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THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

ARTICLE

Online Searching in PBL Tutorials

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This study aims to explore how online searching plays a role during PBL tutorials in two undergraduate health sciences curricula, Medicine and Dentistry. Utilizing Interactional Ethnography (IE) as an organizing framework for data collection and analysis, and drawing on a critical theory of technology as an explanatory lens, enabled a textured understanding of student practices and beliefs regarding online searching during face-to-face PBL tutorials. Two event maps trace key transitions in learning regarding online searching in one cycle of problem-based learning in each program. From a critical perspective, analysis of students' stimulated recall interviews indicated that the use of students' personal mobile devices with online searching capacity is considered a dynamic pedagogically and socially constructed process. Online searching during the PBL process is also viewed as a "site-of-struggle" where there are challenges for first-year undergraduates when implementing such learning technologies in PBL tutorials.

Keywords: medical education, dental education, online searching, online information, problem-based learning, PBL, interactional ethnography, critical theory of technology, learning technologies

Introduction

Attention to the role of learning technologies in inquiry-based learning has been increasing in the last decade, particularly in areas examining how such technologies foster student capabilities in knowledge building processes (Bridges, Botelho, Green, & Chau, 2012a; Bridges, Green, Botelho, & Tsang, 2014; Chan & van Aalst, 2004; Scardamalia & Bereiter, 2006). The long-standing learning sciences research literature indicates that technology can play a supporting role in enhancing the learning process in general (Dillenbourg, Baker, Blaye, & O'Malley, 1995; Goldman-Segall & Maxwell, 2002; Scardamalia & Bereiter, 1993; Stahl, Koschmann, & Suthers, 2006). More recently, these research interests have shifted to examine the role of learning technologies in problem-based learning (PBL) (Bridges, Botelho, & Tsang, 2010; Hmelo-Silver, Duncan, & Chinn, 2007). An emerging convergence of twenty-first century learning with PBL sees increasing student activity in online searching (e.g., online journal articles, or on the World Wide Web) via personal mobile devices (e.g., laptops, mobile phones, tablets) for identifying and assessing information. However, the use of learning technologies has been treated with caution in practice due to some perceived inconsistent educational benefits for learning (Davison, 2005). There is a dilemma that, while

using online information may offer learning opportunities for students, it may also inhibit interactivity in group dynamics and in knowledge co-construction processes. It is debatable whether the inclusion of technological affordances will support or detract from the scaffolding of inquiry-based learning (Hmelo-Silver et al., 2007; Kirschner, Sweller, & Clark, 2006). Hmelo-Silver (2012) suggests that we need to see both the opportunities and challenges of using technology in PBL so that we can understand how to manage learning technologies and maintain meaningful collaborative interactions.

A trend among this generation of PBL learners in using their mobile devices in tutorials indicates an emerging and new learning dynamic. While this practice has been noted in recent PBL research (Bridges, McGrath, & Whitehill, 2012b; Eberbach & Hmelo-Silver, 2012), limited studies have investigated both the opportunities and challenges of using online searching within face-to-face PBL tutorials. One special area of focus is how this new affordance plays a role in the social and pedagogical aspects of the PBL process. Although the issue of online information/literature searching has recently been examined in broader higher education (Tsai, Liang, Hou, & Tsai, 2012), in medical education (Maggio et al., 2012), and in PBL for all subjects and at all levels in a tertiary institution (Laxman, 2010), qualitative studies examining students' practices and perceptions of online searching for

PBL in health sciences education is an area where researchers need to gather more insights. Further studies on the applications of technologies in PBL curricula is needed to fully understand their potential in health sciences education (Jin & Bridges, 2014).

This study, therefore, aims to explore how online searching plays a role during PBL tutorials in two undergraduate health sciences curricula, Medicine and Dentistry. Studies in PBL in health sciences education have increasingly adopted qualitative methods to more deeply explore the nuances of the lived PBL experience (Cooper & Carver, 2012; Green-Thompson et al., 2012). An Interactional Ethnographic (IE) framework (Castanheira, Green, Dixon, & Yeager, 2007; Green, Dixon, & Zaharlick, 2003) serves in this paper as an organizing framework and a set of research practices to explore patterns and practices of online searching within and across PBL tutorials in two health sciences PBL curricula. In addition, a critical theory of technology (Feenberg, 1991, 2005) is adopted as an explanatory lens in data analysis and discussion to address the research question, How does online searching play a role during PBL tutorials in undergraduate health sciences curricula?

