and *technology facilitates group interaction.* The themes are summarized in Table 1. The themes were not coded exclusively, therefore individual instances may have been coded as more than one theme.

Table 1. *Summary of ePBL Themes*

Theme	Subthemes	Description and examples
Technology facilitates group interaction	Technology updates previous educational tools	Whiteboard slides used as PowerPoint might be used in a classroom. Students use hand icons to "raise their hand" Students send files back and forth as they might pass documents between each other
	Technology facilitates novel forms of interactions	Whiteboard slides edited by students. Whiteboard can be used to write "anonymously." Whiteboard is the same in all rooms. All members can write on the whiteboard simultaneously. Text messages can be used when voice something doesn't work. Text messages tend to contain less "formal" information/exchange. Text messages used to provide feedback/ideas in a less direct manner. Emoticons used in text messages. Lack of visual cues decreases the sense of physical "Presence" and allows observers to observe without interference. Facilitators can "control" students by moving them to different rooms and by controlling the "mic." Students can signal people in other rooms. Icons (e.g., happy faces, sad faces can indicate emotional tone more than a "hand

		up" vote). Room jumping by facilitator
Discussion of technology-facilitated communication difficulties		Students describe to each other how to access files on desktop. Students discussed features of Elluminate. Students discuss how to share files. Students request that volume be raised or lowered.

The relative frequencies of the coding occurrences are summarized in Figure 3.

