CHAPTER 10

How Can Screen Sharing Support Knowledge Coconstruction in Technology-Enhanced Problem-Based Learning?

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INTRODUCTION

In the late 1990s, three undergraduate health-care professional programmes (medicine, dentistry, and speech and hearing sciences) at the University of Hong Kong implemented problem-based learning (PBL) as their teaching philosophy, curriculum design, and pedagogy. While the three programmes varied in design and approaches in their implementation, they all employed the core principles of PBL to provide students with opportunities to work collaboratively in a small group and to apply practical and theoretical knowledge to problems designed to simulate real-life scenarios in clinical settings (Barrows, 1996). As a constructivist approach more recently grounded in the learning sciences, the PBL process of understanding the complex dimensions of ill-structured problems and working towards solving them supports students in becoming professionals and lifelong creators of collaborative knowledge at their workplaces (Lu, Bridges, & Hmelo-Silver, 2014). With teachers no longer acting as the primary source of information but as facilitators who support student learning through knowledge construction, new forms of learning software and educational technologies have been adopted as tools for supporting the facilitation process (Jin & Bridges, 2014; Savin-Baden, Poulton, Beaumont, & Conradi, 2016; Lajoie et al., chapter 12 in this volume). One of the more recent

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educational technologies in use is ClickShare™, a wireless presentation system wherein users connect via the ClickShare™ app and share their ideas from their own laptops or mobile devices to the large, central screen (Barco, 2016). The aim of this ethnographic study is to explore how students and their facilitator use ClickShare™ to support knowledge coconstruction within PBL tutorials and to analyse the social and academic consequences of the use of this technological affordance. Before we describe the study’s data collection procedures, analysis, and discussion, the next section outlines the background of PBL with specific reference to facilitation goals and educational technologies.

BACKGROUND

PBL and Facilitation Goals
PBL is a constructivist educational approach in which the facilitator acts as a cognitive coach who guides students working in groups to “develop flexible knowledge, effective problem-solving skills, self-directed learning skills, effective collaboration skills, and intrinsic motivation” as they go through the PBL processes (Hmelo-Silver, 2004, p. 240). The PBL facilitator’s interventions diminish over time as students develop these skills (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2006). The processes include identifying the key facts, formulating and analysing the problem, generating hypotheses, identifying knowledge gaps (learning issues), gathering data during self-directed learning (SDL) time, and synthesising and applying the newly acquired knowledge to the problem at hand (Hmelo-Silver, 2004). Following Barrows’ model (1988), a traditional problem cycle in the study’s programme consisted of an initial tutorial (T1), followed by SDL, then one or two more tutorials to close the PBL cycle. In the local model of implementation, lectures, seminars, workshops, and clinical placements may occur with the problem cycle between PBL tutorials to support SDL or as separate curriculum “blocks” in the overarching structure.

Advocates argue that the learning environment of PBL tutorials is authentic and learner centred, and hence students’ learning interest can be easily stimulated. For example, Koh, Khoo, Wong, and Koh’s (2008) systematic review found PBL enhances the learning experience and equips students with a wide range of skills, such as interpersonal, communication, and teamwork. However, critics have indicated that some students may
find PBL problems difficult to navigate in a PBL tutorial, and they may not be able to engage in the learning activities once they lose track of the discussion, due to a lack of either prior knowledge or concentration (Kirschner, Sweller, & Clark, 2010). The counterargument is that facilitators can and should play a critical role as scaffolds in the PBL process to address the issue of cognitive load (Hmelo-Silver, Duncan, & Chinn, 2007). According to Hmelo-Silver and Barrows (2006), the main performance goals for PBL facilitators are to

1) keep all students active in the learning process,
2) keep the learning process on track,
3) make the students’ thoughts and their depth of understanding apparent, and
4) encourage students to become self-reliant for direction and information. (p. 27)

To support these goals in more recent, technology-infused learning environments, PBL facilitators are now taking advantage of educational technologies as an additional scaffold to support student learning throughout the PBL process.

**Educational Technologies for PBL**

Through the use of new software and applications, computer-supported collaborative learning (CSCL) helps students learn together and provides creative opportunities for intellectual exploration and social interaction, with the goal of creating a learning environment that enhances the practice of group meaning making (Stahl, Koschmann, & Suthers, 2006). In CSCL environments, students can use their computers to search for information on the internet and to gather, present, and discuss the new information collaboratively (Stahl, Koschmann, & Suthers, 2006). Jin and Bridges’ (2014) systematic review of the literature from 1996 to 2014 identified three types of educational technologies used in PBL: learning software and digital learning objects; interactive whiteboards (IWBs) and large, central screens; and learning management systems (LMSs). The review of study findings indicated positive learning outcomes for undergraduate students, including

- facilitating understanding of information and complex phenomena;
– having a positive impact on active learning and critical thinking;
– providing a rich, authentic learning environment;
– supporting student development of medical expertise through the accessing and structuring of expert knowledge and skills;
– making disciplinary thinking and strategies explicit;
– providing a platform to elicit articulation, collaboration, and reflection; and
– reducing perceived cognitive load. (p. 4)