Literature Review

Learning Technologies in PBL

As noted in recent overviews, the role of learning technologies in supporting the PBL process is growing exponentially; however, research in this area is scarce (Bridges et al., 2012b; Eberbach & Hmelo-Silver, 2010; Jin & Bridges, 2014). Goldman-Segall and Maxwell (2002) have identified eight roles for technology in learning: (a) access to and structuring of information; (b) curriculum platform; (c) communications media; (d) thinking tools; (e) rich context for learning; (f) collaboration spaces; (g) perspectivity toolkit (which refers to how technologies allow for a relationship to form among the viewer, the author, and the medium); and (h) scaffolding. Kirschner et al. (2006) indicated concern that, as an inquiry-based process, PBL does not provide sufficient scaffolding for learning. However, supporters (Hmelo-Silver et al., 2007) argue that PBL is highly scaffolded, indeed, through the different strategies embedded in the process. Furthermore, they argued for the potential of learning technologies to further support scaffolding of learning. The building research in health sciences education indicates the generally positive effects of using a wide range of technologies in PBL. First, the use of videos and simulations can provide opportunities for rich, authentic problems or cases (Chi, Pickrell, & Riedy, 2014; Hege et al., 2007; Rampling, O'Brien, Hindhaugh, Woodham, & Kavia, 2012). Second, learning technologies

can provide supporting information by embedding expert knowledge and skills in Learning Management Systems for self-directed learning (Bridges et al., 2012a; Lechner, Thomas, & Bradshaw, 1998) or dedicated virtual laboratories or clinics (Schultze-Mosgau et al., 2004). Third, learning technologies can help students and facilitators in making disciplinary thinking explicit by using software for concept mapping (Bridges, Corbet, & Chan, 2015) and hardware to help learners construct explanations, structure tasks, and make them more manageable (Derry, Hmelo-Silver, Nagarajan, Chernobilsky, & Beitzel, 2006). While painting a generally positive picture, a limited number of studies have noted adverse effects of learning technologies in terms of interactivity and the complexity of technologies introduced (Garg, Norman, & Sperotable, 2001), as well as the content or delivery of technologies (Rampling et al., 2012).

Among the few studies of learning technologies in PBL, an even more limited number has examined online searching in PBL, particularly in health sciences education. Laxman (2010) investigated how different online information seeking strategies are utilized to engage in PBL for all subjects and at all levels in a tertiary institution in Singapore. This study has rested in the argument that the basis of mediating skills in PBL is effective information searching skills and has found that information seeking skills played an important role in problem solving. While providing some helpful contributions, there remains a need to more deeply examine students' practices and perceptions of online searching in PBL in health sciences education. This is particularly necessary if we understand how online searching plays a role in PBL interactions and learning processes.

Interactional Ethnography

Interactional ethnography (IE) is an approach in educational research that has been developed over the past 15 years by members of the Santa Barbara Classroom Discourse Group (Green et al., 2003; Rex, 2006). IE is a sociolinguistic approach to examining the social construction of everyday life in social groups; it explores cultural patterns and practices constructed across times and events (Castanheira, Crawford, Dixon, & Green, 2000; Castanheira et al., 2007; Putney, Green, Dixon, Duran, & Yeager, 2000; Putney, Green, Dixon, & Kelly, 1999). From this theoretical perspective, the ethnographer explores how that which "members of a social group propose, recognize, and acknowledge leads to the construction of particular knowledge, meanings of actions, and patterns of activity" (Bridges et al., 2012a, p. 103). IE has resonance with a social constructivist theory of learning, whereby learning is a socially constructed process (Palincsar, 1998). The ethnographic goal is to have emic (insider) perspectives of the community of practice by studying who

can do or say what, when and where, under what conditions, in what way, with whom, for what purpose, and with what outcome (Bridges et al., 2012a; Green & Meyer, 1991; Green et al., 2003; Green, Skukauskaite, Dixon, & Cordova, 2007). This approach provides a systematic and empirical approach to recording, analyzing, interpreting, and reporting learning in action (Green et al., 2007).

In educational research, IE can be seen in studies conducted over time that examine the “referential and intertextual nature of classroom life” (Green et al., 2003). Applied to this study of PBL tutorials in health sciences education, an IE approach supports the exploration of online searching, specifically:

in what members of a PBL group construct, what they take up and use (or not) that is proposed to them, and how their actions, individually and collectively, create a developing web of meanings, understandings and practices needed in subsequent problem-based events. (Bridges et al., 2012a, p. 103)

In this paper, IE is adopted as an epistemological stance, an orienting theory, and a set of research practices to systematically analyze classroom transcripts and learning activity. It enables not only comparisons across different PBL enactments, but, more importantly, provides a basis of tracing over time, members and events, the constructed meanings through analysis of moment-by-moment classroom interactions (Bridges et al., 2012a; Green et al., 2003; Green et al., 2007). Using IE, multiple levels of scale, including three levels of mapping in event maps and discursive work (transcription) of members, are created to show historical contexts that constitute a referential and intertextual analysis of consequential progressions (Green et al., 2007; Putney et al., 1999). This paper focuses on constructing event maps and analyzing interview transcriptions.

Critical Theory of Technology

In Feenberg’s (1991, 2005) critique of the dominant perspectives of ‘instrumentalism’ and determinism, he proposed a “critical theory of technology” as a means to view technology and its usage. According to Feenberg, from the instrumental approach, technologies are tools to serve users’ purposes, whereas technological determinism essentialized technology as an autonomous and deterministic force acting on society. Feenberg (1991, 2005) argued that these two traditional perspectives tended to decontextualize technology and to underestimate the role of social and historical context. He pointed out that technology is neither neutral nor determinist, and rather viewed it as a “battlefield” or “site-of-struggle” where users struggle to influence and change technology in terms of its design, uses, and meanings (Feenberg, 1991; Schmid,

2006). Drawn from the fields of philosophy of technology and constructivist technology studies, the critical theory of technology analyzes technologies and technological systems at two levels to offer “a platform for reconciling many apparently conflicting strands of reflection on technology” (Feenberg, 2005, p. 62). These two levels are:

- a. a primary level at which natural objects are decontextualized to identify affordances;
- b. a secondary level of recontextualization in natural, technical, and social environments (Feenberg, 2005, p. 47).

