Self-Directed Learning and Collaborative Learning in Canadian Junior High Classrooms: Validation of a Questionnaire Assessing Students' Learning with and without Technology

by

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Abstract

The present study examines the use of a questionnaire for the assessment of students' perceptions of their self-directed learning and collaborative learning with and without technology with a group of Canadian junior high school students. The questionnaire was developed by Lee and colleagues (2014) and found to be valid for use with high school students in Singapore. The 18-item questionnaire assesses students' perceptions of their learning across four scales: 1) self-directed learning, 2) self-directed learning with technology, 3) collaborative learning, and 4) collaborative learning with technology. Three hundred and twenty junior high school students from across Alberta, Canada participated in the study by completing the questionnaire. Exploratory factor analysis confirmed that a four-factor structure was present within the sample. A confirmatory factor analysis revealed that the questionnaire did not have sufficient model fit, and demonstrated convergent and discriminant validity across only two of the four scales. A jackknifing procedure was used to systematically remove four items to achieve a psychometrically sound questionnaire with adequate validity and reliability. An examination of the students' perceptions of their learning with and without technology with the reduced questionnaire revealed that Canadian junior high school students readily engage in self-directed, collaborative learning, and self-directed learning with technology. Students reported less engagement in collaborative activities with technology.

Preface

This thesis is an original work by Chantal Labonté. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Understanding the Implementation Process and Benefits of Technology in Instruction and in the Design of Inclusive Junior High (and Middle School) Settings, No. 37831, May 29, 2013.

Dedication

This thesis is dedicated to my mother, who is my biggest cheerleader and supporter in everything I do. While you may not have reached this shared goal of ours, it is because of your support that I am able to. Thank you for your constant love and support, and for the many lessons and values you have instilled in me that have helped me to achieve this goal. As my mother, you were my first teacher. This success is as much yours, as it is mine.

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Introduction

Children today are growing up as 'digital natives' (Prensky, 2001) having not known a time prior to the existence of information communication technologies (ICT). Access to ICT has transformed how they are learning within the classroom and is shaping pedagogical practices (Collins & Halverson, 2010). ICT has become an essential component to how we learn, how we work, how we connect with others, and how we contribute to society (Alberta Learning, 2003; Henry, 2015). As a result, emphasis has been placed on preparing students to enter our complex technology and media-driven enviornment where technology changes rapidly, information is readily accessible, and there are increasing opportunities for large-scale collaborations. Among other 21st-century skills, collaborative learning (CL) and self-directed learning (SDL) have been recognized as necessary competencies to prepare students for the current global knowledge society (Henry, 2015; Partnership for 21st Century Skills, 2011; Voogt & Roblin, 2012). Broadly, CL refers to two or more students working towards a learning goal together (Dillenbourg, 1999), whereas SDL occurs when knowledge, skills, or personal development are attained by an individual through his or her own efforts (Gibbons, 2002).

Learning, whether it is through SDL or CL, takes place within context, and the context of today's learning is technology driven (Domalewska, 2014). Most educators see technology as no better at facilitating teaching and learning than the teacher (Jonassen, Howland, Marra, & Crismond, 2008). "[When] we begin to think about technologies as learning tools that students learn with, not from, then the nature of student learning will change" (Jonassen et al., 2008, p.6). Students learn with technology rather than from it.

ICT has been suggested to promote the development of SDL and CL skills. However, it has also been proposed that students may require SDL and CL skills a priori to benefit from ICT-supported learning. In a study that included high school students from Singapore a positive relationship was found between SDL and CL with and without technology (Lee, Tsai, Chai, & Koh, 2014). Results revealed that students' ability to engage in SDL and CL without technology predicted their ability to engage in SDL and CL with technology. These findings suggest that while ICT can support learning, technology itself cannot have an impact on students who have not developed collaboration and self directed ways of learning. Accordingly, teachers in ICT classrooms should be concerned about their students' learning processes so that they may take full advantage of the benefits of ICT.

As ICT is used within classrooms globally, there is a need for measures to assess the extent of student's CL and SDL. With this in mind, Lee and colleagues (2014) created a questionnaire designed to assess student's perceptions of their SDL and CL with and without technology. The authors validated the four-factor structure of the questionnaire with a group of high school students in Singapore (Lee, Tsai, Chai, & Koh, 2014). The present study utilized Lee and colleagues' (2014) questionnaire to explore whether the questionnaire is valid for use with junior high school students from various schools across Alberta, Canada. The data was collected as part of a larger study, *Flexible Pathways to Success: Technology to Design for Diversity*, examining the implementation of technology within inclusive junior high school classrooms.

Self-Directed Learning (SDL)

SDL has become an essential learning process for achieving meaningful educational outcomes. Gibbons (2002) defines SDL as " any increase in knowledge, skill, accomplishment, or personal development that an individual selects and brings about by his or her own efforts using any method in any circumstances at any time" (p. 2). SDL involves generating personal learning goals, planning, task analysis, self-monitoring, self-evaluation, and reorganizing and adjusting plans based on self-evaluation (Robertson, 2011). During SDL, learners take initiative and responsibility over their learning outcomes (Bolhuis, 2003; Garrison, 1997). By doing so, they are able to customize their approach to learning task (Gibbons, 2002). Garrison's (1997) model of SDL describes three overlapping and connected dimensions that make up SDL: 1) self-management, 2) self-monitoring, and 3) motivation. Based on this model, self-directed learners are motivated to take personal responsibility and control of constructing meaning by integrating new ideas and concepts with prior knowledge (self-monitoring), while also taking personal responsibility and control of the behavioural implementation (self-management) of tasks required to accomplish their learning goals. Motivation influences the initiation and the maintenance of the learner's effort toward achieving the learning goal. SDL appeals to the desire to be in control of choosing what to learn and how to learn it (Garrison, 1997). SDL is necessary for students to develop the capacity for future educational growth and for life-long continuous learning (Gibbons, 2002). Opportunities for SDL allow for students to 'learn how to learn' (Garrison, 1997). In turn, self-directed students create for themselves opportunities to further practice their self-regulatory and metacognitive skills (Biemiller & Meichenbaum, 1992).