In response to the cognitive load debate, Hmelo-Silver et al. (2007) argued for the efficacy of educational technologies in enabling students to learn in complex domains. Supporting this stance, Bridges, Corbet, and Chan’s (2015) ethnographic study illustrated how undergraduate dental students in a PBL group used IWBs to support learning within and across all phases of a problem cycle by extracting and sharing in-house and open access digital texts and materials. The integration of learning software into a PBL curriculum can depend upon factors such as ease of use, accessibility, and user support (Jin & Bridges, 2014). For example, concept mapping software (CMapTools™) has supported blended approaches in undergraduate health professions education and fully online faculty development (Bridges, Dyson, & Corbet, 2009; Bridges et al., 2015; Mok, Whitehill, & Dodd, 2009, 2013). In these cases, concept maps helped to consolidate students’ learning within and across the problem cycle. These initiatives found that through incorporation of concept mapping software, students improved their ability to identify concepts and build relationships and to retain learned knowledge. These studies also illustrated that when combined with a central large screen, concept mapping software can draw students’ collective attention to the group task and help them present their complex ideas more systematically.

While Jin & Bridges (2014) concluded that educational technologies could play an important role in supporting the PBL learning process, they also identified the need for further research “to fully realize their potentials in enhancing inquiry-based approaches in health sciences education” (p. 10). The study reported here takes up this challenge by examining the application of one novel screen-sharing technology (ClickShare™) as a technological tool adopted to support face-to-face PBL group learning processes.
ClickShare™, a wireless screen-sharing presentation system, was piloted in a PBL course on adult speech and language disorders in the Bachelor of Science programme in Speech and Hearing Sciences, BSc (SPEECH). Barco (2016) proposed that by connecting to the ClickShare™ application, students could share their own work or digital reference materials from their own laptops or mobile devices via the central plasma screen for others in the group to see. The shared learning objects can help students focus their attention on the ongoing topic of discussion and raise new topics for investigation. In PBL, the shared learning objects may also help facilitators to scaffold student learning and the effective coconstruction of knowledge. This ethnographic study examined the use of ClickShare™ in a PBL course by addressing the following research question: How do students and their facilitator use a wireless screen-sharing presentation system to support knowledge coconstruction within PBL tutorials?

APPROACH

Interactional Ethnography
Participants provided written informed consent for video and audio recordings and access to ethnographic data relevant to the study (HRECNCF Ref.: EA360314). The study adopted interactional ethnography (IE) as a qualitative research approach to explore how learning is socially and culturally coconstructed in the classroom of a professional undergraduate programme for the preparation of speech-language therapists (Green & Bridges, 2018). The overarching IE goal is to examine what is learned through social interactions and to understand how the practice of a professional community is shaped by what students learn in and across time (Putney, Green, Dixon, Duran, & Yeager, 2000). Specifically, the interdisciplinary research team (education and clinical specialists) sought, through in-depth analysis of the video archive, to identify both the ways in which students learn and what students learn. IE provided a framework for us to explore when and where, under what conditions, for what purposes, and with what consequences and outcomes ClickShare™ use enabled, or did not enable, learning events (Green & Ana Inés, 2008). The ensuing analysis drew on one notion of Vygotskian sociocultural theory, scaffolding, and one key theoretical construct, zone of proximal development (ZPD) (Vygotsky, 1978). These were used to examine how group members
negotiated the use of ClickShare™ and for what purposes and to trace how members’ interactions with the technology during discussion became consequential to their learning over time.

Participants
Nine Year 4 students from the same PBL tutorial group and their PBL facilitator (n =10) from a five-year, full-time BSc (SPEECH) were recruited via email for this study. They participated on a voluntary basis and received no incentives. Following an initial ClickShare™ induction by the facilitator, the technology was made available to the tutorial group in six tutorials (T) across three PBL cycles from October 19, 2015, to November 5, 2015 (see Figure 10.1). The three recorded PBL cycles included cases and inquiry-based materials on

- dysarthria on a patient with head injury (Problem 5 [P5]) (final tutorial for the prior cycle);
- dysphagia on a patient who had a stroke (Problem 6 [P6]) (full cycle);
- dysarthria on a patient with Parkinson’s disease (Problem 7 [P7]) (full cycle); and
- management of a patient after a total laryngectomy (Problem 8 [P8]) (full cycle).

At the time of recording, the curriculum was organised so that each PBL cycle ran over three 3-hour tutorials (T1, T2, and T3). A new problem (P) began in the last hour of the third and final session of the cycle (e.g., P6/T3 and P7/T1), continued into the next full 3-hour session (e.g., P7/T2), and was completed in the first two hours of the third session (e.g., P7/T3 and P8/T1). The ethnographic archive consisted of video and audio recordings for three full PBL cycles (P6, P7, and P8) and for the final tutorial of Problem 5 (P5/T3) (see Figure 10.1).