The use of technologies is considered in a social context reflecting unequal distribution of social power (Feenberg, 2005).

The critical theory of technology has been used by other researchers in the field of computer-assisted language learning (Schmid, 2006; Warschauer, 1999, 2003). Warschauer (1999) analyzed the development of digital literacies in college writing classes. Schmid (2006) investigated how the interactive whiteboard (IWB) was implemented and transformed by members in the classroom. The findings of the latter study indicated that IWBs in the English language classrooms were considered as the result of the interaction of several aspects, including technology characteristics, teachers’ pedagogical beliefs, students’ understanding, as well as the negotiations between students and the teacher (Schmid, 2006). However, there are limited studies applying this theory to investigate learning technology in PBL settings. Since a critical theory of technology views technology as socially constructed, such theory is consistent with an interactional ethnographic approach to data collection and management. In terms of analysis for the study reported here, a critical theory of technology was applied as an appropriate theory to explore the social construction of practices of online searching. Further, it enables a critical interpretation of the data with regard to power and learning dynamics.

Methods

Context of the Study—PBL Models Employed

The study took place in two undergraduate health sciences programs (Dentistry and Medicine) at an English medium University in Asia. These have been described separately as a nearly “pure” PBL curriculum (Dentistry) (Winning & Townsend, 2007) and a hybrid PBL curriculum (Medicine) (Chan, Ip, Patil, & Prosser, 2011). PBL tutorial cycle in these two Faculties broadly follow the traditional Barrow’s model (1988) of Tutorial 1 (T1), followed by self-directed learning (SDL), and a closing Tutorial 2 (T2). Some differences in implementation occur with regard to how the problem statement engages learners. In

the Bachelor of Dental Surgery (BDS), a single scenario (problem statement) is presented at the first tutorial following the closed-loop problem design (Walker & Leary, 2009) where students receive the entire problem statement in the first tutorial and return to this in the final tutorial. They work in groups of 8–10 to identify the facts, brainstorm the ideas, and determine “learning issues” (curriculum topics) in T1, and then, during the independent phase (SDL), students undertake research to gather information and apply knowledge related to the learning issues. In T2, the tutorial group reconvenes and students share and discuss the knowledge they have researched in order to apply it to understanding the dimensions of the problem at hand (Barrows, 1988; Bridges et al., 2012a). In the Bachelor of Medicine and Bachelor of Surgery (MBBS), a more structured, sequential problem scenario (Chan et al., 2011) is distributed in segments across all face-to-face tutorials, that is, new information may be disclosed in a second or possibly third tutorial. Students in the medical PBL model will therefore generate ideas, make a hypothesis about the diagnosis, and identify learning issues each time they meet with the tutor rather than on the first tutorial as in Dentistry. Similar to Dentistry, medical students gather information and knowledge in SDL.

In PBL tutorials in both contexts, students may use their personal mobile devices (e.g., laptops, iPads, mobile phones, etc.) to search online information (e.g., terminologies, images, video clips, simulations, medical/dental case reports, articles, etc.) and then identify, clarify, understand, or assess this information for knowledge building and problem-solving. This learning process is aligned with the social constructivist principles of PBL (Hmelo-Silver & Barrows, 2006).

Data Collection and Analysis

Research data were collected via a variety of ethnographic methods, including PBL tutorial observations, video and audio recordings of PBL tutorials, learning materials in PBL tutorials (e.g., group notes, problem scenarios), researchers’ field notes, students’ stimulated recall interviews, as well as policy documents about PBL tutorials and learning technologies across the two faculties. The videos of PBL tutorials and student interview data are the main discursive data sources

analyzed in this paper. Additional data such as learning materials, field notes, and policy documents were collected to support the construction of event maps, and to further understand the study context during analysis of interview transcripts and PBL tutorial discussions.

Ethical approval was gained from the university. Two first-year undergraduate PBL groups were randomly recruited and consented to participate in this cross-disciplinary study. In the five-year Bachelor of Dental Surgery (BDS) curriculum, the student PBL group consisted of nine participants. In the six-year Bachelor of Medicine and Bachelor of Surgery (MBBS) program, the student PBL group consisted of 10 participants. One cycle of PBL tutorials in each Faculty (i.e., two PBL tutorials in Dentistry and two tutorials in Medicine), conducted during the second semester of the 2012–2013 year, were video and audio recorded. Ethnographic artifacts such as group notes and other learning materials were collected to assist data analysis. Four dental students and nine medical students in these two PBL groups consented to participate in a follow-up stimulated recall interview (SRI). Video segments (2–5 minutes) focusing on online searching activities were selected for SRI. During the stimulated recall, whilst viewing the segments students freely recalled anything interesting and commented on their own and their groups’ learning from using learning technologies (Bridges & Bartlett, 2009; Gass & Mackey, 2000) and explained their perspectives toward the learning technologies. The main data sources in this paper are presented in Table 1.