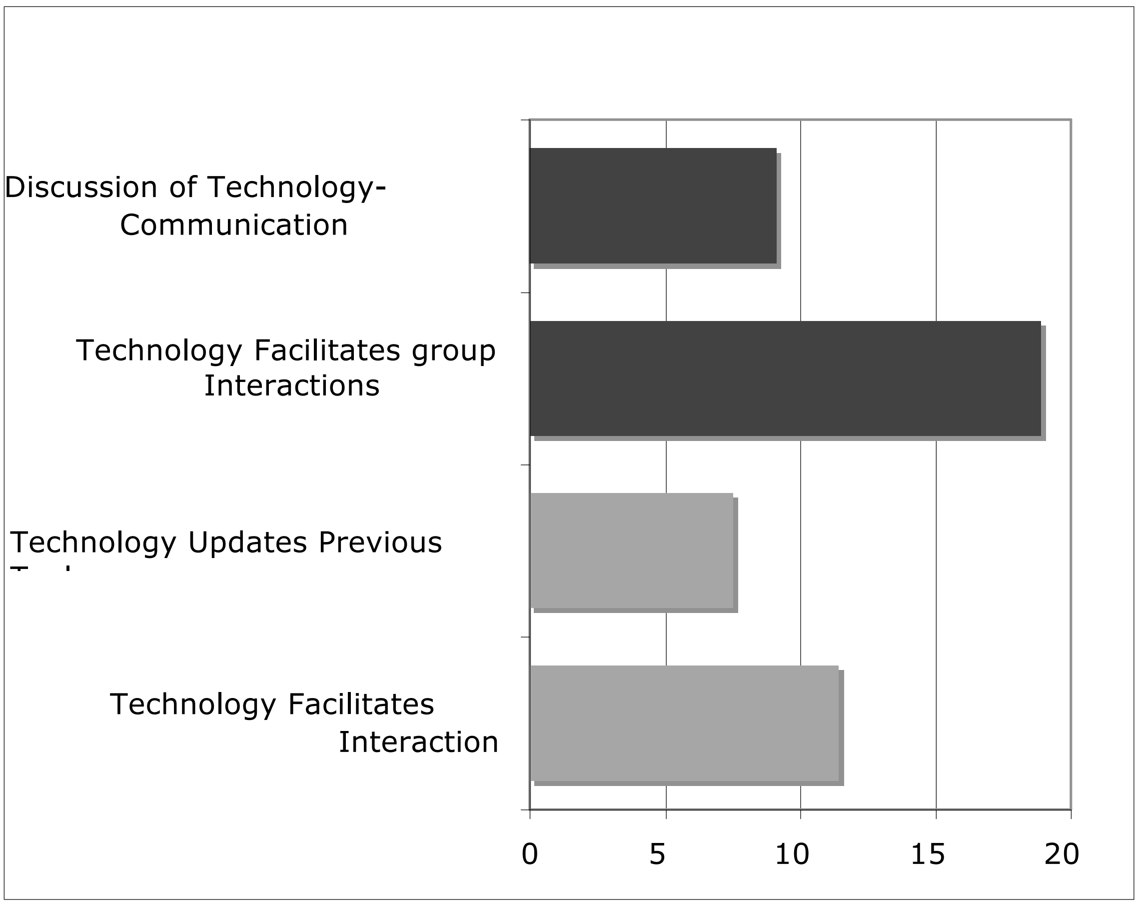

Figure 3. Technology themes for ePBL

Discussion of technology-facilitated communication difficulties. This theme includes all instances where students discussed the use of technology, including students providing feedback on sound volume levels and helping each other access files. This theme is best understood within the context of course development. Most of these instances occurred when students were not yet adept at managing the audio component of the technology environment and were therefore unable to distinguish between voices because of microphone and sound quality issues. Using Elluminate's Voice over Internet Protocol (VoIP) technology as part of the virtual classroom was new to all students. Students worked from their home systems; as a result there was no standard desktop configuration. For example, some students used a hardwired Internet connection and computer headset with a microphone (which worked well) while others connected via a home wireless and used the built-in laptop microphone. This variability resulted in a higher than expected number of unforeseen technology issues early on in the course (e.g., the Elluminate system was sensitive to home wireless bandwidth speeds and signal interference that resulted in random disconnections). These issues decreased over time. This decrease is likely related to the students' *discussions of technology-facilitated communication difficulties,* where team members supported each other when there were technology problems. Students were able to identify many technological "problems" and use feedback to problem-solve in the midst of the rest of the course content. Whereas many studies of technology-enhanced communication have found technology problems to be a theme, this finding is unique in revealing that students decreased these problems by communicating about them. One possible explanation for this difference relates to the student's "problem solving mode" that occurs in the context of PBL. In other words, the instructional setting encouraged students to work collaboratively in a team to solve problems. This real-time 'problem-solving process' was mutually respectful and indicated a high level of team-building.

Technology facilitates group interaction. Within this theme two subthemes were differentiated based on whether the coded instance was similar to what may have occurred in a face-to-face classroom or the instance was unique to the technology enhanced environment. The subtheme *technology updates previous educational tools* describes instances of technology use where the result is not qualitatively different than a type of interaction that occurs in traditional classrooms. By contrast, the subtheme *technology allows novel forms of interaction* describe an online pedagogy that does not tend to occur in traditional classrooms. One example is the students' ability to cue each other during the standardized patient interview by using the text message box. This allowed the students to prompt each other to ask questions, or provide real time feedback without interrupting the flow of the interview, as such feedback would do in a face-to-face environment.

The most interesting finding was that *technology facilitates novel forms of interaction*. This finding relates to Elluminate's capacity to establish real-time/synchronous broadband connectivity for direct voice/video communication, text messages (private and public) and interactive whiteboard sharing, to create teams in private virtual rooms (folders in Elluminate), and to allow for monitoring. These Elluminate features resulted in unique dynamics between teams, SPs and facilitator that would be difficult, if not impossible, to operationalize in a face-to-face setting. See Table 1 for examples.

Discussion

The design of the learning activity (pedagogy) and delivery format (technology) are critical components in developing what Savin-Baden and Wilkie (2006) refer to as the *technopedagogy* of PBL. More specifically, Tallent-Runnels, et al. (2006) remind us that the selection of the most appropriate delivery format or combination of formats should be driven by research:

A key element in online courses is providing effective communication and interaction. A variety of formats are available for online interaction, and many have been used to supplement face-to-face courses for the past several years. However, research needs to be conducted to determine which format provides the highest level of interaction and the most effective learning experiences for various kinds of students. In addition, future studies need to show which format best fits a particular pedagogy used by instructors (p. 117).

