Teachers' Ideas about Learning, their use of Technology and Learner-Centred Classrooms

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Abstract

Despite the ubiquitous and prolific application of computer technologies in educational contexts, technology has not yielded significant transformations of classroom practice. One reason may be due to teachers' understandings of effective learning and how technology can be used to support learning. In this study, we observed and interviewed ten teachers who were considered to exemplary and known to use technology. While there were instances of technology being used to create learner-centred lessons, much of the time technology was used to make teacher-directed practices more efficient. Teachers' understanding of effective learning appears to play an important role in using technology to create learner-centred classrooms.

Introduction

The rapid development of technology and its application to educational contexts has presented educators with a unique opportunity to fundamentally change the way instruction occurs (Mayer, 2010; Richardson, 2012; Sheppard, Seifert & Wakeham, 2012). Teachers have at their disposal a vast repertoire of possibilities for creating enriched, engaging educational experiences. Most importantly, the utilization of technology creates the potential for developing classrooms that are learner-centred (Tamid, Bernard, Borokhouski, Abrami, Richard & Schmid, 2011). Yet, there is nothing inherent in the technology that will necessarily result in learner-centred classrooms. In fact, the evidence suggests that the adoption of technology leads to little change in classroom practice (Collins & Halverson, 2009; Cuban, 2001; John & Wheeler, 2008; Mayer, 2010; Penuel, 2006; Sheppard & Brown, 2014; Sheppard, Seifert & Kelly, 2008; Sheppard et al., 2012). For example, in a study of the adoption of laptops by students in a high school, Sheppard et al. (2008) reported that the laptops were little utilized and had minimal impact on practice. Teachers in these classes were likely to use the laptops for presentation of information, record keeping and communications while students seldom used them in support of their own learning.

Similarly, in 2009, Collins & Halverson observed "deep incompatibilities between the demands of the new technologies and the traditional school" (p.5) arguing that, "the lockstep model of most classrooms undercuts the power of the new technologies to individualize learning… [and moreover], trying to prepare students for the 21st century with 19th century technology is like teaching people to fly a rocket ship by having them ride bicycles." (Collins & Halverson, p.5-6 & 9).

Having observed that technology has not yet transformed classroom practice, Mayer opined that the failure might be the result of a focus on technology rather than on learning per se (Mayer, 2010). That is, initiatives aimed at adopting technology have failed because they do not take the learner into account as a consequence of a flawed assumption that the teacher and learner will adapt to the new technology (Mayer, 2010, p.183). That is, while technology has the potential to create student-centered classrooms, it has failed to do so because is has ignored the two fundamental principles relating to learner-centred classrooms: (a) instruction is based upon a profound understanding of learning and (b) lessons are developed from the perspective of the learner (McCombs, 2000).

Learning and comprehension requires students to create meaning (Wittrock, 1989) by engaging in cognitive and metacognitive processes (Winne & Hadwin, 1998). These processes are executed by the student or invoked through appropriately designed instructional prompts, cues or tasks (Winne, 1985; Wittrock, 1989). Critical to effective learning is the development of self-regulatory and agentic processes (Zimmerman, 2000; Bandura, 2001; Puustinen & Pulkkinen, 2001) that may be heavily influenced by the classroom environment (Butler & Cartier, 2004; Perry, Vandekamp, Mercer & Norby, 2002).

In learner-centred classrooms, the students' individual needs determine the teaching-learning processes. Although the content as outlined in the textbook or the curriculum guide may be considered as important, it is viewed as "powerless without an engaged learner" (Lent, 2012, p.14). As a consequence, teachers in learner-centred classrooms consider students' abilities and interests, and focus on making tasks relevant. They recognize and support the diverse needs of students in their classrooms, provide students with choice and control over their learning, provide time for critical reflection, facilitate collaborative student engagement and critical reflection, and encourage students to make meaningful real-world connections (Lent, 2012; McCombs, 2000). Consequently, instruction in a learner-centred classroom has several noteworthy characteristics: (a) Students are engaged in activities that involve finding

meaning and involve complex thinking. To that end, they learn cognitive and metacognitive strategies to support thinking; (b) Students are engaged in collaborative activities to generate meaning and solve problems; (c) Students are working at appropriate levels through accommodations of their individual needs, and (d) Students are working on activities that allow them to develop self-regulation through exercise of autonomy and self-determination. (Sheppard et al., 2012, p.2)

As an extension to past research, we are interested in two questions. First, how do teachers who are considered exemplary use technology in their classrooms? Is it being use to create learner-centred environments? Second, how do teachers understand effective learning, effective classrooms and technology's role in supporting learning?