Self-directed learners engage in specified tasks and apply appropriate strategies that allow them to take control of constructing and managing their learning. Robertson (2011) analyzed the learning logs of 113 university students engaged in a SDL exercise to determine the SDL strategies the students used. The students described their learning through a design diary blog that was shared with their peers. The results indicated that the students who engaged in SDL set their own learning goals, analyzed the learning environment, identified gaps in their learning, planned their actions and learning, self-evaluated their work, and self-monitored their progress. (Robertson, 2011). Self-directed learners rely on a variety of goal-oriented behaviour to independently manage their own learning and accomplish their learning goal.

SDL has been associated with a variety of meaningful learning skills and outcomes, such as critical thinking and logical thinking skills (Willett, Yamashita, & Anderson, 1983). A meta-analysis of instructional systems used in elementary and high school science education identified one study examining the effect of SDL on critical thinking ability compared to traditional educational methods. The effect size (0.17 SD) revealed that SDL has a small significant effect on critical thinking skills. Additionally, the meta-analysis identified three studies examining the effect of SDL on logical thinking skill. A medium average (0.4 SD) effect size was found, suggesting that SDL has a significant modest impact on logical thinking skills compared to the effects of traditional methods on logical thinking skills (Willett, Yamashita, & Anderson, 1983). SDL has a small effect on critical thinking skills and a modest effect on logical thinking skills. Additionally, the relationship between academic success and SDL is well documented within higher-education settings. In one study, Findlater and colleagues (2012) examined the effects of introducing SDL practices to teach anatomy on the academic performance of undergraduate medical students at the University of Edinburgh. Over a period of five years after introducing SDL, there was a significant improvement in examination scores, a significant reduction of students failing the course, and a significant increase of students achieving a distinction grade (>90-92%). Findlater and colleagues concluded that the practice of SDL improved students' engagement resulting in students gaining a better understanding of the course content (Findlater et al., 2012). The relationship between academic achievement and SDL is less well studied with high school students (Bassett, Martinez, & Martin, 2014). Bassett, Martinez, and Martin (2014) compared the achievement of high school chemistry students exposed to 9 weeks of SDL to the achievement of students exposed to the same chemistry content through teacher-led instruction. Both forms of instruction resulted in significant increase in students' chemistry knowledge. Contrary to findings in higher-education settings suggesting that student's achievement is improved by SDL when compared to outcomes with teacher-led methods, results revealed significantly greater gains in students' course knowledge for the teacher-led instruction group. Student's tendencies to rely on the teacher for step-by-step support may have affected the achievement of students within the SDL class. The teacher's inexperience with facilitating SDL may have also impacted the results (Bassett, Martinez, & Martin, 2014). While prior research demonstrates the benefit of SDL over teacher-led instruction, high school students and teachers may require additional support to be successful with SDL.

SDL allows for students to be prepared for success in higher levels of education (Bolhuis, 2003). In higher-education settings, undergraduate engineering students with a high degree of readiness for SDL were found to have a high level of academic achievement, while poor self-management skills strongly predicted poor academic performance. Self-management is a key component of SDL (Stewart, 2007). Additionally, readiness towards SDL and prior academic performance were a strong predictor of students' academic achievement in a distance education course where course material was provided over teleconference. Together prior academic performance and SDL readiness explained 48% of the variation in academic performance among students in the distance education course (Hsu & Shiue, 2005). The acquisition of SDL skills allows students to 'learn how to learn' and, as such, has been identified as an essential skills for students to become continuous leaners and to gain the ability for further educational growth (Garrison, 1997). Within the workplace, employees with a readiness for SDL have higher levels of outstanding and satisfactory job performance in positions requiring creativity and problem-solving skills (Guglielmino, Guglielmino, & Long, 1987). Self-directed learners are well prepared for success in the 21st century workplace.

SDL is viewed as implying a purely individual pursuit of knowledge and learning goals (Bolhuis, 2003). However, students who are engaged in SDL may receive a variety of support from teachers and peers to complete their learning goals (Robertson, 2011). The quality of these interactions with teachers and peers has an influence on the student's motivation to persist with their SDL goals (Sze-yeng & Hussain, 2010). Self-directed learners work closely with other students and adults (Gibbons, 2002). As such, SDL goes hand in hand with CL.

Collaborative Learning (CL)

Just as the old adage ‘two heads are better than one’ (Heywood, 1546) suggests, there are benefits for students when they work together. Broadly, CL can be defined as any situation where two or more ‘heads’ learn together (Dillenbourg, 1999). When students are engaged in CL, they develop and work towards a shared common learning goal (Clark, 2001; Dillenbourg, 1999). CL involves taking on the perspective that others are a learning source of expertise and knowledge (Henry, 2015).

From a social constructivism point of view, knowledge is constructed within a social context, through the process of negotiating meaning with others (So & Brush, 2008). According to Vygotsky (1978) this social negotiated learning and growth occurs when a child works collaboratively with more skilled partners within the child’s zone of proximal development. The zone of proximal development is defined as the “distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978; p.38). It is within this zone that cognitive growth and learning is expected to occur. When experts or more skilled peers are sensitive to the novice student and respond according to their needs within this zone of proximal development, the student is able to gain knowledge, beliefs, and problem-solving skills. In the classroom, CL occurs during tasks that encourage students to assist each other in such a way that the less competent members will benefit from the assistance that they receive from the more skillful peers whose learning is advantaged in return by their role as teacher (Bjorklund, 2012). During CL, students serve as a source of support and learning for each other as they engage in a process of explaning and modeling solutions, discussion and reflection (Bolhuis, 2003).