Researchers have found that technology must be chosen based on the effect that specific features have on the learning processes and goals (Groen, Tworek, & Soos-Gonczol, 2008; Bernard et al, 2004). Asynchronous delivery using text-based learning interactions often takes place using course management software such as WebCT/Blackboard (Luppicini, 2007). Research on synchronous learning/instruction has focused on chat (e.g., instant messaging or discussion boards) with some examples of video or teleconferencing (Bernard et al., 2004; Tallent-Runnels et al., 2006; Roblyer, Freeman, Donaldson & Maddox, 2007; Yang & Liu, 2007), and more recently, in the use of online real-time environment game designed worlds (Annetta, Murray, Laird, Bohr, & Park, 2008).

Previous research has demonstrated that desktop peer-to-peer synchronous technologies (Elluminate Live) could be effectively used to teach health sciences students' team process skills when real-time interactions are required (Carbonaro et al., 2008). This study extends that research to elucidate how PBL was combined with technology in an interprofessional Health Science course to form ePBL. The most significant design challenge was mapping a face-to-face PBL simulated learning activity into an online learning environment while maintaining the integrity of the interactivity that occurs in the face-to-face learning environment. This was primarily due to the necessity for real-time interactions between the SP and the student team.

The theme *technology facilitates group interactions* ties directly to the use of the design for interaction framework proposed by Strijbos, Martins, and Jochems (2004). In a PBL environment interactions are required to focus the group on problem solving, clear communication, and collaboration, all of which are essential components for learning in this context. In face-to-face groups, members often have the advantage of physical proximity, nonverbal-communication, and the ability to co-manipulate physical space (e.g., a student may highlight a section of a book and pass it around to the others). However, when students meet in a virtual environment, their abilities to communicate depend on the characteristics of the virtual space and communication medium itself (Savin-Baden & Gibbon, 2006).

Peer-to-peer desktop text/voice/video technologies enable PBL online synchronous activities to function in a more dynamic interactive environment (Anderson et al., 2006; Yang & Lui, 2007). It is clear from the themes that emerged from the data that ePBL in a synchronous context can preserve many of the necessary characteristics of face-to-face PBL. In fact, new forms of communication were present in the ePBL interactions. This supports Cousin's (2005) assertion that there have always been strong links between technology and pedagogy dating back to the first use of tools to support and enhance instruction. Technology either contributes to or, in some cases, directs the instructional strategy (how often do you see an instructor write on PowerPoint slides the way they once did on overhead slides). In the context of this study we noted that the lack of physical "presence" creates a context that limits some forms of communication, but also creates new opportunities for different group dynamics, for example:

- Interactions between the SP and the team may be different without the physical presence of the facilitator "watching"

- The team may interact with each other ("sliding each other notes") using the text box during the interview with the standardized patient, possibly cuing each other on questions to ask, etc. "without the standardized patient seeing"
- A shy person might also be more likely to "talk" if they can't be seen - in the virtual environment, or may "text" a response that they would not have said in person
- The team is able to look up other information (e.g., on Google or in their text books) during the interview, while another person is talking

In a PBL activity where students are working though a typical dilemma the level of interaction is extensive. Students ask the SP probing questions in order to understand the issues. In a normal face-to-face situation the students would see each other, the SP, and the facilitator. Physical communication indicators (facial expression, voice intonation, etc.) would facilitate the interpretation of behaviours and statements. Therefore, the more indicators that technology translates, the more information is available for students (and facilitators) to understand each other. Interactions where *technology updates previous educational tools* resulted in an identifiable theme in the ePBL model designed for this class. In the virtual classroom, Elluminate provides tools and techniques that differ only marginally from what would occur in a face-to-face situation. For example, the opportunity to utilize an interactive whiteboard, to raise your hand by using the hand icon tool, or the pass/share documents back and forth, are all typical interactions one could normally do in a face-to-face setting. In this sense the technology simply provides a medium to facilitate these types of interactions.

Implications

E-learning provides flexible opportunities for health practitioners to learn team-based collaborative professional development. However, the time necessary to learn the technology used in the delivery of these programs often creates challenges. In the UK, the National Health Service (NHS) and the National Health Service University (NHSU) indicate a trend towards earlier utilization of e-learning for professional practice (Childs et al., 2005). The NHS also developed a shared strategy for e-learning and identified e-learning as a central strategic delivery mechanism for potentially reducing the work related time to learn new technologies. Finally, communicating and collaborating at a distance is increasingly a requirement for health practitioners. Therefore developing these online team-based skills early in the careers of Health professionals are increasingly necessary to support patient care.