All video recordings of PBL tutorials were transcribed using Transana. In this study, qualitative data is analyzed inductively and recursively, applying the key analytic constructs of IE. Two event maps (Figures 1 and 2) were constructed to examine learning processes based on the key events of online searching within and across the two face-to-face, facilitated PBL tutorials. Each event map presents both the horizontal timelines of the events and phases of activity across each first year, as divided into modules/blocks, as well as the vertical unfolding of key events, which represent the episodic nature of members’ online searching activity (Green et al., 2003). By tracing learning activities and phases both

Table 1. Main data sources.

Events	Location	Data source	Students (Year 1)
Tutorial 1 (T1) × 2	Scheduled university tutorial room	Video + audio + field notes + learning materials	N = 9 (Dentistry) N = 9 (Medicine)
Tutorial 2 (T2) × 2	Scheduled university tutorial room	Video + audio + field notes + learning materials	N = 9 (Dentistry) N = 10 (Medicine)
Stimulated Recall Interview (SRI) × 13	University tutorial room	Screen capture recording + audio	N = 4 (Dentistry) N = 9 (Medicine)

vertically and horizontally, these event maps provide insights into students' practices in the adoption of online information for learning in PBL across contexts and over time. Figure 1 provides a representation of the 13 problem cycles across two modules within one semester of the Year 1 program in Dentistry. Figure 2 provides a representation of the 12 problem cycles in the same semester in Year 1 of Medicine. The third problem in Module IV in the second semester in Dentistry and a final problem in Block III in Medicine were selected as anchors in each event map for the display and analysis of online searching within and across events of the problem. The chain of learning processes and key events for each tutorial selected are presented in the swing-out tables that make visible the developing activity on each tutorial.

A four-step framework was drawn upon to analyze interview data (Monrouxe, Rees, & Hu, 2011; Ritchie & Spencer, 1994). Step 1 is familiarization whereby data was viewed and read. Step 2 is identification of a thematic framework, and transcripts of interviews were analyzed to identify key themes and sub-themes. Step 3 is indexing, and an initial index was developed. Step 4 is mapping and interpretation (in this case, drawing on a critical theory of technology). In this process of data analysis, connections were explored among students' practices and perceptions of online searching across PBL tutorials. Efforts were made to safeguard the quality of the inferences made about the data. All four authors verified the interpretations of data analysis. In addition, reflexivity is acknowledged to enhance the awareness of the researchers relationship to the field as well as encouraged self critique in the research processes and products.

Results

Event Maps

As shown in figures 1 and 2, different resources of online information such as the Google search function, YouTube videos, and electronic articles were identified as adopted in the students' PBL learning process in both disciplinary contexts. A critical theory of technology is used as an explanatory and practical paradigm to analyze the stimulated recall interview data in order to investigate the relationship between technology and social elements of PBL tutorials as well as its relationship to the distribution of social power.

Stimulated Recall Interviews

Characteristics of Online Information

Before examining the critical aspects of online searching in PBL tutorials, it is important to first map the types of online activities evident in the video recordings. In the stimulated recall interviews, students indicated that instant online

searching in PBL tutorials included seeking terminologies, cases, pictures, and video clips. MBBS Student 5 reflected:

Because there's so many different words that we haven't come across before the PBL case and if we don't know the definition about that word and we cannot proceed so that I think using that kind of devices can help us to understand more about each page so that we can have a more in-depth discussion. (SRI1, MBBS, S5)

Students appeared to acknowledge that searching different terminologies supported information clarification, understanding of problem scenarios, and enabled them to move toward more in-depth group discussions. MBBS Student 6, below, pointed out that online searching was helpful to understand cases when students encountered new materials:

The mobile is really helpful because sometimes we can encounter some cases that we didn't learn in the lecture or we have no ideas about it so using internet we could have a little bit idea. (SRI2, MBBS, S6)

While students pointed out that instant online searching of terminologies and cases helped their understanding and promoted discussion, they seemed to recognize that online information such as images and video clips provided rich contexts for learning. BDS Student 1 reflected:

We can find some colorful and clear images. (SRI3, BDS, S1)

BDS Student 4 emphasized the usefulness of video clips for presenting information in the learning process. This online information enhanced understanding of background information.

For the video clips sometimes it is quite helpful because it presents information in another way. (SRI4, BDS, S4)

The mapping of activities has indicated the wealth of resources available online. Drawing on a critical perspective, it is important to consider the impact of such technological affordances on the social and cognitive aspects of learning in PBL.