While a social constructivist perspective is most often associated with CL, there is no consensus on how to define 'collaboration' and the related concept of 'cooperation' (Resta & Laferriere, 2007). According to Roschelle and Teasley (1995), collaboration refers to "a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (Roschelle & Teasley, 1995; p. 70), while cooperation is referred to as "the division of labour among participants, as an activity where each person is responsible for a portion of the problem solving" (Roschelle & Teasley, 1995; p. 70). CL differs from cooperation based on the division of labour within the group. While working cooperatively, students divide the tasks to be completed, complete these tasks independently, and come together to construct the final product from these individually completed tasks. In contrast, during CL, students are engaging with one another throughout the entire learning task, although some spontaneous division of labour may occur. They complete the final product together, rather than 'coming back together' to construct the final product (Dillenbourg, 1999).

CL has the potential to augment the quality of student discourse, to provide students with alternative explanations, and to foster the generation of multiple solutions during problem solving activities. This in turn can lead to greater conceptual understanding for students (O'Donnell, 2006). Terenzini and colleagues (2001) examined the extent that courses taught using CL and active learning facilitate undergraduate engineering students' problem-solving, communication, and collaborative group work skills (i.e., conflict resolution skills, active listening, and group decision-making) compared to traditional lecture methods. Students (N=480) from 17 engineering classes completed a survey of their perceptions of their skill progress throughout the course, either a traditional lecture format course or a CL format course. Students across both course types did not significantly differ in gender, race, prior grades, class year, or parent's level of education. Students in the CL course reported significantly greater increases in their communication skills, group skills, and design skills, a skill related to engineering content. CL was found to have a substantively large effect on all of those skills. Effect size, reported in percentile points, revealed that students engaging in CL gain an average increase of 11 percentile points in communication skills, 34 percentile points average increase in group skills, and 23 percentile points average increase in content-related design skills. When controlling for pre-course differences among student characteristics, the difference in gains remain significant. The gains in students' communication skills, group skills, and content-related design skills were influenced substantially more by their CL learning environment than any differences in students' characteristics (Terenzini, Cabrera, Colbeck, Parente, & Bjorklund, 2001). Additionally, the effect of CL on critical thinking skills, and students' knowledge and comprehension of course content was evaluated with 48 undergraduate students. Students were given the same task to complete either independently or collaboratively following a lecture given to all students on the topic of the task. Students in the CL groups were encouraged to discuss their thought processes for solving the problems, and were instructed to listen carefully to group members' comments and reconsider their own opinions based on group members' comments. Instructions stated that each group member had to be given an opportunity to share their ideas. Students were given the choice of who to work with and they worked in groups of four. A pre-test revealed that students' results were not significantly different between groups. Post-test scores revealed that students who engaged in CL performed significantly better on items requiring critical thinking skills. There was no significant difference in students' factual knowledge and comprehension of course content on the post-test (Gokhale, 1995). These results support the claim that CL provides students with the opportunity to analyze, synthesize, and engage in the material in a way not afforded to students during individual learning, fostering students' critical thinking skills. These affordances can lead to higher levels of academic achievement. A meta-analysis based on 116 studies revealed that university students who engaged in CL within small groups had greater academic achievement than students who did not engage in CL (Springer, Stanne, & Donovan, 1999).

In a high school setting, Hussain, Anwar, and Majoka (2011) examined the effect of group-based learning on the academic achievement of high school physics students. Eighty-eight grade 10 students were assigned to either a group activity-based instructional method or the traditional instructional control group based on pre-test scores of their physics knowledge. There was no significant difference between groups on the pre-test. Students were taught according to their instructional method for 40 minutes a day for four weeks, at the end of which a post-test was administered. A comparison of the performance of the two groups of students on the post-test revealed that CL resulted in a significantly better overall student achievement. Students exposed to CL performed significantly better when tested on their knowledge, comprehension, and application of the physics content. The results support the effectiveness of CL for teaching high school level courses (Hussain, Anwar, & Majoka, 2011).

When students engage in discussion and collaboration throughout their learning, they become more engaged in the learning process. When asked to comment on their learning experience, the majority of undergraduate students (N=24) engaged in CL reported that working in groups allowed them to better understand the content and enriched their thinking process. Additionally, they felt that the shared responsibility for completing the learning task reduced anxiety associated with problem solving (Gokhale, 1995). A meta-analysis based on 9 research studies on CL within undergraduate science, mathematics, engineering, and technology students revealed that students who had opportunities for CL in small groups had greater persistence within their courses than students who did not engage in CL. The same meta-analysis also revealed, based on 11 studies, that students engaged in CL within small groups held more favourable attitudes towards their coursework than their peers who do not engaged in CL (Springer, Stanne, & Donovan, 1999). Opportunities for peer interaction leads to more positive attitude towards learning and higher levels of motivation to learn compared to students who do not have opportunities to engage with their peers (Resta & Laferriere, 2007). Thus, CL enriches the learning process.

ICT-Supported SDL and CL

Technology may be used in educational settings in a variety of capacities. Current technology supported learning practices include technology-rich learning environments, network-enhanced learning environments, blended learning environments, and virtual learning environments (Resta & Laferriere, 2007). Activities within technology-supported classrooms usually include using the Internet to find information and participating in group discussions about learning tasks with peers in the classroom and in online environments, as well as traditional non-technological activities, such as accessing information through textbooks and direct instruction (Lee et al., 2014). These learning activities are in line with the ways that high school students report interest in learning. Of 956 high school students surveyed, 25% of students expressed a preferred interest in learning through the Internet, 24% expressed preferred interest in learning through direct instruction from the teacher, 24% expressed preferred interest in learning through discussion with classmates, 13% expressed preferred interest in learning through books and print media, and 14% expressed preferred interest in learning through watching television or movies (Strom, Strom, Wing, & Beckert, 2009). ICT learning environments allow students the opportunities to learn through a variety of media.