In a typical PBL session, students engage in the collaborative construction of group notes, information search, and sharing of self-directed research, and the facilitator scaffolds the discussion with open-ended, nondirective questions (Barrows, 1988). In the BSc (SPEECH) model at the time of recording, there were skills laboratories between PBL tutorials to support self-directed learning and one master lecture during the course (Whitehill, Bridges, & Chan, 2013). Particular to local practice,
students also received a list of core readings and supplementary readings and completed a preparatory “reading form” as a summary, including critique, reflection, and arising questions. This was submitted prior to the PBL session to help students prepare for discussion in the tutorial. In each PBL tutorial, a student became the clerk who took group notes for the discussion on a shared Google Docs™. Other group members were able to view and edit the group notes by logging in to the same Google Docs™. In the next tutorial, another student would become the new clerk for taking group notes.

Data Collection
PBL sessions took place in a custom-designed tutorial room with an IWB (see Figure 10.2). Following ethnographic principles, the researchers video- and audio-recorded learning as it naturally occurred in the classroom (Baker, Green, & Skukauskaite, 2008; Derry et al., 2010). Three sets of cameras (cameras A, B, and C) on mounted tripods captured the PBL group interactions and IWB from different angles (Figure 10.2). Additional audio recordings (voice recorders 1 and 2 on the central table) captured the naturally occurring PBL tutorial discussions. All students (S1–S9) sat
Around the table to discuss the problem/case at hand, while the facilitator sat towards the back of the tutorial room.

The final ethnographic archive consisted of recordings, curriculum documents, problem statements, whiteboard images from tutorial discussions, group notes in the form of Google Docs™, and concept maps. Trained research assistants transcribed the video- and audio-recorded PBL sessions. The research team verified the transcripts and engaged in joint video analysis as both internal and external ethnographers, as well as disciplinary, cultural guides (Green, Chian, Stewart, & Couch, 2018).

Data Analysis and Interpretation

An interactional ethnographer explores what is constructed in and through the moment-by-moment interactions among group members, how they interact in order to negotiate events, and how knowledge and texts generated in one key event influence and become a resource for members’ actions in subsequent events (Castanheira, Crawford, Dixon, & Green, 2001; Green & Bridges, 2018). Following the IE approach, analysis of the transcripts focused on who talked about what, for what purposes, and with what intended outcomes, all analysed during “rich points” or key events, identified in this study as being when students employed ClickShare™. Using a telling case method (see Mitchell 1984 in Green & Bridges, 2018), the analysis examined how actions and interactions of the facilitator and her students were shaped by what was constructed in previous events and

Figure 10.2 PBL tutorial room with an IWB, ClickShare™, and recording equipment.
the social and academic consequences of the associated discourse and actions for students in the group. An event map (see Figure 10.3) traced key learning events that were prompted by ClickShare™ across the problem cycles. Microanalysis of related discourse and artefacts examined how these events contributed to student learning.

Analysis drew upon the work of Vygotsky (1978) to provide explanations for how a technology-rich approach to scaffolding could support, or did not support, student learning in a PBL environment. Scaffolding is the assistance or guidance provided by a more capable or competent person (usually the teacher or peer), which will eventually be removed from the process as the learner gradually develops the skills and abilities necessary for completing certain tasks autonomously (Vygotsky, 1978). The concept of the zone of proximal development (ZPD) identifies the difference between what one can do without help and what one can do with help (Vygotsky, 1978). In the learning process with a knowledgeable other, the expectation is that the ZPD would be minimised through scaffolding. It has been argued that scaffolding helps students to bridge from current knowledge to practices (Reiser & Tabak, 2014). In PBL, when students have identified their group’s learning issues (objectives), they will undertake independent research during SDL to collect resources and learn new knowledge to support the problem-solving process. Although students have gained new knowledge, their research and independent learning skill set may still be incomplete (Reiser & Tabak, 2014). This mismatch may create difficulties for them in applying what they have learned during SDL. Therefore, students need guidance from their teachers, who deconstruct the complex skills and tasks into small components. Their teachers may also perform the actions for learners (modelling) repeatedly until the students are able to associate the modelled actions with the learning goals (Reiser & Tabak, 2014). Based on these premises, when students have learned how to complete the task and have also understood the idea of how to complete a similar task independently, they are able to take responsibility for their own learning, and teachers can then remove the scaffolding (Vygotsky, 1978). As the students are developing the skills to identify the relationships between learning objectives and the problem-solving procedures, the need for explicit facilitator guidance is gradually minimised. Scaffolding has become a critical concept in learning and assisting learners in developing their full potential through teacher guidance, collaboration with more capable peers, and various tools (Hoadley, 2018). In the next section, the
**Figure 10.3** Event map of Clickshare™ key events.

### ClickShare™ was used in 14 occasions:
- Oct 19, P5/T3 & P6/T1: Facilitator ➔ Student 4 ➔ Student 5 ➔ Student 7 ➔ Facilitator ➔ Student 2
- Oct 26, P6/T3 & P7/T1: Student 5 ➔ Facilitator
- Oct 29, P7/T2: Student 3 ➔ Student 3 ➔ Student 5
- Nov 5, P8/T2 & P8/T3: Facilitator ➔ Facilitator ➔ Student 3

### ClickShare™ was not used in 2 PBL tutorials:
- Oct 22, P6/T2
- Nov 2, P7/T3 & P8/T1
application of ClickShare™ as a technological tool for scaffolding student learning and collaboration is examined.