Complexities of Selecting Quality Information

While it was evident that online information seeking was a growing, socially accepted practice in the learning groups, students recognized particular challenges regarding the increased complexities of selecting quality information. The issue of reliability was seen as a potential distraction from engagement with the problem/case at hand. Additionally, timing and number were viewed as problematic with multiple searching, potentially disturbing learning synchronicity. A BDS student reflected:

It seems we are a bit in a hurry as we are just randomly surfing some. Surfing some websites and we don't know if the website is reliable or not. So that information is not really correct. (SRI5, BDS, S1)

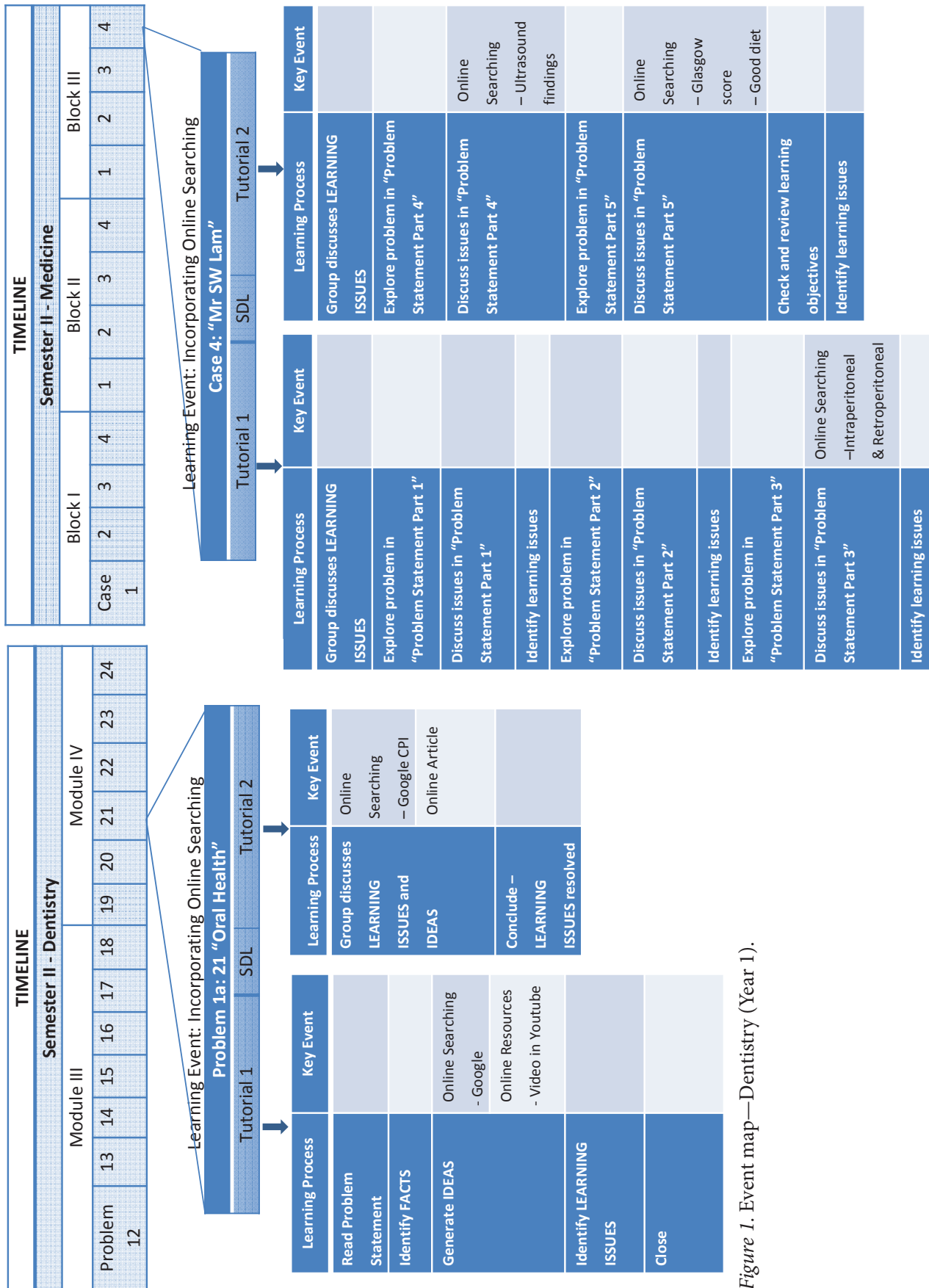


Figure 1. Event map—Dentistry (Year 1).