ICT-technologies can facilitate access to both information and online expertise for the purpose of pursuing learning goals and interests (Teo, et al., 2010). The abundance of open education websites and learning portals provides learners with a plethora of informational material and opportunities to learn. Good information cannot only be found in print form but can also be transmitted via digital media formats (i.e., videos, podcasts, audiobooks, etc.). Websites such as *Wikipedia*, *Youtube*, and *Khan Academy* have all been identified as website used by self-directed learners (Bonk, Lee, Kou, Xu, & Sheu, 2015). There is no shortage of ways that a student may choose to access content and information.

Aside from accessing information, ICT also provides additional instructional affordances to facilitate both SDL and CL. Tools such as email, online chat forums, blogs, wikis, videoconferencing systems, and course management systems have all been used to support online CL (Resta & Laferriere, 2007). These Internet tools and technologies allow for an active rather than a passive process of receiving and evaluating information (Domalewska, 2014). Blogs have been identified as a medium to support SDL while allowing students to learn from and support their peers, facilitating CL (Robertson, 2011), although the use of blogs to facilitate CL may be limited (Domalewska, 2014). Additionally, when adult learners used web platforms, such as *Moodle, Google Docs,* and *Wikispaces*, the use of technology empowered students' ability to engage in SDL, although participants experienced an initial learning curve (Sze-yeng & Hussain, 2010). *Wikispaces* can be used as a project management tool enabling students to monitor and plan their learning while remaining connected to their greater learning community. With *Wikispaces*, teachers are able to monitor their students' progress. *Moodle* is a course management system that is most often used as a repository where students can access course documents. Formal discussion can also be facilitated through the discussion forum. Informal discussion can take place over social media and communication platforms, such as *Facebook* (Sze-yeng & Hussain, 2010). These tools and online environments have built-in features to facilitate CL and SDL, and enhance the learning process (Domalewska, 2014).

When learning technology and ICT is used in CL, the technology becomes a tool of *intellectual adaptation*, a term put forth by Vygostky to describe methods of transmitting thinking and problem-solving skills that children gain from working with more competent peers during collaboration (Bjorklund, 2012). ICT-supported CL can occur within online networks or when peers engage in the use of ICT collaboratively (i.e., completing a task together using a shared computer). Blaye and colleagues (1991) examined the collaborative learning of 11 year-old students (N=39) during user-user interaction while completing timed problem-solving pirate ship game presented on the computer. The students participated in three consecutive sessions. During the first two sessions, the children either worked independently or in pairs. During the third sessions, all children worked independently. The students who worked collaboratively within pairs were found to be twice as likely to complete the task successfully compared to children working on the task alone. Of even more interest, it was found that students who had previously worked in pairs during the first two sessions were twice as likely to complete the task successfully when working alone during the third session, compared to children who had only worked along, despite having the same amount of exposure to the task (Blaye et al., 1991). Collaborative learning increased task success and the learning that occurs in CL is carried forward when students work independently. When engaging in CL in online environments, some students may feel less intimidated to participate in group discussions than in a face-to-face context. Online environments can afford those students equal access to participation (O'Donnell, 2006). A review by Resta and Laferrière (2007) found that when higher-education students were engaged in CL supported by computer-mediated online networks, students experience higher academic achievement, greater mastery of subject matter, and increased success during problem-solving tasks compared to students engaged in independent computer-supported learning. Additionally, compared to face-to-face settings, students report higher levels of learning in online environments. Online groups discussions tend to be more complex and more challenging. Online groups, also, perform better on tasks requiring idea generations than do groups working in face-to-face settings (Resta & Laferriere, 2007). Students experience the benefits of CL when using technology and, in some instances, the benefits of CL appear to be enhanced by technology.

Technology in Alberta's Classrooms

Educational policies within Alberta support 21st-century competencies and the use of technology to facilitate their development. The Ministerial Order of 2013 states that "education in Alberta will be shaped by a greater emphasis on education than on the school; on the learner than on the system; on competencies than on content; on inquiry, discovery and the application of knowledge than on the dissemination of information; and on technology to support the creation and sharing of knowledge than on technology to support teaching" (Alberta Education , 2013; p. 2). This Ministerial Order outlines several goals for education in Alberta. One of these goals is to enable the development of competencies across subject areas so that students are able to know how to learn, which is described as the ability "to gain knowledge, understanding or skills through experience, study, and interaction with others" (Alberta Education, 2013; p. 2). This goal is directly related to the acquisition of SDL and CL skills. Further, the emphasis on technology to support the creation and sharing of knowledge supports the use of technology during SDL and CL. Alberta Education recognizes ICT as the new way to communicate, problem solve, and innovate. Alberta Education's philosophy is that "the ICT curriculum is not intended to stand alone, but rather to be infused within core courses and programs" (Alberta Learning, 2003; p.1). Infusing ICT within the curriculum is an effective means to providing students with ICT skills (Pich & Kim, 2004), and allows for opportunities for learning both with and without technology across all subject areas within classrooms.

The ICT curriculum spans all elementary and secondary levels from grades kindergaten to twelve (Alberta Education, 2013).

Alberta Education's ICT curriculum is well suited to allow for ICT-supported SDL and CL within classrooms. Alberta Education's Learning and Technology Policy Framework demonstrates the commitment to ICT-supported SDL and CL within the province by specifically outlining ideas for how teachers can adopt technology within their classrooms to increase student learning. The framework calls specifically for the use of technology to support SDL and CL. It calls for technology as a means to provide students with a variety of ways to "learn, communicate, collaborate, ask important questions, solve problems, and demonstrate what they know and can do", allowing for students the choice of how they wish to engage in their learning (Alberta Education, 2013; p. 21) In addition, it calls for technology to enable students to engage in CL to complete complex tasks (Alberta Education, 2013).