ANALYSIS

Across the six tutorials in which ClickShare™ was available, the facilitator and students employed it on 14 occasions in four PBL tutorials (P5/T3 & P6/T1, P6/3 & P7/T1, P7/T2, and P8/T2 & P8/T3). The group did not adopt ClickShare™ in two PBL tutorials (P6/T2 and P7/T3 & P8/T1). The shaded segments of the event map (see Figure 10.3, above) indicate the key learning events in which discussion of the resources shared by ClickShare™ became consequential to group learning through the collective decision to include these in the group notes drafted by the clerk in the shared Google Docs™. In the following subsection, analysis of the discourse and actions of participants across five key events (see Figure 10.3) explores how the students and their facilitator employed ClickShare™ as a technology for collaboration and scaffolding.

Collaboration and Scaffolding in PBL

Student and facilitator use of ClickShare™ ranged from nine occasions (student-initiated) to five occasions (facilitator-initiated) in 4/6 PBL tutorials recorded across three PBL problem cycles (see Figure 10.3). Shaded segments on the event map indicate the key events across the problem cycles in which students or the facilitator employed the ClickShare™ functions to share journal articles, group notes, and brain images while explaining concepts or ideas in real time. The iterative and recursive ethnographic tracing of the historical and consequential nature of these sharings and discussions is indicated in the event map (Putney et al., 2000). Central to identifying these “rich points” (or key events) was the group decision to include the shared digital objects in the “collaborative group notes,” a local term for the record of the case discussion and synthesis of new knowledge.

Key Event 1

The first key event occurred in the combined session (P5/T3 & P6/T1) when the facilitator joined in the ongoing discussion by asking the group: “Do you guys know of any device that helps remember the functions or just the names of the cranial nerves?” (Excerpt 1, 1:09:37). Student 4
(S4) responded to the question: “There is a video from YouTube that our classmate shared” (Excerpt 1, 1:09:50). Then S4 and S3 tried to search for that video. Meanwhile, the facilitator used ClickShare™ to share a chart (Excerpt 1, 1:09:54) to stimulate quick recall of the functions and names of cranial nerves. She then recommended that the group use this chart as a framework to develop their own chart. After that, she also shared an image using ClickShare™ and recommended the group draw all ideas into an image. The clerk, Student 2 (S2), asked the facilitator to share with the group after class (Excerpt 1, 1:11:26). It was not clear whether S2 found the image or the chart useful and wanted to include either in the group notes. Later, the first author found that only the framework was applied in the group notes for Problem 5, as the names and functions of the cranial nerves appeared in the first two columns (see Artefact 1, Figure 10.7). However, the image shared by the facilitator was not included in the group notes. Therefore, the sharing of the chart by the facilitator was the first key event that contributed to student learning and note generation.

Excerpt 1: Synthesizing Information for Problem 5

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:09:37</td>
<td>Facilitator</td>
<td>Do you guys know of any device that helps remember the functions or just the names of the cranial nerves?</td>
</tr>
<tr>
<td>1:09:50</td>
<td>S4</td>
<td>There is a video from YouTube that our classmate shared.</td>
</tr>
<tr>
<td>1:09:54</td>
<td>Facilitator</td>
<td>Okay, could you include that in your notes maybe? ((S4 unplugs the dongle [the ClickShare™ USB for screen sharing] from S5’s laptop and plugs in S3’s laptop; S3 shares screen to IWB and searches for the video on YouTube)) I’ll . . . I will show you this too meanwhile. ((trying to use ClickShare™ to split screen and make her chart full screen on the IWB but unsuccessful))</td>
</tr>
</tbody>
</table>

![Figure 10.4](image)
How do we make it big? (asking the technician next to her))
Oh, so we can . . . oh, to make it a full screen, okay. 
((making her chart on the right-hand side full screen using ClickShare™))
Okay, um, can you see this? ((showing her chart on IWB; all students are paying attention to the IWB))

**Figure 10.5**

so um, pretty easy way to remember . . . and then the functions. . . . Alright, so um those are two little ways you could help remember ((S6 nods her head)).
And then another is . . . I found I found this, this photo ((switching to an image; all students are still paying attention to the IWB))

**Figure 10.6**

which I think it is a good visual, right? So you guys did a great job . . . put all of the . . . you know the whole chapter into a very organized chart, but sometimes for people who are more visual I think this is kind of um a nice way to ((S6 and S7 nod their heads)) . . . you know, okay?