Method

This particular study utilized two methods of data collection – observations and interviews. Four school districts in an eastern Canadian province were invited to participate in the study. We asked each school district to recommend elementary or intermediate schools with exemplary teachers who were known to use technology regularly in their classrooms. Each school district nominated teachers who we then asked to participate in the study. From this nomination, 10 teachers agreed to participate–3 teachers in one district, 5 teachers in another, and 1 in each of the other two districts.

Classroom observations

Having obtained a sample of exemplary teachers, we began to study their pedagogical use of technology using naturalistic observations. In total, 32 classroom lessons with ten teachers were observed. Each teacher was observed on at least two occasions; most were observed three or four times, with one teacher being observed six times (Table 1).

Classroom observations were arranged in consultation with the teacher at a time that was convenient to the teacher and when the teacher was using technology in his/her class. During the lessons, the researcher acted as a non-participant observer. She would blend into the class taking notes of the activities of the teacher and students, including the technology being used and interactions occurring. Occasionally, the researcher would interact with students, but in general the contact was minimal. During the in-class observations, the researcher looked for evidence that technology enabled students to better access and transfer prior knowledge, provided them with

increased opportunities to demonstrate autonomous strategic self-directed learning, or enhanced the quality of their learning.

Table 1:   Number of observations per teacher

Teacher	District	School	Grade	Number of observations
6		Pebble	5	4
9		Violet	6	2
10	District A	Violet	5	6
3		Holt	4	3
2		Fern	4	4
1		Bobsleigh	4	2
7	District B	Timber	4	3
8		Timber	5	3
5	District C	Paxt	4	4
4	District D	Mackerel	6	4

Transcriptions of field notes were created for each lesson observed. Summaries of each transcript were subsequently created to concisely articulate the significant events transpiring in the lesson. Two researchers reviewed these summaries and reached agreement on the match between the summaries and the field notes. After reading each summary to develop an overall sense of the activities in the classroom, we analyzed each summary to identify *meaning units* within the lesson (Rennie, Phillips & Quartaro, 1988; Dupuis, Bloom & Lougheed, 2006). A meaning unit refers to a phrase or sentence that expresses a single idea (Dupuis et al. 2006), which Fischer and Wertz (1979) referred to as "a distinguishable moment in the overall experience" (cited in Halling, 2008, p.163). In this case, meaning units refer to behaviours exhibited by the teacher or student (e.g., "teacher asks question" or "student writes answer on interactive white board"). We also created meaning units to describe the type and use of the technology being referenced (e.g., "display a website" or "create a story web").

The identification and coding of meaning units were achieved by the consensus of two of the researchers. Two researchers read the transcripts and reached agreement on the coding. The classroom observations data were coded and analyzed using QDA Miner (Provalis, 2011), a software program for analyzing qualitative data. Text segments identified as meaning units were "tagged" with a code. These codes were then analyzed in two ways. Quantitative methods provided descriptive and summary information. This was supplemented with qualitative analyses of meaning units.

Interviews

Interviews were conducted with the principals and teachers; focus groups were held with students. Interviews of teachers were arranged at a time and location convenient to the teacher. Interviews typically took place in the school and lasted approximately 30 to 60 minutes. The interviews typically took the form of a conversation between the researcher and teacher. During the conversation, questions about technology, effective learning and effective classrooms were asked. Recordings of interviews were subsequently transcribed. As with observations, the researchers analyzed the transcribed text in order to identify meaning units. In this case, a meaning unit referred to words or phrases representing teachers' described behaviours, their ideas about learning, their use of technology, and students' behaviours. Having achieved consensus between two researchers, the interview meaning units were analyzed using QDA Miner (Provalis, 2011).