In implementing ICTs within classrooms across Alberta, Alberta Education was tasked with both providing infrastructure (i.e., Internet connectivity, technological tools, such as computers and tablets) for schools, and resources for teachers to support the adoption of these technologies in their classrooms (Pich & Kim, 2004). Each school jurisdiction is responsible for developing their own implementation plan for the use of technology within their classrooms. This responsibility is sometimes passed along to individual schools. A variety of technology implementation strategies are used across the province, such as providing students with one-to-one tablets and instituting a bring-your-own-device programs where students are asked to bring and use their own technological devices within the classroom. These implementation strategies differ across schools in the same jurisdiction (Smith, 2016). Thus, the range and use of technology across classrooms may vary greatly across the province.

The *Flexible Pathways to Success* project explored the implementation of educational technologies in inclusive junior high school classrooms. Teachers, actively implementing ICTs within their classrooms, used the Substitution, Augmentation, Modification, and Redefinition model (Puentadura, 2010) to augment and facilitate students' learning processes. Classroom observations revealed that teachers most frequently used technology to augment, modify, and redefine instructional activities, rather than simply replacing old instructional practices with technology. Students were given ongoing opportunities to use technology for learning. A variety of ICTs were available and students were given the choice of which ICTs to use to support their learning. Classroom observation of student technology use varied by classroom but, on average, it was revealed that students used technology for educational purposes actively 71.22% of the time, indirectly 16.19% of the time, and did not use technology 12.54% of the time. Students used a variety of devices including laptops, tablets, and smartphones. Students engaged with these technologies to complete assigned tasks, access learning management systems, such as Moodle, create reports and presentations, access information using the Internet, and use a variety of applications for multimedia creations. Observations of teacher technology use revealed that the majority of the time (66.63%) teachers used technology indirectly as a means to support their practice (Smith, 2016).

Assessing Student's Perceptions of their Learning

As ICT continues to be increasingly implemented as an instructional means to support SDL and CL within classrooms in Alberta and beyond, it is important for teachers to assess the extent of student learning within ICT-supported classrooms. Given that there is a relationship between students' SDL and CL in non-technological settings and their ability to engage in SDL and CL with technology (Lee et al., 2014), it is important for teachers to gain an understanding of the extent of their students' ability to apply SDL and CL across both settings with and without technology. This would help teachers develop pedagogical practices that foster and facilitate SDL and CL across all settings experienced by students in ICT-classrooms. Students' perceptions of their learning ability need also to be considered. Students' perceptions and beliefs about their efficacy to learn affect student motivation and ability to succeed academically (Bandura, 1993). Furthermore, by examining the relationship between students' perceptions of their SDL and CL with and without technology, teachers can effectively adapt pedagogical practices and integrate ICT within their classrooms (Lee, et al., 2014).

To assess both SDL and CL within ICT-supported contexts in one instrument, Lee and colleagues (2014) developed a questionnaire to evaluate secondary school students' perceptions of SDL and CL with and without technology. Their instrument was pilot-tested and validated among high school students in Singapore. An exploratory factor analysis (EFA) revealed that four factors should be retained based on the eigenvalues over 1.0 rule. The four factors were found to explain 79.10% of the total variance. Based on the EFA results, the 26 item questionnaire was reduced to 18 7-point Likert scale items across four scales representing the four factors: 1) SDL without technology (SDL), CL without technology (CL), SDL with technology (SDLT), and CL with technolgy (CLT). Findings revealed sufficient internal consistency with an overall Cronbach's alpha of 0.95. Coefficients above 0.7 have been suggested as acceptable estimates of internal consistency for research purposes (Kaplan & Saccuzzo, 2013). Following the EFA, structural equation modeling was used to further validate the measure and examine the relationships between the scales. A confirmatory factor analysis (CFA) revealed the questionnaire to have good construct validity, convergent validity, discriminant validity, and reliability (Lee et al., 2014).

On average, students reported their SDL, CL, and CLT as slightly agreeable and SDLT (means greater than 4) as slightly less agreeable (mean = 3.98) on the 7-point Likert scale (i.e., 1-Stongly disagree, 7-Strongly agree). These results imply that, on average, high school students might not always use their ICT-technologies to engage in SDL (Lee et al., 2014). There was a positive relationship between SDL and CL, as well as between SDLT and CLT. Structural equation modeling supported a structure where SDL and CL each positively correlated with SDLT and CLT, respectively. The results of structural equation modeling suggest that those students who engage in SDL and CL without technology are better able to engage in SDL and CL with technology.

Validity and Reliability

Validity and reliability are essential to the assessment of students' perceptions of their learning. The results of the instrument are only valid for the purposes, population, and for the given times supported by the evidence of validity (Downing, 2003). Lee and collegues (2014) provided validity evidence for the interpretation of the questionnaire results for the perceptions of SDL and CL with and without technology of Singapore high school students. Additional evidence is needed to support its use for interpretations with populations other than Singaporean high school students.

Validity is "the agreement between a test score or measure and the quality it is believed to measure" (Kaplan & Saccuzo, 2013; p.135). Validity provides the evidence to support the interpretation of test or questionnaire results (Downing, 2003). "Validity argument relates theory, predicted relationships, and empirical evidence in ways to suggest which particular interpretative meanings are reasonable and which are not reasonable for a specific assessment use or application" (Downing, 2003; p. 831). Evidence for the validity of a test can come from many sources. Testing the validity of the factorial structure of the test allows for the extent to which each item measures the specific factor they were designed to measure to be determined (Byrne, 2010). Test of the fit between the factorial model and the data indicate the degree to which the items measure their respective constructs, and provides evidence for construct validity. Providing an indication of how well the instrument supports the underlying theory (Hooper, Coughlan, & Mullen, 2008). Convergent and discriminant validity are used to establish the validity of constructs. Convergent validity evidence shows that the instrument correlates well with other instruments that measure the same or similar construct. To demonstrate evidence of discriminant validity, an instrument has low correlations with other unrelated constructions (Kaplan & Saccuzzo, 2013). Combined convergent and discriminant validity evidence provides support for the interpretation of the construct.