<table>
<thead>
<tr>
<th>1:11:26</th>
<th>S2 (the clerk)</th>
<th>How do we include this (the chart or the image) in our notes?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:11:28</td>
<td>Facilitator</td>
<td>Oh you want me to um upload it on the er? Form, that’s it.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Okay</td>
</tr>
</tbody>
</table>
### Functions of the cranial nerves

#### 4. Assessment of intelligibility, comprehensibility and efficiency of communication

**a. How to conduct and interpret cranial nerve examination (bed-side assessment)? Basic function of Cranial nerves**

<table>
<thead>
<tr>
<th>Cranial nerve</th>
<th>Functions</th>
<th>Assessment</th>
<th>Effect of lesion on speech</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trigeminal (CNV)</strong></td>
<td>Jaw movement</td>
<td>Observation of jaw motility, involuntary chewing and trismus (clenching of teeth)</td>
<td>- Slow or imprecise AMRs - Unilateral UMN lesion: no Significant effects</td>
</tr>
<tr>
<td></td>
<td>Afferent</td>
<td>- Ask the patient to close eyes, touch forehead, cheek, mandible</td>
<td>Unilateral LMN lesion: Jaw will be deviated to the affected side during closure (Sailor, 2011)</td>
</tr>
<tr>
<td></td>
<td>- Pain</td>
<td>- Apply light pressure at face, cheek, tongue, teeth, and palate (Duffy, 2013)</td>
<td>Bilateral lesion: UMN exaggerated jaw jerk reflex (10% of adults have this reflex)</td>
</tr>
<tr>
<td></td>
<td>- Thermal</td>
<td>As for sensation</td>
<td>Not able to elevate jaw -&gt; imprecise articulation</td>
</tr>
<tr>
<td></td>
<td>- Mechanical</td>
<td>As for motor: - Asymetrically tightly clenched of teeth - Mandible out the midline - Jaw jerk reflex: finger at the jaw, tap the finger with hammer</td>
<td></td>
</tr>
<tr>
<td><strong>Facial (CN VII)</strong></td>
<td>Efficient</td>
<td>Observation of face symmetry and forehead wrinkling</td>
<td>UMN lesion: - Contralateral lower face lesion - Bilateral lesion: - Distorted speech esp bilateral and labiodental sounds - Slow speech rate</td>
</tr>
<tr>
<td></td>
<td>- Facial movement</td>
<td>As for motor</td>
<td>LMN lesion: - Upper and lower face ipsilateral paralysis: - &gt; facial asymmetry - Atrophy</td>
</tr>
<tr>
<td></td>
<td>- Hyoid elevation</td>
<td>Strength is assessed by applying equal force to the muscles 1) Smile 2) Raise eyebrows 3) Close eyes (strength is indicated by the patient's ability to close eyes tightly) 4) Puff cheek</td>
<td>- &gt; facial asymmetry - Atrophy - Fasciculation</td>
</tr>
<tr>
<td></td>
<td>- Stapedius reflex</td>
<td>As for sensation 1) Distinguish a sweet taste with sugar water on Qtip</td>
<td></td>
</tr>
<tr>
<td><strong>Glossopharyngeal (CN IX)</strong></td>
<td>- Pharyngeal movement</td>
<td>The ability to produce reflex (25% population have absent gag reflex)</td>
<td>Hypersalivation resulted from compromised pharyngeal elevation</td>
</tr>
<tr>
<td></td>
<td>- Pharyngeal and tongue sensation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 10.7** Artefact 1, p. 13 of the group notes for Problem 5 (researcher annotations added).
The facilitator’s use of ClickShare™ to share a chart as a framework and the PBL group clerk’s later application of this framework to the annotated student group notes (Artefact 1) illustrates two of the PBL facilitation goals listed above goal 2, “keep the learning process on track,” and goal 3, “make the students’ thoughts and their depth of understanding apparent.” The facilitator kept the learning process on track by providing an exemplar as a scaffold to guide students on note generation. In sharing with ClickShare™, she not only made it visible to the collective but also provided a framework to enable joint coconstruction by the whole group (Hmelo-Silver & Barrows, 2006). In this key event, the required action for the students was to create a framework to summarize ideas (modelling), but the students had not learned about the framework previously. This was one of the learning tasks they should have undertaken independently. Therefore, the facilitator performed this action once as a scaffold to model for students how to learn the relationship between the learning objective and the learning task (Reiser & Tabak, 2014). It shows ClickShare™ playing an important role in scaffolding, as it allowed the facilitator to make public the chart (framework) as an exemplar and resource for enhancing group interaction.

**Key Event 2**

The second key event took place in the same PBL tutorial (P5/T3 & P6/T1) when S4 and S7 built on S5’s presentation on hypodense areas (Excerpt 2, 1:16:14) and the basal ganglia (Excerpt 2, 1:24:44) and added their viewpoints in the discussion. S4 responded to S5’s presentation on hypodense areas (Excerpt 2, 1:19:25) by giving her view: “And we can also say this stage is sub-acute, sub-acute when it is isoted (when there is an isodense lesion) and hypodense will be chronic.” When S5 was trying to identify the site of the lesion from the CT scan in the journal article that she shared via ClickShare™, S7 explained the brain image and provided the answer (Excerpt 2, 1:25:52). Evident from the student-generated synthesis of final group notes (see Artefact 2 in Figures 10.10 and 10.11) was that S4, S5, and S7’s discussion contributed to a collective understanding about the consequence of a hypodense area and the location of the basal ganglia. The shared CT scan in the article helped the whole group to focus on the ongoing discussion and visualize S5’s interpretations on the results of the CT scan. It would have been very difficult for S5 to explain her interpretation verbally without using a shared visualisation. Therefore, ClickShare™ not only helped S5 to present her ideas but also helped the whole group
to understand S5’s ideas and respond accordingly. From an interactional perspective, the interaction among S5, S4, and S7 increased at 1:16:14 when S5 employed ClickShare™. Consequentially for their learning, this led to the coconstruction of the group notes (Artefact 2) by these three students. As students were active in the learning process and were able to make their thoughts and depth of understanding apparent (Hmelo-Silver & Barrows, 2006), the facilitator did not intervene in the discussion and let the students take the responsibility for their own learning.