Results

Using the data gathered through classroom observations, two researchers independently labelled each lesson according to two dimensions. First, each lesson was labelled according to the dominant type of classroom structure for the lesson. The emergent categories were: (a) *whole class* instruction in which the teacher led the instruction and all students participated in the same activity; (b) i*ndependent* work in which students performed separate tasks; and (c) *activity centres* in which groups of students rotated through a set of stations of activities. Second, each lesson was described as being teacher-directed or learner-centred. In addition, teachers were categorized by their level of sophistication with using technology as either novice, comfortable or sophisticated. Data were also coded along six general themes: type of technology being used, its purpose, student actions, teacher actions, student engagement and cognitive activity.

Observations of teachers

Classroom structure

The most common classroom structure observed was the whole class setting. Twenty-one of the 32 lessons observed (66%) were considered to use a whole class setting (e.g., teacher explanations or class discussions). Eight lessons (25%) were set up as independent activity (e.g., blogging or research projects) while three (9%) involved activity centres. The most frequent subjects observed were mathematics and language arts (34% and 28% respectively). The subjects for the remaining 11 classes were

science, social studies and music (15%, 15% and 6% respectively). Ten of the 11 mathematics classes observed were whole class settings; the remaining one used activity centres. Activity centres were most likely to be set up in language arts classes while independent activities were likely to occur in language arts, science or social studies.

One-half of the teachers observed indicated that they had participated in some form of professional development concerning the creation of learner-centred classrooms. A cross-tabulation analysis of the coded data revealed that four of the six teachers who created lessons involving independent activities had received professional development training. However, two of the three teachers who used activity centres had not received professional development training. Overall, we found that teachers receiving professional development training were as likely to use a whole class setting as those who did not receive it.

What technology was being used and for what purpose?

A wide variety of technological devices were used in the lessons observed, ranging from computers and interactive white boards to mathematics manipulatives and printed materials such as encyclopaedias and dictionaries (see Table 2). The most commonly observed devices were the interactive whiteboard (25 lessons) and computers (11 lessons). A cluster analysis of the codes for technology (Figure 1) revealed three patterns of how technology was being used.

The first cluster represented lessons in which computers were used to run applications such as story mapping programs or blogging. In these lessons, students typically worked at activity centres or undertook independent activities using computers in a lab. The following excerpt is an example of this type of use of the technology:

Table 2:   Technologies employed in the observed lessons

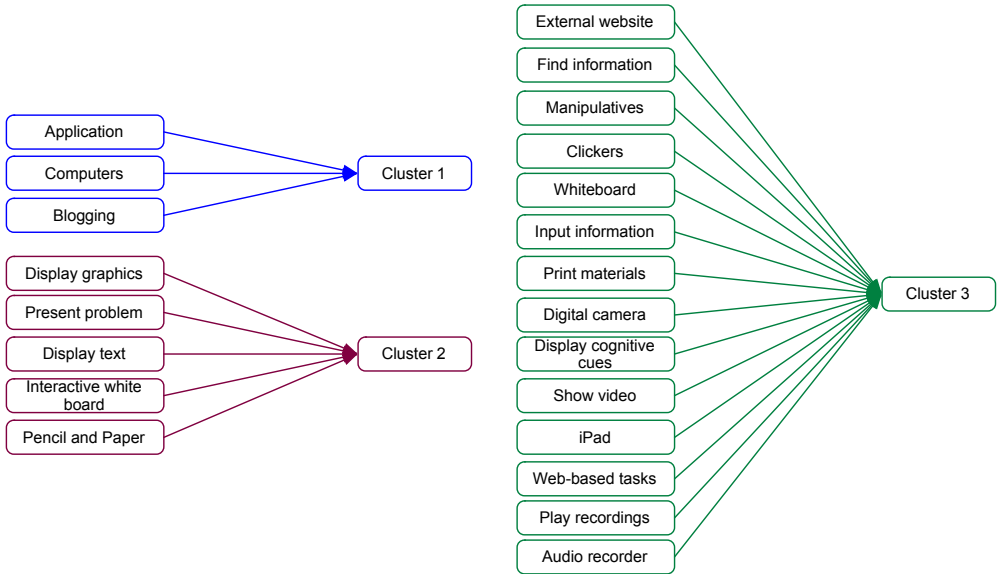| Technology used	Number of lessons
Interactive white board	25
Computers	11
Pencil and paper	8
Whiteboards	4
Print materials	2
Interactive response device	2
Manipulatives	1
Audio recorder	1
iPad	1