Reliability refers to how relatively free of measurement error the test is (Kaplan & Saccuzzo, 2013) and is related to how well the test scores can be reproduced over time (Downing, 2003). Evidence for reliability is commonly provided through indicators of internal consistency. Internal consistency is an indicator of the extent to which the items within a scale are consistently measuring one another suggesting that they are evaluating the same factor (Terenzini, et al., 2001). Reliability is a key aspect of validity. An instrument cannot be found to be valid without adequate reliability.

Present Study

With the increase of ICT within Alberta classrooms, there is a need for a valid and reliable assessment tool to measure the extent of students' learning processes in these classroom environments. As instruments exist to assess the learning processes (CL or SDL) of students in higher education (So & Brush, 2008; Williamson, 2007) and high school (Ayyildiz & Tarhan, 2015; Lee, et al., 2014; Teo, et al., 2010), there is a need for a valid and reliable instrument for use with younger students in junior high school settings.

This research examines the validity and reliability the instrument created by Lee and colleagues (2014) for use with Canadian junior high school students. Additionally, students' perceptions of SDL and CL with and without technology of the Canadian junior high school students are examined. The research is guided by the following questions: 1) Are the scales for measuring SDL, CL, SDL with technology (SDLT), and CL with technology (CLT) created by Lee and colleagues (2014) valid and reliable for evaluating Canadian junior high school students' perceptions of SDL and CL with and without technology?, and 2) What are students' perceptions of their SDL and CL with and without technology in technology supported junior high classrooms in Alberta? The Lee and colleagues questionnaire was found to be psychometrically sound (Lee et al., 2014) with their sample of Singaporean high school students. Based on these results, we hypothesize that the instrument will be sufficiently valid and reliable with our sample. We hypothesize that a 4-factor model similar to Lee and colleagues (2014) will be found.

In regard to our second question, given the emerging use of technology in Alberta classrooms and 21st-century learning processes of SDL and CL, we hypothesize that students will perceive that they engage in SDL and CL in their classrooms with and without technology.

Methods

Participants

Three hundred and twenty-five students (52.6% male) from 8 schools across 5 jurisdictions in Alberta, Canada were asked to participate in the study and complete the questionnaire. Of these students, a small number (N=5) did not complete all the items in the questionnaire. A missing value analysis procedure was conducted to determine whether there was a pattern to the missing values. Little's (1988) missing completely at random (MCAR) test was non-significant (chi-square = 9.892, df = 26, sig. = 0.998), revealing that the values were missing at random. As only a few cases have missing values and they are missing at random, it is appropriate to drop the cases with missing values from the data set (Tabachnick & Fidell, 2001). As a consequence, all 5 cases with missing values were deleted from the data set. A total of 320 participants remained.

Students were enrolled in grades 5 to 9, with the majority of students in Grade 8, (3.1% Grade 5, 2.8% Grade 6, 16.3% Grade 7, 55.3% Grade 8, 22.2% Grade 9) inclusive ICT classrooms. The distribution of students in each grade per school can be found in Table 1. Teachers reported that the inclusive classroom environments included many students with learning needs, ranging from 10-85% per classroom depending on the school.

The participating jurisdictions and schools were part of a larger study, *Flexible Pathways to Success: Technology to Design for Diversity*. Participating schools were located in both rural (School B and School D) and population centers across various regions of the province.[1] Four schools (School A, C, E, and F) were located in areas classified as small population centers and 2 schools (School G and School H) were located in areas classified as medium population centers. Population estimates were based on the 2011 Canadian census data (Statistics Canada, 2011). A percentage of 64.4% (N=206) of the participants came from English speaking families. The remaining students came from families where another language other than English was spoken in the home.

Procedure

The questionnaire was administered to students between November 24, 2014 and January 22, 2015 (i.e., in the second year of the project) as part of a larger battery of questionnaires. Students completed all questionnaires within their respective classrooms using an online survey administration and data capture program. To complete the questionnaires, a research assistant provided instruction to students via video embedded within the online platform. Every item was read aloud to the student.

Measure

The 18-item questionnaire created by Lee and colleagues (2014) was used to assess students' perceptions of their SDL and CL with and without technology (Lee et al., 2014). This instrument aims to assess and contrast students' perceptions of their learning

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[1] According to Statistics Canada, a rural area refers to areas outside of population centers, defined as areas with a population of at least 1,000 and a population density of at least 400 people per square kilometre. Small population centres have a population between 1,000 and 29,999, whereas medium population centres have a population between 30,000 and 99,999 (Statistics Canada, 2011).

skills, specifically SDL and CL with and without technology within ICT-supported classroom environments. The instrument, containing 18 items across 4 scales (SDL, CL, SDLT, and CLT), was administered to participants. Each scale contains items that prompt students to rate their learning skills on a 7-point Likert scale (i.e., 1-strongly disagree, 7-strongly agree). Scale scores are calculated by taking the average of the ratings for items included within the scale (Lee et al., 2014). A copy of the complete item set can be found in Appendix A. The 4 scales are described below:

Self-directed learning without technology (SDL) scale.

This scale, made up of 4 items, assesses students' perceptions of the extent to which they take an active role in their learning in face-to-face non-technological settings. Items such as "In this class, I think about different approaches or strategies I could use for studying the assignments" assess the extent that the student utilizes suitable learning strategies. Other items measure the student's understanding of their learning needs and the extent that they evaluate their learning outcomes (Lee et al., 2014).

Collaborative learning without technology (CL) scale.

This 5-item scale assesses students' perceptions of the extent to which they participate in group discussions and learning within face-to-face non-technological settings. Items, such as "In this class, my classmates and I actively work together to help each other understand the material", are designed to measure student's contribution to group work and interactions (Lee et al., 2014).

Self-directed learning with technology (SDLT) scale.

This scale, comprised of 5 items, assesses student's perceptions of the extent to which they take an active role in their learning in ICT-supported classroom settings.