Excerpt 2: Synthesizing Information for Problem 5

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:16:14</td>
<td>S5</td>
<td>It shows that there are some sagittal views ((all students are paying attention to the IWB; S5 uses ClickShare™ to split screen and share the CT scan found in an article on the right-hand side of the IWB; the clerk takes notes on the left-hand side of the IWB))</td>
</tr>
</tbody>
</table>

Figure 10.8

In fact, from CT scan we have different views ((all students are paying attention to the IWB)). And the view we had, on the, from the case history is high-mid brain level . . . yea . . . and for hypodense er hyperdense area, so er for acute haemorrhage, it will be hyperdense so it will (be) right red, and after 4 days to 2 weeks, it will be isodense, so that the basal will be similar to the colour of the brain. And it will finally be darker than the brain after 2 to 3 weeks. ((the clerk jotting down the notes))

Hypodense. Maybe haemorrhage stage ((suggesting the note taking)) I don’t know. ((the clerk is jotting down the notes))

Post-haemorrhage after 2 to 3 weeks ((suggesting the note taking; S3, S4, and S5 are paying attention to the IWB; the clerk is jotting down the notes; S6, S7, and S1 are discussing on their side))

In fact, there will be isodense. There will be isodense period. It will be 4 days to 2 weeks after the haemorrhage.
And we can also say this stage is subacute, er subacute when it is isoted . . . and hypodense will be chronic ((the clerk is jotting down the notes; other students are focusing on their mobile devices))

Because other (parts in this journal article) are quite . . . quite difficult ((laughing)), but I think this . . . the best thing I think is that we can identify ((pointing to the IWB)) the structure from the CT scan more easily because they have pointed this quite well ((all students are paying attention to the IWB)), so I better share this to you. ((S3 nods her head))

I am wondering the view is up . . . higher than that of er basal ganglia. Because um ya ((using the split screen function to show the CT scan in an article; all students are paying attention to the IWB))

Figure 10.9

Um we have, um CT scan has different um can scan different segments and for A is a basal ganglia region. So it is quite different from the upper cortex, is it . . . It seems to me that the scan would be more like an upper cortex instruction. Can I make it brighter? Is it useful? Not useful? Isn’t it? ((asking the group whether the screen becomes brighter))

Can you move up to the basal ganglia? ((asking S5 to scroll up))
Because it has the internal capsule container and also contact ((pointing to the CT scan on the IWB; all students are paying attention to the IWB)), which is also signal to adaptation beside the CT scan, so I would suggest this is basal ganglia.

Okay.

Key Event 3
The third key event occurred at 1:16:54 in P7/T2 when S3 shared a journal article on the prognostic factors for the progression of Parkinson's disease and provided information on the HY scale (Excerpt 3, 1:18:45; Artefact 3 in Figure 10.14). S3’s contribution to coconstruction of knowledge was evident in the group notes (Artefact 3). By using ClickShare™, S3 was able
to present what she found during SDL to support collaborative knowledge building, as evident in the consequential uptake in the group notes. Given that the facilitator did not intervene in S3’s presentation, the learning process made visible S3’s acting with autonomy.

Excerpt 3. Synthesizing Information for Problem 7

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Discourse</th>
</tr>
</thead>
</table>
| 1:16:54| S3      | I have a journal (article) talking about the prognostic factors ((grabbing the dongle [the ClickShare™ USB for screen sharing]))
1:16:59 Facilitator  Say again? Prognostic?

1:17:02 S3  I have a journal (article) ((S5 helps plug in the dongle to S2’s laptop)) talking about the prognostic factors for the progression of Parkinson’s disease by . . . ((waiting for ClickShare™’s screen sharing response to the IWB))

1:17:30 S3

Figure 10.12
((S3 talks about the first prognostic factor, which is not included in the group notes))
And then another report it says the age of onset is another prognostic factor . . . like older age will er indicate like faster progression ((using ClickShare™ to share a journal paper; all students are focusing on the IWB; the clerk jots down on p. 5 of the group notes for problem 7))

What to do now? ((S3 uses lip language to ask S6))
((S3 keeps scrolling down the article))

1:18:45 S3

Figure 10.13
Here it shows er another . . . another type of progression. This is using the scale we mentioned before the HY scale. ((S3 continues to share the same journal and talks about HY scale; the clerk jots down on p. 6 of the group notes for problem 7))
Key Event 4