Figure 1. Cluster analysis of technology use, type and purpose

> *Students are assigned a computer, one per student. Students are making cartoons using a programme called Cartoon Creator. The cartoons are to depict in words and illustrations their reactions to a book they have read. … Students have to create a cartoon as a book report. Students have choice about which book to report on; what backgrounds, characters and dialogue to use in the cartoon; and the number of panels…. When students are finished they have permission to work on their blogs–making postings or comments on other's blogs. Once they are finished the cartoon and blog, they can sign on to authorized sites. (Field notes summary: Fern, Day 3)*

In most instances, the computer aided students in the creation of some artifact. The most common activity was writing which involved creating blogs and responses to blogs, or finding information and writing a report. Occasionally, students used applications to create story webs or mind maps, and in one instance students used an application to create a book report in cartoon format while in another they compared commercials and their messages by creating storyboards.

The second cluster can be described as teachers using the interactive whiteboard for displaying text or graphics, or presenting a problem. The most common use of the interactive whiteboard was for displaying information, much in the same way as using a blackboard or whiteboard. This information could be instructions for an activity, keeping a list of names on a checklist, or displaying a copy of a poem.

As an example from our observations, "the teacher put a math problem on the interactive whiteboard, students write their answers on their whiteboards. Teacher discusses strategies with students. Teacher gives them a new problem, then another" (Field notes summary: Holt, Day 3). After presenting the information, students would be asked to complete some a pencil and paper worksheet or assignment. This pattern of presentation and/or explanation followed by discussion and assignment of student work is consistent with our observation of most classes having a whole-class structure.

Although the interactive whiteboard was used frequently "as giant whiteboard" (Teacher interview: Bobsleigh), there were singular instances where it accomplished other tasks. For example, the interactive whiteboard was used to access external websites (Statistics Canada), use web-based applications (Google Earth), show a video, or play an educational game (Math Baseball). On two occasions, interactive response devices (clickers) were used to interactively input information from students that was displayed on the interactive whiteboard as a bar graph to facilitate whole-class discussion.

The third cluster represented the use of technological devices for particular purposes as singular events. For example, one teacher used interactive response devices (clickers) to generate bar graphs. Another teacher used the interactive whiteboard to record students' oral reading, while in another class the student used a digital camera to take photographs for his report.

What the teachers and students were doing

Table 3:   Occurrences of observed teacher actions

Teacher action	Number of lessons
Teacher explains	17
Teacher discusses	14
Cognitive or metacognitive prompts	14
Teacher circulates	12
Teacher questions	10
Teacher models	7
Works one-on-one	2

Our analysis of teachers' actions produced results consistent with teaching practices in a whole class structure (Table 3). Teachers' explanations were the most frequently occurring teacher actions (17 of 32; 53.1%), followed by discussing (14 of 32; 43.8%) and questioning (10 of 32; 31.3%; see Table 3). However, teachers were also observed utilizing cognitive and metacognitive prompts (14 of 32; 43%). Teachers often provided students with prompts to encourage and develop thinking about their thinking as students worked on problems, demonstrated solutions or answered questions. These prompts were often reminders about executing strategies for completing a task, asking for explanations of strategies used, or discussing possible strategies for solving problems. For example, during one lesson, the "teacher asks a student to explain his strategies to the class" (Holt, Day 2). In another instance, "the teacher reminds children to practice active listening and to make connections – to make pictures in their heads – to tune in their brains (Holt, Day 4).

As with teacher behaviours, student actions were coded and the results are presented in Table 4. Given that teacher behaviours were most consistent with a whole class structure, it is not surprising that student actions were also consistent with a whole class structure. The most common student actions observed were independent work (16 of 32; 50.0%) and completing worksheets or assignments (12 of 32; 37.5%). However, students were observed to be explaining (7 of 32; 21.9%), creating (9 of 32; 28.1%) and discussing ideas (6 of 32; 18.8%). They were also seen helping each other out (8 of 32; 25%) and working together (6 of 32; 18.8%).