Recommendations and Conclusions

Our findings suggest there are benefits to using online synchronous technologies in the context of interprofessional skill development in an interprofessional health sciences course. However, more research is needed to understand how the delivery format can impact learning in a variety of instructional groups.

Based on this research, three key recommendations are outlined. First, technological issues should be tested and resolved in a tutorial and practice session prior to the actual SP sessions to minimize the disruption of technology related problems. This would also allow students to become familiar with the features of Elluminate so they can focus on the problem-solving process rather than the technology.

Second, aside from the technical aspects of online group work, students should be given a tip sheet on how to use certain features of the online application to express responses or attitudes that would be typically expressed automatically as non-verbal behavior in face-to-face environments. Students should be made aware that, to lessen misunderstandings and to fully express themselves, they need to make more conscious choices about their communications than they do in face-to-face environments.

Finally, in a PBL activity where students are working though a typical dilemma the level of interaction is extensive. Therefore, students should be able to meet face-to-face before the online sessions so they have a sense of each other as group members. If this is not possible, there should be an introductory activity within the online sessions that helps students form an impression of each of their classmates. Including a photograph or unique icon for each student along with a descriptor (eg., their professional area) will help students develop an identity online. This will encourage group interaction within the online sessions.

Overall, online team-based collaboration that requires real-time synchronous interaction needs to be understood in an instructional context. A more complete understanding of collaboration in this complex environment may lead to more effective practitioner and patient interactions in care settings that occur at a distance.

References

Anderson, L., Fyvie, B., Koritko, B., McCarthy, K., Paz, S. M., Rizzuto, M., Tremblay, R., & Sawyers, U. (2006). Technical evaluation report: Best practices in synchronous conferencing moderation. *International Review of Research in Open Distance Learning, 7*(1), 1-6.

Annetta, L., Murray, M., Gull Laird, S., Bohr, S. & Park, J. (2008). Investigating student attitudes toward a synchronous, online raduate course in a multi-user virtual learning environment. *Journal of Technology and Teacher Education. 16* (1), 5-34.

Beaumont, C., & Cheng, C. S. (2006). Analysing the use of communication tools for collaboration in PBLonline. In M. Savin-Baden & K. Wilkie (Eds.). *Problem-based learning online,* Berkshire, England: Open University Press.

Bernard, R.M., Abrami, P.C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Wallet, P.A., Fiset, M., & Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74,* 379-434.

Cantrell,M.J. & Deloney, L.A. (2007). Integration of standardized patients into simulation. *Anesthesiological Clinics of North America*, *25*(2), 377-383.

Carbonaro, M., King, S., Taylor, L., Satzinger, F., Snart, F., & Drummond, J. (2008) Integration of e-learning technologies in an interprofessional course: A pilot study. *Medical Teacher, 30*(1), 25-33.

Cook, D.A. (2005). Models of interprofessional learning in Canada. *Journal of Interprofessional Care*, (Suppl. 1), 107 - 115.

Cook, D.A. (2005). The research we still are not doing: An agenda for the study of computer-based learning. *Academic Medicine, 80*, 541 - 548.

Cousin, G. (2005). Learning from cyberspace. In R. Land and S. Bayne (Eds). *Education in Cyberspace.* New York, New York: Routledge Falmer.

Graham, S. (2005). Learning together in practice: A survey of interprofessional education in clinical settings in South-East England. *Journal of Interprofessional Care*, *19*(3), 223-235.

Groen, J., Tworek, J. & Soos-Gonczol, M. (2008). The effective use of synchronous classes within an online graduate program: Building upon an interdependent system. *International Journal on E-Learning*. *7* (2), 245-263.

Harvard, B., Du, J., & Xu, J. (2008). Online collaborative learning and communication media. *Journal of Interactive Learning Research, 19*(1), 37-50.

Heard, J. K., Cantrell, M., Presher, L., Klimberg, V. S., San Pedro, G. S., & Erwin, D. O. (1995). Using standardized patients to teach breast evaluation to sophomore medical students. *Journal of Cancer Education, 10(4),* 191-4.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, *16,* 235-266.

Iedema, R., Meyerkort, S., & White, L. (2005). Emergent modes of work and communities of practice. *Health Services Management Research, 18(1),* 13-24.