The next key event occurred at 1:45:05 in the last tutorial of Problem 8 (see Figure 10.3), when the facilitator used ClickShare™ to display a diagram and encouraged her students to adopt this for both sharing accessed images and visualizing their own ideas (Excerpt 4). The students did not know a diagram was available online. The facilitator saw this learning need and shared a diagram via ClickShare™ to visualize her idea. The clerk then searched for the diagram on Google in real time and included it in the group notes (Excerpt 4 and Artefact 4 in Figure 10.16). This facilitator activity illustrates PBL performance goal 4, encouraging learner autonomy (Hmelo-Silver & Barrows, 2006). Key to learner autonomy is that students have control and agency in deciding when they should share visual representations. In addition, by sharing the diagram for collaborative knowledge building via ClickShare™, the students had learned a new step, visualizing ideas with a diagram, to add to the known sequence (Reiser & Tabak, 2014). They had therefore acquired more complex learning behaviours from simpler learned behaviours. The goal of scaffolding here was to help them develop their full potential in learning independently.

Excerpt 4. Synthesizing Information for Problem 8

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:45:05</td>
<td>Facilitor</td>
<td>And then recently um I don’t know if you guys can see it ((using the split screen function to show a diagram)) I think a nice diagram here ((making the diagram a full screen))</td>
</tr>
</tbody>
</table>
Figure 10.15
This is a nice diagram that shows okay, pre-operative, post-operative. And you can see okay air, food and the system. I think something like this graphic or you guys have another one from the skills lab, it’s a really good way to kind of make this a little more useful ((the facilitator stops sharing the diagram on the IWB and returns to the group notes)). I think this is good but I don’t think you know when you guys do the revision, it is that useful. So you might want to include (the diagram in the group notes), you could even draw one or make one, I just think a visual is a little easier to draw these ideas kind of together. ((the clerk searches for the diagram on Google right away and then includes it in the group notes of Problem 8))

Figure 10.16 Artefact 4, part of p. 5 of the group notes for Problem 8.
Key Event 5
The final key event indicated in the event map (see Figure 10.3) occurred at 2:04:01 during the atypically combined tutorials in this final problem of the module (P8/T2 & P8/T3). At this instance, Student 3 (S3) shared a journal article using ClickShare™ (Excerpt 5, 2:04:01). The article title was then included in the collaborative group notes (Artefact 5 in Figure 10.18). S3’s presentation on the result of radiotherapy (Excerpt 5, 2:06:12) was also included in the group notes. S7 also added her idea on dry mouth (Excerpt 5, 2:04:50) after S3’s sharing of the article, and it is included in the group notes. ClickShare™ helped S3 make her thoughts and the depth of her understanding apparent. The facilitator did not need to intervene in the discussion at this moment, as ClickShare™ became the technology that supported student learning. The learning process was on track.

Excerpt 5. Synthesizing Information for Problem 8

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:04:01</td>
<td>S3</td>
<td>I have a journal (article) about dysphasia after total laryngectomy (all students are paying attention to the IWB). And it says that um if there is no complications, then the patient usually can be normal swallow about 5-7 days after surgery, but it also mentions some complications such as . . .</td>
</tr>
<tr>
<td>2:04:50</td>
<td>S7</td>
<td>. . . Because the surgical procedures (are) always in combination with radiotherapy, and therefore they may also have some dry mouth, and dry mouth, it may affect the lubrication of bolus and make it more difficult to manage.</td>
</tr>
<tr>
<td>2:06:12</td>
<td>S3</td>
<td>I think the loss of sense of smell and taste can also be a result of radiotherapy. ((the clerk jots down the notes))</td>
</tr>
</tbody>
</table>
DISCUSSION

In PBL, the facilitator does not act as the source of information but rather guides and supports student learning when needed. Analysis presented in this IE indicates that the facilitator only provided scaffolding with the use of ClickShare™ when the students could not complete the tasks without her guidance. By sharing new knowledge with the students via ClickShare™, the whole group could make the move, in the Vygotskian sense, from “what they cannot do” without incorporating new knowledge to “what they can do” with incorporating new knowledge. The repeated interactions over the course of the five key events supported their movement towards closer approximation of the modeled actions and their association of these actions with the learning objective and the learning task (Reiser & Tabak, 2014). The facilitator provided scaffolding via ClickShare™ based on the learning needs of the whole group. After the first ClickShare™ trial (P5/T3 and P6/T1), the facilitator reflected in the group debriefing on her experience with using ClickShare™. The group debriefing was a part of the formal stage of the PBL cycle in which members (students and their facilitator) reflected on or evaluated their own and peers’ performance:

I think I did well using my ClickShare™ a couple of times, however I think I could have done better by not jumping in onto discussion
In P5/T3 and P6/T1, the facilitator employed ClickShare™ twice (see Figure 10.3, 1:09:37 and 1:41:46) to share a chart as a framework and a graph to prompt students to generate some hypotheses. These sharings supported performance goals 2, “keep the learning process on track” and 3, “make the students’ thoughts and their depth of understanding apparent” (Hmelo-Silver & Barrows, 2006). In both key events 1 and 2, when the facilitator and S5 shared the results of their online searches with the group using ClickShare™, the whole group’s shared attention was on the IWB. This collective engagement then prompted a clear and focussed discussion.