Table 4:   Occurrences of students' actions

Student actions	Number of lessons
Students work independently	16
Students complete worksheets or assignments	12
Students help each other	8
Student demonstrates	8
Student explains	7
Students working together	6
Students working on technology	6
Students work in pairs	3
Students participate in class discussion	3
Student asks question	3
Student imitates	2

Teacher and student actions were subjected to a cluster analysis with three broad categories of teacher/student actions emerging (Figure 2) illustrates the relationship between teacher and student actions. The clusters can be interpreted as describing behaviours consistent with: (a) a whole class settings (Clusters 1a and 1b), and (b) actions that were based upon group work or activity centre (Cluster 2), and (c) teacher-directed rote learning (Cluster 3). In lessons consistent with the patterns of Cluster 1a and Cluster 1b, the teacher was seen explaining, discussing, and providing cognitive and metacognitive prompts. Student behaviour in this structure included creating and discussing ideas, providing explanations, and completing worksheets or assignments. The dominant technology used was the interactive whiteboard, which was used to provide a means of displaying information that would become the catalyst for discussion. For example:
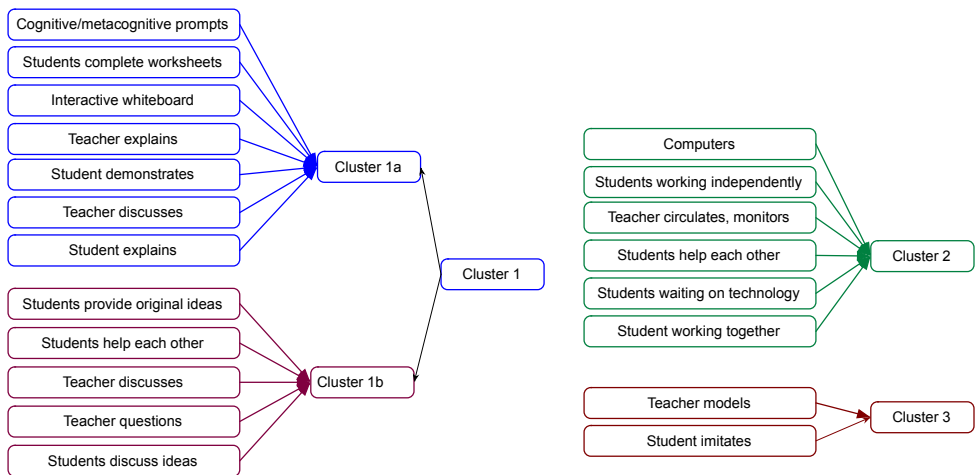

Figure 3. Results of cluster analysis of teacher and student behaviours

The teacher has a poem (In Fanders Fields) displayed on the Smartboard. She calls students' attention to the board and reads the poem. She uses features of the programme (highlight, underline, finger point) as she reads the poem. … She asks students to think of what the words mean and what they think. A discussion ensues. (Field notes summary: Holt, Day 3).

Student engagement and thinking

As students proceeded with their work instances of both engagement and lack of engagement were observed. Students, for the most, participated in class, were engaged in their work and no discipline or behaviour issues were observed. There were a few instances where students were deeply engrossed in their work; however, there were also instances where students became disengaged, bored and disinterested. Using technology did not necessarily result in engagement:

> *Students work individually or with a partner. Teacher passes out math exercise books. Some students use paper and pencil only. Others use individual 8 x 10 whiteboards with whiteboard markers to try out possibilities. Students concentrate on assigned tasks and work quietly arriving at the answer. From time to time they ask for clarification from each other or the teacher (Field notes summary: Fern, Day 2).*

Although using technology does not necessarily result in engagement, it could prompt thinking that leads to engagement. In one language arts class, the interactive white board was used to display information and a story-web program was used to map ideas that became the foundation for engagement:

> *The teacher presents a book called Frosty's New Friend. A picture of the cover is displayed on the interactive white board. The book cover and stuffed toys are props to assist with their writing activity–a demand piece. The teacher calls their attention to the illustration on the interactive white board, and they discuss ideas about what is going on in the picture. The teacher then reminds students to use their strategies for writing stories. She then calls up a program and starts creating a story web. Students express ideas and the teacher puts them in the web. She starts to circulate as students begin their stories. The students get the dictionaries from the shelves. Students check spelling. Others look for words. Some students are writing quite rapidly. Others are thinking a lot. The classroom is very quiet and the students are concentrating on their task. Some students have personal spellers and as they find new words they put them in their personal spellers. The class ends. The students do not want to stop. It is time for recess (Field notes summary: Timber 5, Day 3).*

The use of technology does not necessarily result in engagement. For instance, in one class, even though the class was structured around activity centres, one of which involved using computers, the level of sustained student engagement among individual students seemed questionable:

> *Students help one another. For example, when one student is having trouble signing in, another in the group helps him. As the students rotate out of the computer centre and other children arrive (this happens at different times for different students), students appear initially very excited about having a turn at the computer. As time goes on, students drift away from the computers to do other activities. Initially there is a feeling of competition for the computers, but by the end of the class there are two vacant stations.*

Similarly, in a languages arts lesson being led by the teacher, students were initially engaged but eventually started to drift away:

> *There is a paragraph on the interactive white board. Today's lesson is about voice in writing. The teacher asks the students how the paragraph could be improved. They provide suggestions. Students are sitting, listening, looking and attending to what the teacher is saying.... The teacher tells the students they will need to use these strategies later when they are writing their paragraphs so they need to pay attention. Some students seem to be losing interest.... The teacher cautions they do not want to make their paragraph too busy. Students seem to be losing interest (Field note summary: Fern, Day 1).*

In another class:

> *Students are using a word processor to record their information. Many students are using print materials to find their information. One girl writes out her project by hand and then types it into the template. Students discuss their animals and information, and help each other with difficulties. The teacher circulates and helps students when they raise their hands. Students have content questions; others have technical questions about how to move objects around the page*

> *or copy pictures. The students seem to be losing interest as time progresses (Field note summary: Paxt, Day 3).*

Teacher interviews and effective learning

As describe in the methods section, teachers were interviewed as well as observed. During their interviews, teachers were asked about effective learning and effective classrooms. Results from coding teachers' responses to questions about learning, classroom practice and technology are presented in Figure 3. In this diagram, labels in the boxes represent ideas identified in the teachers' protocols or variables used to describe teachers. The numbers with parentheses inside the boxes are the numbers of teachers making statements labelled by that code. The exception is the three boxes describing classroom structure; those numbers refer to the number of observed lessons corresponding to each type of structure. Line labels are the probability of an element (or code) being associated with a type of teacher (learning-centred: LC or teacher-directed: TD). Overall, teachers had surprisingly little to say about effective learning, what it is or how it occurs. In total, teachers made 64 statements identifying 41 elements (average of 6.4 and 4.1 respectively), ranging from a minimum of three statements about two elements to a maximum of nine statements about of seven elements. Teachers' responses indicated that almost all teachers thought learning was effective when students were engaged, yet there was little articulation of what this meant or how it was achieved. Most teachers also commented that effective learning occurred when students worked collaboratively, and when they were developing meaningful understanding of the content. While these ideas are consistent with the principles of learning and learner-centred classrooms that were stated previously in the paper, there was little description of these ideas, and not all teachers articulated all of these ideas.

A closer examination revealed that teachers who were learner-centred made greater numbers of statements. It was also the case that differentiated instruction, scaffolding and developing self-direction were recognized as components of effective learning by LC teachers but not by any TD teachers. Likewise, when a factor of effective learning was mentioned, it was more likely to be mentioned by an LC teacher than a TD teacher. Overall, it appears that LC teachers have a better understanding of effective learning than TD teachers. A cluster analysis of the co-occurrence of codes yielded two significant patterns. The first pattern, collaboration, engagement and understanding were the elements of effective learning. In the second pattern, differentiated and scaffolded instruction constituted effective learning. Yet while, these two patterns of

elements emerged, the actual number of teachers that fitting into each pattern is small, meaning that few teachers identified these elements concomitantly.