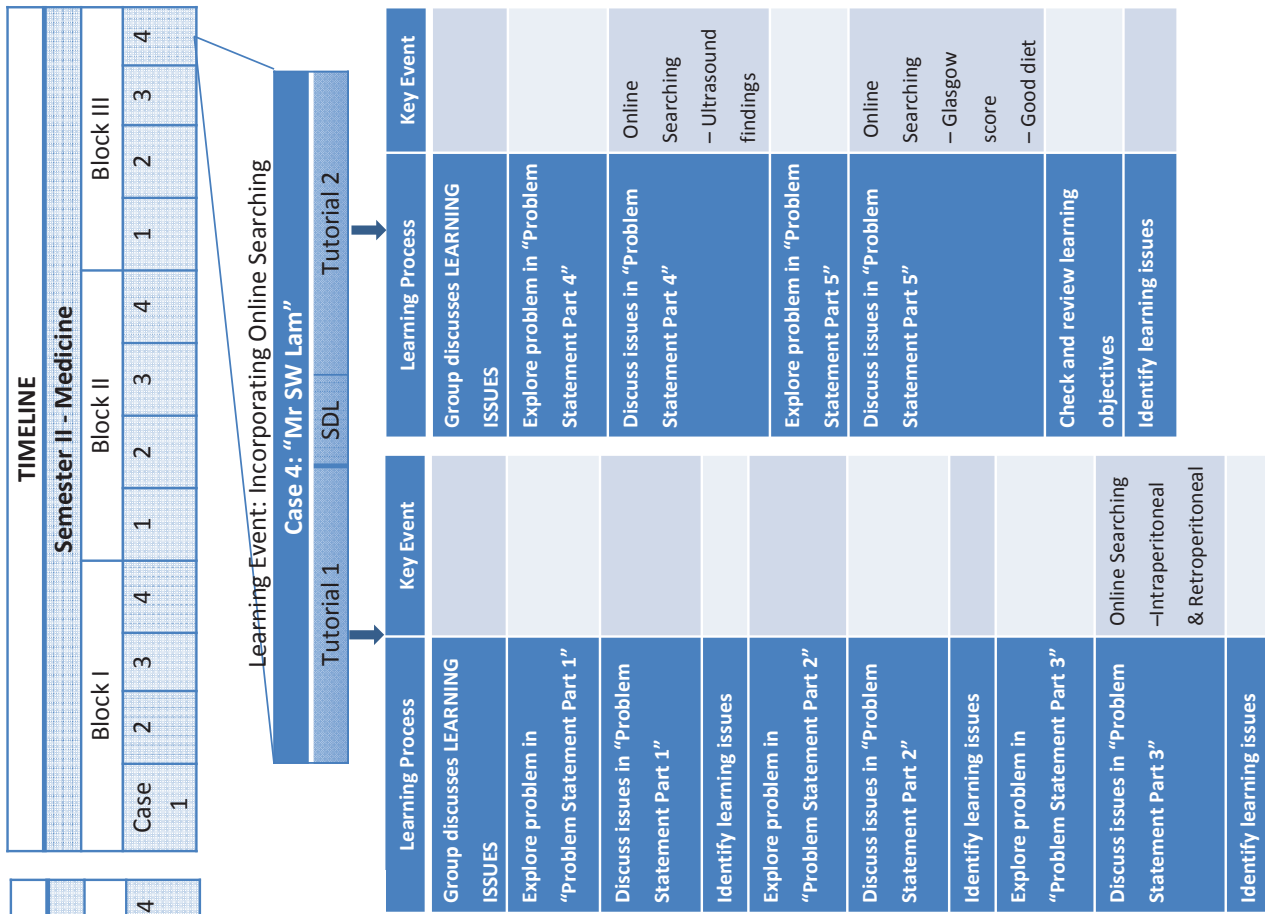


Figure 2. Event map—Medicine (Year 1).

BDS Student 1 pointed out that the searching time was too limited for students to find reliable websites and correct information. Speed became an issue where students also seemed to search too fast before thinking. MBBS Student 5 reflected on similar issues about speed and reliability of online information. A new practice of collective searching seems to have arisen. This was seen as a possible way to ensure the reliability and trustworthiness of resources. While its efficiency might be questioned, there lies an opportunity for heightened critique and a possible impact on deeper learning.

It is not very reliable for some sites. but then we first use Wikipedia and then we search that one and look for that in on the website, because we have a few people to surf for the same thing so that we will see whether their sources match each other or not. I think this makes the thing more reliable. (SRI6, MBBS, S5)

In taking a stance toward information management and knowledge construction, students indicated that the exponential amount of available information resulted in greater uncertainty regarding the outcome and quality of the online information they captured. The “lost in the woods” phenomenon is evident in BDS Student 1’s reflection and his request for guidance below. The ambiguity of locating and selecting online information is a common phenomenon to the first-year experience, and particularly to first-year students’ adjustment to PBL (Skinner, Braunack-Mayer, & Winning, 2012).

There is too much information that we can find from the net or from the books. So sometimes we might be confused of which information is use useful or reliable so the Faculty maybe can give us some more guidelines. (SRI7, BDS, S1)

While online journal articles were recognized as a useful learning resource in PBL tutorials, BDS Student 3 reported that he had doubts and uncertainty about using a learning resource produced at a more complex level of academic discourse.

I find that this kind of journal article is quite specific for their research interests and for our tutorial basically we are dealing with a broader horizon, so using this online journal article often cannot help us answering the question. (SRI8, BDS, S3)

This student raised issues of selecting relevant learning resources and usefulness of online journal articles for problem-solving in the first year of an undergraduate program. Research has indicated expert-novice differences in processing information and understanding complex systems (Carter, 1988; Hmelo-Silver, Marathe, & Liu, 2007).

Compared to experts and facilitators, first-year students will generally lack the skills or capacities of mapping academic journal articles against problem scenarios, forming connections among pieces of information, and applying knowledge in articles into meaningful cases.