Items such as “In this class, I use the computer to get ideas from different websites and people to learn more about a topic” are designed to measure students’ use of technology in understanding their learning needs, selecting appropriate learning strategies, and evaluating their progress and performance on learning tasks (Lee et al., 2014).

Collaborative learning with technology (CLT) scale.

This 4-item scale assesses student’s perceptions of the extent to which they use ICTs to participate in group discussions and learning. Items such as “In this class, my classmates and I actively discuss our ideas online to come up with better ideas” measure student’s contribution to group work and interactions within ICT-supported classroom settings (Lee et al., 2014).

Questionnaire items were adapted by Lee and colleagues (2014) from existing instruments. Items on the SDL and CL scales were based on the students’ perceptions of classroom knowledge building (SPOCK) measure developed by Shell et al. (2005) and Resta et al. (1996). Items on the CLT scale were adapted from the CLT scale created by Goh, Chai, & Tsai (2013). Items on the SDLT scale were revised from the self-directed learning with technology scale by Teo et al. (2010) (Lee et al., 2014).

In creating the original scales, the authors underwent a process of consultation with two professors of education and technology, and five teachers to determine if the instrument had good face and content validity. Based on teachers’ recommendations, items were modified for clarity and to reflect ICT-supported SDL, CL, SDLT, and CLT classroom practices. Ten students were then asked to think aloud while they complete the questionnaire. Items were then modified based on this feedback, following which of the scales were found to have good validity through exploratory and confirmatory factor analysis with a sample of high school students in Singapore (Lee et al., 2014).

Results

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS for Mac: Version 24) software. Confirmatory factor analysis was conducted using the Analysis of Moment Structures (AMOS) add-on for SPSS for Windows (Version 24).

Data Screening and Preliminary Analysis

Prior to data analysis, the data set was checked for accuracy. Frequencies, and minimum and maximum statistics were calculated in order to examine the range of scores within the data set. As no values entered fell outside the range of possible values for each variable, the data set does not appear to contain any errors.

Factor Analysis

Exploratory factor analysis.

To confirm the underlying structure of the questionnaire, an exploratory factor analysis (EFA) was conducted on the 18-item questionnaire using the principal component analysis technique. Before performing the analysis, the data was assessed for its suitability for factor analysis. Our sample size is appropriate for factor analysis according to Tabachnick and Fidell’s (2014) recommendation of a sample size of at least 300 cases. Barlett’s Test of Sphericity was significant ($p= 0.00$), and the Kaiser-Meyer-Oklin (KMO) value was 0.89, exceeding the recommended minimum value of 0.6

(Tabachnick & Fidell, 2014). These results support the appropriateness of factor analysis with our sample.

The number of factors to retain was based on the eigenvalue-greater-than-one rule, and scree plot examination. The principal component analysis results indicate the presence of four components with eigenvalues of 6.48, 2.12, 1.36, and 1.16. The percent of variance explained by the four factors was 36.02, 11.77, 7.54, and 6.46, respectively, with a total variance explained of 61.80%. Inspection of the scree plot (Figure 1) revealed that a fifth factor may be considered. However, with an eigenvalue of 0.99, the fifth factor was not retained based on the eigenvalue-greater-than-one rule.

Oblimin rotation was used, as the items of the questionnaire appear to be related (Lee et al., 2014). Inspection of the component correlation matrix, found in Table 2, indicates that this was a reasonable assumption. Given that all correlation coefficients were above 0.3, it is appropriate to take an oblimin rotation approach over other approaches that assume that factors are not correlated (Pallant, 2001).

Oblimin rotation revealed the presence of a simple structure, with each item loading strongly on only one component. With our Canadian sample, each item loads onto its respective factor as determined by Lee and colleagues (2014), the authors of the questionnaire, with the exception of one item. Item CLT4, *In this class, my classmates and I actively work together to construct ICT-based documents (e.g., presentation slides, web pages)*, loads on the SDLT factor rather than the CLT scale as expected. CLT4 correlates strongly with SDLT with a coefficient of 0.79, while it has a weak correlation of 0.36 with CLT. Table 3 presents the rotated factor loadings for each item, as well as descriptive statistics for each of the scales and items.

Confirmatory factor analysis.

Confirmatory factor analysis (CFA) with maximum likelihood estimates was used to establish the validity of the 4-factor measurement model described by Lee and colleagues (2014). The maximum likelihood method was appropriate, as there was no evidence of non-normality within the data. No items or subscales were found to have a skewness value larger than an absolute value of 3.0 or kurtosis value with an absolute value larger than 8.0 (see Table 2), which are the cut-off values, recommended by Kline (2011).

Model fit was assessed using a range of indices. Hooper, Coughlan, and Mullen (2008) suggest the use of a variety of indices as each represent a different aspect of model fit. First, model chi-sqaure (X^2) value was determined. While this is the traditional measure of model fit, this value is sensitive to sample size, almost always rejecting models with large sample sizes, and assumes multivariate normality (Hooper, Coughlan, & Mullen, 2008). As such, the normed chi-square, chi-square/degrees of freedom (X^2/df), will also be used. A range of no more than 3.0 is often suggested to indicate an acceptable fit between the hypothesized model and the sample data (Teo et al., 2010), although recommended ranges vary from as high as 5.0 to as low as 2.0 in the literature (Hooper, Coughlan, & Mullen, 2008). Root mean square error of approximation (RMSEA), normed-fit index (NFI), and comparative-fit index (CFI) statistics will also be reported. The RMSEA is one of the most informative indices, as it is sensitive to the number of estimated parameters with the model. RMSEA values of less than 0.08 reflect good model fit. The NFI ranges from 0 to 1, with a cut-off point of 0.9 and greater indicating acceptable model fit. The CFI statistic also ranges from 0 to 1 with a cut-off point of 0.95 and greater as indicating good model fit (Hooper, Coughlan, & Mullen, 2008). To evaluate the validity and reliability of the structure, the composite reliability (CR) and the average variance extracted (AVE) were calculated. CR is a measure of internal consistency of the latent constructs (i.e., factor) (Fornell & Larcker, 1981). A CR value greater than 0.7 indicates good internal consistency (Hair, Black, Babin, & Anderson, 2010). The AVE indicates the average percentage of variation explained by items for each latent construct and provides us with an indicator of convergent validity (Fornell & Larcker, 1981). An AVE value greater than 0.5 indicates good convergent validity. An AVE score that is less than 0.5 indicates that the variance due to error is larger than the variance explained by the construct, suggesting concerns with convergent validity. Discriminant validity is achieved when the items within a factor account for more variance than the factor shares with other constructs in the model. To establish discriminant validity, the square root of the AVE for each factor is compared with the factor's inter-construct correlations. The square root of the AVE, which is based on the standardized loadings between an item and its factor, should be larger than the factor's correlations with other factors. This comparison reveals whether the factor is sufficiently distinct from the other factors (Henseler, Ringle, & Sarstedlt, 2015; Fornell & Larcker, 1981).