Teacher interviews and effective classrooms

Analysis of teachers' answers to questions about effective classrooms produced 17 elements. Most teachers recognized that providing accommodations for students, creating variety, offering choices and providing opportunities for collaboration were elements of effective classrooms. While these ideas are consistent with the principles of learner-centred classrooms, both the number of ideas expressed by teachers and the depth of articulation was low. Beyond that, there was considerable diversity in ideas about elements of effective classrooms ranging from providing opportunities for physical involvement and mobility to structures of direct teaching and promoting metacognition. What is striking to note is that when a teacher made a statement and an element identified, it was more likely to be mentioned by a teacher who was LC than TD. LC teachers made statements about 16 elements while TD teachers made statements about 10 elements. For example, while providing choice was mentioned by 8 teachers, more LC teachers mentioned it than TD teachers. Likewise, while a few teachers mentioned direct teaching as a component of an effective classroom, the teachers were more likely to be LC than TD.

The cluster analysis of co-occurrence resulted in five different patterns of ideas about effective classrooms. The first emergent pattern was that of diversity: an effective classroom offered variety, provided choice and accommodated students' needs. The second pattern was that of instruction: the effective classroom involved direct teaching, the use of activity centres and technology. Third, a management pattern was present in which the effective classroom was one in which the teacher was able to "read the students," effect smooth transitions between activities and provide feedback to students. Providing spaces for learning and opportunities for mobility emerged as the fourth pattern, while utilizing pre-assessments and access to special needs supports was the fifth pattern. While these distinct patterns were present, the actual numbers of teachers associated with each was small.
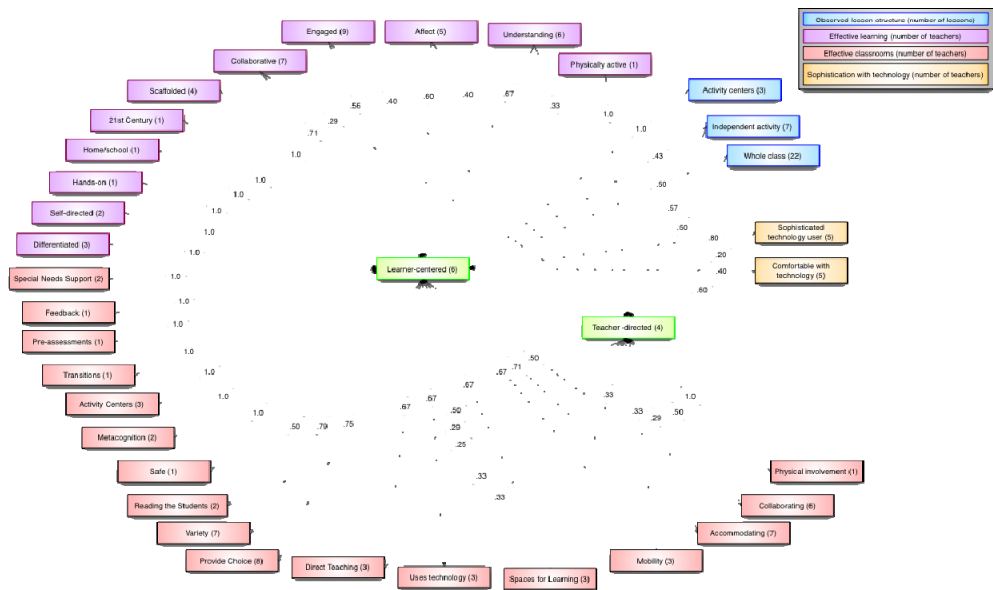
Figure 3. Statements about effective learning, effective classrooms, type of classroom structure and level of technology sophistication for learner-centered and teacher-directed teachers
Note: The labels colour-coded boxes are observed classroom elements derived from coding (see legend). With the exception of lesson structures, numbers inside each box indicate the total number of teachers making statements labelled by that code. For lesson structures, the numbers indicate the total number of observed lessons corresponding to each type of structure. Line labels are the probability of an element being associated with teaching approach (LC or TD).

Teachers, learning and technology

Teachers were asked about questions about the use of technology in their classroom: how they plan for using technology, how they use it to adapt to students' needs, what role it can play in learning and how it has changed their role as teachers. From our analyses, a few important highlights emerged. First, if a teacher was a sophisticated user of technology, that teacher was more likely to be an LC teacher than a TD teacher. Second, using technology to engage students in learning was the most common way in which technology could enhance learning (5 teachers). It was also noted by a number of teachers that technology can support differentiation (7 statements by LC teachers, 1 by a TD teacher) and inclusion, permit accommodation to students' needs and allowing for greater flexibility within lessons.