To sum up, S4 responded to the facilitator’s sharing of a chart by requesting the facilitator to share it with the group (Artefact 1), while S4 and S7 also joined in the discussion by adding their ideas to S5’s, which helped the construction of the group notes (Artefact 2). Therefore, this ethnographic tracing of the role of ClickShare™ during this single PBL tutorial (P5/T3 and P6/T1) indicated how application of this technology contributed to students’ learning processes in sharing their ideas and in stimulating the whole group to making active contributions to the discussion. In these instances, the technology not only served as a scaffold for the acquisition and coconstruction of knowledge but also acted as a prompt to enhance within-group interactions (see Hmelo-Silver, Bridges, & McKeown, 2018).

In ensuing PBL tutorials, the facilitator and students continued to incorporate ClickShare™ as a technological tool for scaffolding and collaboration. In P7/T2 (see Figure 10.3, 1:37:20), after S3 used ClickShare™ to share a journal article found during SDL research on the topic of fronto-striatal cognitive deficits at different stages of Parkinson’s disease, the facilitator used a technique called “reflective toss” to scaffold the group’s thinking processes (Hmelo-Silver & Barrows, 2006). The reflective toss takes place when a teacher takes the meaning of a student’s ideas and asks the student to elaborate. This act lets the student take responsibility for his or her own learning. The facilitator prompted the students to make their thinking visible and apply what they had learned by asking an open-ended question:

Given your [S3’s] understanding about impaired working memory in Parkinson, impaired short term memory span or working...
memory, how much can you [S3 and other students] integrate that to practice in a team?

ClickShare™ in this example provided an opportunity for S3 to share her ideas with the group. It also led to improved facilitator understanding of what S3 and her peers already knew, which was consequential to her subsequent prompting of the students to construct knowledge collaboratively.

In P8/T2 and P8/T3 (see Figure 10.3, 1:45:05), when the students were discussing the total laryngectomy and the clerk was jotting down the ideas in bullet points in the group notes, the facilitator simultaneously showed them a diagram using ClickShare™ and commented that it was a nice diagram that shows okay, pre-operative, post-operative [laryngectomy]. . . . I think something like this graphic or you guys have another one from the skills lab. It’s a really good way to kind of make this a little more useful. . . . I just think a visual is a little easier to draw these ideas kind of together.

Students agreed that the shared diagram was useful. To further encourage the use of diagrams, the facilitator suggested that they summarize the ideas in a diagram of their own. The shared diagram was then inserted into the group notes (see Artefact 4). This sharing of a useful diagram again helped the facilitator to attain facilitation goal 2 of keeping the learning process on track. The discussion around the shared diagram then helped students to improve their understanding of the pre-operative and post-operative conditions of a total laryngectomy (see Hmelo-Silver et al., 2018).

Students took the initiative to employ ClickShare™ on nine occasions to share new information with the group in order to support collaborative learning. ClickShare™ stimulated the whole group to actively contribute to the discussion, with the ethnographic tracing indicating consequential progression, in which some ideas were adopted and included in the collaborative group notes (see Artefacts 1–5). The social interactions within the group were enhanced as students made use of ClickShare™’s screen-sharing function and others built on what was shared and discussed. When students were able to share ideas using ClickShare™, the whole group could move from “what they cannot do” without sharing new knowledge to
“what they can do” with sharing new knowledge. Given that the ZPD was the gap between “what students cannot do” without scaffolding and “what students can do” with scaffolding, our analysis has indicated that a central role of ClickShare™ was to help students narrow the ZPD and gain control of both disciplinary subject matter and collective learning processes. This analysis has indicated that ClickShare™ was important for supporting students’ gradual development of the skills and knowledge necessary for becoming clinical professionals.

Limitations
The adoption of an ethnographic telling case approach may have limited the generalisability of the findings; however, this allowed an in-depth exploration of the “how” of PBL learning processes with the use of educational technologies. Recording ClickShare™ activities on an IWB was challenging, despite using three cameras. In the future, supplementary recordings using screen capture software on students’ or the facilitator’s laptops could enhance the quality of the ethnographic archive. Finally, the group did not employ ClickShare™ in two PBL tutorials. Additional interviews with the group members could have provided further understanding of why the technology was not taken up on these occasions.

CONCLUSION
As a novel tool, ClickShare™ played a role in the presentation of learning objectives, the collaborative construction of knowledge, and the scaffolding of learning in the PBL tutorials. Analysis of the video recordings indicated that both students and the facilitator used ClickShare™ to present their ideas, share images or journal articles, coconstruct the group notes, understand and react to others’ ideas, and share useful resources on the IWB. ClickShare™ not only helped the facilitator to scaffold students’ active construction of knowledge but also helped students to coconstruct knowledge in PBL tutorials through the process of social interactions (Sawyer, 2006a, 2006b). The results of this study could inform future directions in the design and development of educational technologies for PBL as well as inform understanding of new technology-engaged PBL facilitation strategies.
ACKNOWLEDGEMENTS

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