Learning Preferences

Students noted that their personal learning preferences and those of their group members have played a role in PBL tutorials. MBBS Student 6 reflected an autonomous approach whereby he was fully aware of the advantages of online searching and took charge of his own learning by determining a preference for face-to-face discussion in the PBL tutorial.

Search on the web quickly easily on the internet access but personally I didn’t use laptop for tutorial because of my own preference. (SRI9, MBBS, S6)

Such self-regulating activities were also employed by BDS Student 2. This student took responsibility for monitoring and adjusting his learning in PBL tutorials. He checked his and others’ ways of learning and progress toward goals in addition to changing his learning based on monitoring. While originally reluctant to search online, he was eventually swayed to transition to online searching within tutorials when it became evident that this practice was becoming a social norm within the tutorial group. He reflected:

I don’t like to gather information but after this long period I accept it. And then I see other start to search and then I start to search. (SRI10, BDS, S2)

The interview data seemed to indicate that there was a point of negotiation between students regarding their searching practices and frequency of online searching. As indicated by BDS Student 2, T1 should be a procedure that requires more mental thinking rather than the information gathering. Although he did not prefer to search online in PBL tutorials, his own learning practice in PBL group was negotiated and reconstructed by power relations within the group that subsumed his own learning preferences.

Group Interactions and Knowledge Building

While it seems that it was common for students to use their personal mobile devices to search online with the perceived goal of supporting collaborative learning, students had concerns. BDS Student 2 and MBBS Student 5 indicated concerns regarding effective usage of time and efficiency of group interactions while searching online.

I will have to search for, Which site do I put this figure in? Which is very time-consuming after I search the site and he or she has moved onto other things. (SRI11, BDS, S2)

It appears that there was a conflict between the students' own searching processes and the whole group's learning process. Since it was time-consuming to search online, this searching practice might leave a student behind group discussion, and his or her searching results might not contribute to the discussions. MBBS Student 5 also pointed out:

Now each one of us uses one computer and I think this hinders our interaction because everyone is just searching on their net on their own computers and then when they find something they just speak out and that I think the interaction is not enough if everyone is using one computer. (SRI12, MBBS, S5)

MBBS Student 5 indicated the importance of group interactions, and he noted that using their own computers and reading information aloud from a screen might hinder group interactions. New and emerging ground rules of online searching or using personal devices might need to be employed by PBL groups. MBBS Student 6 reflected that note-taking was an effective way of deep learning (Biggs, 1999) by reinforcing his memory and helping to digest information, instead of copying, pasting, and reading out knowledge at a relatively superficial level.

I believe I think that making notes, using traditional notebooks somehow reinforces my memory. It makes me digest the information that I've obtained. Not just merely copying. If I use computer I will just copy paste and simply I didn't absorb the images the knowledge I would just read it out during tutorials, and then I will forget it very soon. (SRI13, MBBS, S6)

Different Practices and Facilitators' Pedagogical Beliefs

A few students indicated that there were different practices of online searching in different modules.

This PBL group is unlike the PBL group in the first semester, at that time my group is often search from the internet and we can often see many people search from Wikipedia or any other sources of information and then read out or present. But this time this PBL group, it's not very common for us to search from the internet. (SR14, MBBS, S9)

This excerpt indicates that students tended to adopt surface approaches and make greater use of online searching in a PBL group in the first semester, and that such practices decreased in the second semester. BDS Student 3 below indicated the possible reasons for such variation in practices across different PBL groups:

He was searching, but it is quite different from what I used to do in T1. In the previous modules the facilitators didn't

allow us to do so. If we have any questions, we should find it for further discussion in T2. (SRI5, BDS, S3)

In the interview, facilitators' pedagogical beliefs were identified as an important aspect to have influenced practices of online searching in PBL tutorials. Another student also reflected:

My previous tutor didn't allow us to use computer in T1. All information should not be searched during T1 because T1 should be a procedure that requires more mental thinking rather than the information gathering. But this is a new group and new group has new style, I shouldn't bring my past group experience here. (SRI6, BDS, S2)

This observation seems to indicate that students' practices of online searching depended on the power relations in PBL contexts. Facilitators' pedagogical beliefs were most likely to influence and characterize learning processes in PBL because facilitators played an influential role in PBL group management, especially in the first year. As indicated by BDS Student 2 and Student 3, when facilitators did not allow students to search online in PBL tutorials, they focused on group discussion and thinking processes. While there were not clear guidelines across groups and many facilitators did not object to online searching, the uptake of the affordance showed great variation across the experiences of these 13 first-year health sciences students.

To sum up, online searching is thus viewed as the result of the interaction of several aspects, including the characteristics of the online information itself, the complexities of selecting quality information, individual learning preferences and group normative behaviors, beliefs regarding group interactions and knowledge building in PBL, as well as facilitators' pedagogical beliefs.