Overall, there was a variety of singular explanations given for how technology could enhance learning and practice suggesting no common understanding of the application of technology to classroom practice. Yet while some teachers noted that technology can have its positive effects, it can be counterproductive as well. For example, one teacher noted that using the computer is not simply for playing games, it must be used for a specific task for a specific need. The application of technology to the lesson needs to be thought out. As a result, teachers pointed out that the use of technology has placed greater demands on them. Planning lessons and finding resources has resulted in them being *busier* and presented greater challenges.

Of the 64 statements made about the use of technology to enhance learning, only two were directly related to learning as a cognitive or thinking activity. In one instance, the teacher commented that technology can enhance creativity; in the other, the teacher stated that the teacher can be used to activate prior knowledge. This suggests that teachers may have only a superficial understanding of learning and how technology can be used to enhance learning. Indeed, one teacher commented that the technology has not changed her role as a teacher. Rather, she did her planning and preparation and if technology could support her work she would make use of it.

Discussion

Previous research has suggested that the introduction of technology into classrooms does not necessarily lead to the transformation of classroom practice. Indeed, there is an implicit assumption that the introduction of technology will result in greater student engagement and enhanced learning. Our research suggests that this is not necessarily the case. In fact, our observations suggest that there are many lessons in which students are deeply engaged and technology is not being used, and many lessons in which technology is being used for trivial purposes. Our observations showed that there are instances where technology can aid in the creation of a learner-centered classroom. Yet, there are many more instances of technology being used to support teacher-directed lessons.

In order for a transformation of classroom practice to occur, teachers need to understand the fundamental principles of learning and how technology can be used in accordance with those principles. Our findings in this study suggest that while teachers might have an intuitive sense of effective classroom practice, their articulation of what constitutes effective learning and how technology can be used to support it is superficial. Our results suggest that LC teachers had a better understanding of both technology and learning than TD teachers. This suggests that professional

development efforts should be directed towards helping teachers develop a better understanding of the learning-centred classroom and the principles of effective learning.

Our analyses have led us to believe that some teachers were using technology in ways that made conventional, primarily teacher-directed teaching more effective and efficient. Other teachers, however, perceived technology as a useful tool to facilitate student engagement and therefore designed their classrooms as learner-centred environments. Although there is no doubt that we observed both teacher-directed and learner-centred approaches to teaching and learning, those contrasting approaches fail to capture the reality of what we observed. In spite of the fact that the classrooms we visited were recommended as having exemplary teachers who were known to use technology regularly in their classrooms, our classroom observations reveal the existence of a teacher-directed/learner-centred continuum. These findings do not give us any confidence that there is anything inherent in the use of emerging computer technology that contributes to more learner-centeredness, even when the teachers who are using various technologies are considered by district personnel or their school principal to be exemplary.

These findings have important implications for district policy and professional development. Often, professional development has focused upon the technology itself rather than learning. We suggest that professional development should continue to support teachers' use of technology because teachers who were sophisticated users of technology tended to be learner-centred. But we also suggest that professional development should focus on helping teachers to develop a more sophisticated understanding of learning and the principles of the learner-centred classroom. The issue may be that teachers cannot use technology to develop a learner-centred classroom because they do not have a profound understanding of the relationship between a particular technology and learning.

This study was exploratory in nature, and has a number of limitations to be considered for future research. First, the participants were volunteers from a pool of teachers nominated as exemplary by district personnel. Consequently, the criteria for being exemplary is uncertain and, perhaps, questionable. In further studies, researchers might consider focusing on more specific criteria for the inclusion of teacher participants. Second, teachers were observed for a limited number times within a specific time interval. This suggests that the observations were a snapshot of a very short interval taken from a long timeline. Third, further conceptualization of the

learner-centred classroom is needed. What does it mean to be learner-centred? And should, or can every lesson be learner-centred? If not, perhaps our observations were taken at an unfortunate time.

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