Jennings, D. (2006). PBLonline: a framework for collaborative e-learning. In M. Savin-Baden & K. Wilkie (Eds.), *Problem-based learning online,* Berkshire, England: Open University Press.

Luppicini, R. (2007). *Online Learning Communities (Ed.).* Greenwich: Information Age Publishing.

Mayer, R.E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*(1), 14-19.
McConnell, D. (2002). Action research and distributed problem –based learning in continuing professional education. *Distance Education, 23* (1), 59-83.
Offir, B., Lev, Y., & Bezalel, R. (2008). Surface and deep learning processes in distance education: Synchronous versus asynchronous systems. *Computers & Education, 51*(3), 1172-1183.
Rourke, L., Anderson, T., Garrison, D. R. & Archer, W. (1999). Assessing social presence in asynchronous text-based computer conferencing. *Journal of Distance Education 14* (2) 50-71.
Penman, M. & Lai, K. W. (2003). Synchronous communication and higher-order thinking in a tertiary course in occupational therapy. *Journal of Interactive Learning Research, 14(*4), 387-404.
Roblyer, M. D., Freeman, J., Donaldson, M. B, & Maddox, M. (2007). A comparison of outcomes of virtual school courses offered in synchronous and asynchronous formats. *Internet and Higher Education, 10* (4), 261-268.
Savin-Baden, M., & Gibbon, G. (2006). Online learning and problem-based learning: complementary or colliding approaches. In M. Savin-Baden & K. Wilkie (Eds.) *Problem-based learning online,* Berkshire, England: Open University Press.
Stacey, E. (2005). Problem-based learning online, In T. Evans, P. Smith & E. Stacey (Eds.), *Research in Distance Education: selected refereed papers from the 2004 Research in Distance Education conference,* 59-70, Geelong, Australia: Deakin University.
Stemler, S. (2001). An overview of content analysis. *Practical Assessment, Research & Evaluation, 7*(17). Retrieved from http://PAREonline.net/getvn. asp?v=7&n=17.
Strijbos, J. W., Martens, R. L. & Jochems, W. M. G., (2004). Designing group based learning: Six steps to designing computer-supported group based learning. *Computers & Education*, *42*, 403-424.
Trinidad, S., & Pearson, J. (2004). *Implementing and evaluating e-learning environments.* Paper presented at Beyond the Comfort Zone: Proceedings of the 21st ASCILITE Conference, Perth, Australia.
Tallent-Runnels, M. K., Thomas, J. A., Lan, W.Y., Cooper, S., Ahern, T.C., Shaw, S. & Liu, X. (2006). Teaching courses online: A review of the research. *Review of Education Research, 76,* 93 - 135.
Taylor, E., Cook, D., Cunningham, R., King, S., & Pimlott, J. (2004). Changing attitudes – health sciences students working together. *Internet Journal of Allied Health Sciences & Practice*, *2*(3).
Valaitis, R. K., Sword, W. A., Jones, B., & Hodges, A. (2005). Problem-based learning online: Perceptions of health science students. *Advances in Health Sciences Education*, *10*, 231-252.
Veermans, M. & Cesareni, D. (2005). The nature of the discourse in web-based Collaborative Learning Environments: Case studies from four different countries. *Computers & Education, 45,* 316-336.
Westberg, S. M., Adams, J., Thiede, K., Stratton, T. P., & Bumgardner, M. A. (2006). Innovations in teaching: An interprofessional activity using standardized patients. *American Journal of Pharmaceutical Education, 70*(2), Article 34.
Yang, Z., & Liu, Q. (2007). Research and development of web-based virtual online classroom. *Computers & Education, 48*, 171-184.