Discussion

Students' personal mobile devices were recognized not simply as a learning tool in PBL tutorials. From the perspective of a critical theory of technology, the use of students' personal mobile devices with online searching capacity can be considered as a pedagogical and socially constructed dynamic process (Feenberg, 1991, 2005). Specifically, while online searching was adopted, utilized, and transformed by students and facilitators in PBL groups in a dynamic and iterative process of inquiry, its implementation led to tensions with regard to group dynamics and epistemology. The use of personal mobile devices in PBL in these two undergraduate programs was constructed, negotiated, and reconstructed in the specifically situated context of PBL in the first

year of health sciences curricula. Online searching as a social practice and a disruptive discourse were analyzed to explore how online searching plays a role in PBL tutorials. Although every member in a PBL group reported the convenience and usefulness of online information, multiple effects were evident. These included questioning the nature and characteristics of online information, complexities of selecting quality information, students' or PBL groups' learning preferences, students' concerns regarding group interactions and knowledge building, and facilitators' pedagogical beliefs. All of these new dimensions were interwoven to play a role in students' online searching during PBL tutorials.

This active process involves different social relationships and negotiations of power (Fairclough, 1991, 2005; Feenberg, 1991, 2005). For example, students' personal learning preferences may be influenced by their facilitator's pedagogical belief regarding the role of online searching in PBL tutorials. Such interactions between students and facilitators were likely to be rooted in social relationships and an established hierarchy between students and teachers or novice and experienced clinicians. Therefore, there is a need to understand the cultural or disciplinary contexts (Hmelo-Silver, 2012) in which learning technologies occur. By defining the accepted usage of online searching and the devices appropriated to access online information, an opportunity exists to guide equitably all facilitators and PBL groups as they adapt learning technologies to local situations.

By adopting a critical theory of technology perspective, online searching during the learning process in PBL tutorials can be seen as not only promoting collaborative learning and enhancing students' problem-solving and self-directed learning skills, but also as a "site-of-struggle" (Feenberg, 1991, 2005). From the stimulated interview data above, first-year students were seen to struggle in the practice of selecting, using, understanding, and elaborating online information. The varieties of electronic resources accessed can include general search engines, subject-specific search engines, general and subject-specific websites, as well as popular and extensive medical databases such as PubMed. This wealth of online information may be a challenge for first-year health sciences students in locating and selecting appropriate resources. It requires students not only to develop an awareness of the available online resources, but also to hone their search skills to ensure reliability, usefulness, depth, and breadth of resources while heeding the need for time-effective and comprehensive searches (Maggio et al., 2012).

Students also struggle with online searching during face-to-face tutorials, as they are concerned about the efficiency of their groups' interactions and, more importantly, how such additional activity can potentially impair group dynamics and individual cognition. The findings in this study indicate

a need for the training of both facilitators and first-year students to assist them in understanding the critical role of online information to the PBL knowledge construction process. Technological, pedagogical content knowledge (Mishra & Koehler, 2006) needs to be considered in the way that educational technologies and pedagogy of using technologies are included in the curriculum. Scaffolded support can be built into face-to-face learning so students can efficiently and constructively derive meaningful use of technology when sourcing and interpreting online information. Strategies include, but are not limited to, assisting students to:

- a. employ a variety of search and information management strategies to identify multiple information sources;
- b. critically judge the validity and reliability of the information retrieved;
- c. evaluate, synthesize, and apply online information in light of the problem scenario/case at hand.

This level of increased transparency of the role and utility of online searching in PBL may further support the achievement of the higher-order thinking skills that PBL is cited as promoting so effectively (Prosser & Sze, 2013).

Conclusion

This study has utilized Interactional Ethnography (IE) as an organizing framework and has drawn upon a critical theory of technology to provide an in-depth and textured understanding of online searching in face-to-face PBL tutorials. Using the IE approach, two event maps were constructed to trace key transitions in learning, and the key online searching events in one cycle of problem-based learning in two PBL cycles of activity in undergraduate Medicine and Dentistry. The maps provide a clear and succinct picture of online searching activity in the two PBL models over time. Critical analysis of students' stimulated recall interviews indicated that the use of students' personal mobile devices with online searching capacity is considered a dynamic pedagogically and socially constructed process involving different social relationships and negotiations of power. Accessing and evaluating online information can contribute to students' problem-solving, self-directed learning, and collaborative learning in PBL tutorials. However, specific challenges are evident for first-year undergraduates transitioning from secondary education when implementing such learning technologies in PBL as a mostly new approach to the acquisition of disciplinary knowledge, skills, and attitudes. From a critical theory of technology perspective, the results indicated not only the opportunities and challenges of using online information for

learning in PBL tutorials, but also how the social and pedagogical aspects of online searching impact group processes and knowledge construction within PBL tutorials.

Although a certain amount of non-generalizability exists, this small-scale study across first-year PBL groups in two undergraduate health sciences programs suggests trends that are likely to resonate to PBL in other disciplinary contexts and to other small-group, inquiry-based learning contexts. Guidance for using/searching online resources in PBL tutorials is needed for better facilitation and management of PBL group discussions. Facilitators and policymakers need to pay more attention to supporting students' development of online searching strategies, particularly in advanced information searching skills (Laxman, 2010; Tsai et al., 2012) so that their activities remain germane to achieving meaningful learning and understanding, and do not interfere with PBL learning goals. Online searching in PBL holds much promise if we can support undergraduates in information management and the development of higher-order thinking processes critical to modern knowledge economies.

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