Appendix A

Designing Instruction for Computer-mediated Communication group-based learning

Strijbos, Martins, and Jochems (2004)		INTD Course
1. Determine learning objectives	(1) What type of skills will be taught? Open skills: argumentation, negotiation, discussion of multiple alternatives Closed skills: acquisition of basic skills, basic procedures (long division), concept learning	Objectives: Develop Open Skills including: • Communication (e.g., feedback) • Consensus building • Problem solving in group context • Self-reflection • Conflict resolution
	(2) Are all students required to learn the same skill(s)?	Yes
	(3) Must all students individually display mastery of the learning objectives?	No, all students are required to demonstrate competence, not mastery of skills.
2. Determine the expected (changes in) interaction	(4) Specify the expected interaction according to three levels if applicable.	The majority of the interactions is conceptualized as a combination of temporal communication structures, both *two-way reactive* and *interactive reciprocal* (Level two) and content or discourse analysis of the communicative statements or acts (Level three).
	(5) Will the interaction focus on feedback (e.g., commenting draft/final version)?	Feedback from group members and SP
	(6) Will the interaction focus on exchanging (or creating) ideas (or findings)?	Yes
	(7) Will the interaction focus on discussion, argumentation of multiple alternatives/opinions?	Yes

	(8) Does interaction require co-ordination of activities whilst solving a complex problem?	Yes
	(9) Does interaction require a collaboratively written report (report written together with other students) representing shared understanding?	No report, but a shared understanding is represented
3. Select the task type	(10) Which task-type is best suited for teaching the selected skills? Open skills: ill-structured task with no clear solution, multiple alternatives, outcomes, opinions or procedures Closed skills: well-structured task with (few) one possible solution(s) outcome(s) or procedure(s)	PBL scenarios that involve a typical case such as that shown in Appendix A. No clear solution to the PBL activities (there could be multiple alternatives)
	(11) Are all students required to study the same material?	Yes
	(12) Will they have to solve a complex and ambiguous problem with no clear solution?	Yes
	(13) Will the chosen learning objectives and task-type require communication?	Yes
4. Determine whether and how much pre-structuring is needed	(14) Will the chosen learning objectives and task-type require co-ordination?	Yes
	(15) Determine to what extent the group interaction processes will be pre-structured in advance? e? High level of pre-structuring: student interaction is prescribed by the teacher (giving or receiving feedback, suggestions or help), content focussed (content-based roles, resource	Interactions have a low level of structuring. Problem solving is based on discussion of an ethical dilemma presented by a SP.

	interdependence) Low level of pre-structuring: students shape their groups' interaction processes with little or no teacher involvement (knowledge building, case based discussion of multiple alternative solutions, PBL)	
	(16) Are students each assigned to a portion of the material?	No, the group interacts as an interdisciplinary team
	(17) Are students each assigned individual responsibilities for interaction and group performance?	Students have professional differences, but no pre-specified roles in the group
	(18) Are students dependent on each other during the whole course or only a part of the course?	Part of the course
	(19) How will the students be graded: individual test-scores, one group-score for the group's performance, individual- score for each members' participation and contribution, or a combination?	Individual and group participation and performance
5. Determine group size	(20) Is interaction with other group members obligatory ('positive interdependence') or optional?	Obligatory
	(21) Is there a set minimum for group interaction participation (e.g., discussion entries)?	Yes, participants are required to interact in order to provide responses to the dilemma posed.
	(22) Is the effort of all group members needed to achieve the learning objectives?	Yes
	(23) Is the interaction focus on feedback (dyads preferred), idea generation (large group preferred) or consensus generation and negotiation (small group preferred)?	Providing feedback is a skill to be practiced and enhanced. Achieving consensus is more important than exhausting all possible ideas.

	(24) Will all members have to contribute equally?	Yes, there should be relatively equal contributions depending upon the student's discipline and the content of the scenario.
	(25) Is there a need for diversity in opinion (discussion) or more focus on exchange of ideas (feedback)?	Both diversity and idea exchange are equally important to ensure everyone's perspectives are included.
6. Determine how computer support can be applied to support CSGBL	(26) How are students supposed to 'collaborate': at a computer or via computers?	Via computers
	(27) Will Communication be mainly face-to-face, computer mediated (CMC) or a combination? Is student interaction same time/ same place (face-to-face: with and at computer)? Is student interaction same time/different place (synchronous/real time CMC)? Is student interaction different time/different place (asynchronous CMC)?	Combination, but mainly CMC The majority of the interactions are synchronous, but asynchronous interactions will occur.
	(28) What kind of support is required: file sharing, communication, or a combination?	A combination, but mainly communication.
	(29) Which tool e.g., newsgroup, groupware or chat supports the group-based learning setting best?	Chat was the tool that supported this group-based learning best.