Analysis of the measurement model.

The initial analysis of the measurement model as proposed by Lee and colleagues (2014) did not suggest acceptable model fit. Inspection of the modification indices indicated that model fit might be improved by correlating four sets of error variances. The model fit improved through the use of correlation of error terms was assessed using a range of indices: X^2= 323.02, df=125, p=0.00, X^2/df= 2.58, NFI=0.87, CFI=0.92, and RMSEA=0.07 (90% CI of 0.06-0.08). These results suggest a mediocre model fit with some indices revealing acceptable fit, while others failed to find an acceptable fit according to the recommended cut-off described in Hooper, Coughlan, and Mullen (2008).

Regression weights, CR, and AVE results, displayed in Table 4, suggest good composite reliability, but indicate that the individual SDL and SDLT items do not correlate well with each other within their factor, suggesting poor convergent validity. SDL and SDLT factors are not well explained by their observed variables or items (Hair, Black, Babin, & Anderson, 2010). Table 5 contains the inter-correlation between factors, the square root of the AVE along the diagonal. Examination of this table reveals discriminant validity concerns for the SDL and SDLT scales. The square root of the AVE for SDL is smaller than the correlations between SDL and CL, and the square root of the AVE for SDLT is smaller than the correlations between SDLT and CLT. The SDL scale is not sufficiently distinct from the CL scale, whereas the SDLT scale is not sufficiently distinct from the CLT scale.

The results suggest that the measurement model has mediocre model fit but only when correlations of error terms are added to the model. The proposed questionnaire structure was found to have good composite reliability. Concerns were found with the convergent and discriminant validity of the SDL and SDLT scales.

Jackknifing Procedure

In an effort to achieve validity for the questionnaire, a jackknife approach, as described by Larwin and Harvey (2012), was performed to systematically reduce the number of items. The jackknifing procedure involves removing one item at a time and estimating model fit for each resulting model. The selection of the item to be removed from the questionnaire is based on which model produces the best model fit estimations. The process of removing items one by one continues until several conditions are met: the original factors continue to be explained by three observed items, the reduced model maintains structural integrity, the reduced model correlates with the primary factor model at a level greater or equal to 0.95, and the resulting reduced model has good model fit (Larwin & Harvey, 2012). Items were removed following this process until the resulting model displayed good model fit, and adequate composite reliability, convergent validity, and discriminant validity as measured by the CR and AVE.

Following the systematic removal of items from the original model, the removal of item CLT4 resulted in a model that demonstrated the best model fit. The model fit for the CLT4-removed model was assessed using a range of indices: X^2= 2368.35, df=113, p=0.00, X^2/df= 2.11, NFI=0.89, CFI=0.94, and RMSEA=0.06 (90% CI of 0.05-0.07). The CLT4-removed model has acceptable fit with three of the indices (X^2 , X^2/df and RMSEA) revealing good model fit. A summary of the model fit indices is displayed in Table 6. To evaluate the validity and reliability of the structure, the CR and AVE were calculated. The results, displayed in Table 7, suggest that all scales have good composite reliability but that the convergent validity concerns remain present for SDL and SDLT. This suggests that the SDL and SDLT factors are not well explained by the items that were intended to measure these constructs. The inter-construct correlations found in Figure 2 reveal that concerns with discriminant validity of the SDLT scale were resolved.

However, discriminant validity with the SDL scale remains. The SDL scale continues to be not sufficiently distinct from the CL scale.

Following the same approach, the jackknifing procedure was repeated several times until a model with a good model fit and acceptable reliability and validity was achieved. After each item removal, the removal of another item was tested systematically, and the item resulting in the best model fit was removed. The model fit indices for each model are located in Table 6, and the CR and AVE results are in Table 7. Figure 2 contains inter-construct correlation and square root of the AVE information for each model. After the removal of item CLT4 from the model, item SDL3 was removed and the model fit and validity was assessed. The model had adequate fit and sufficient composite reliability. As it still contained the same convergent and discriminant validity concerns, the jackknife procedure was repeated, and item SDLT4 was removed. This resulting model had good model fit and sufficient composite reliability, and the AVE indicated a resolution of the concerns with convergent validity for the SDLT scale. However, concerns with convergent and discriminant validity remained for the SDL scale. The jackknife procedure then resulted in the removal of item CL5. With the removal of item CL5, the SDL factor displayed adequate convergent validity and concerns with discriminant validity were resolved. This model also had good model fit, and good composite reliability. The jackknifing procedure was not continued as a model with good model fit, and adequate reliability and validity was reached. With the removal of items CLT4, SDL3, SDLT4, and CL5, the questionnaire reached an acceptable level of reliability and validity for use with Canadian junior high students. A diagram of the resulting measurement model can be found in Appendix C.

Alberta Students' Perceptions of their Learning

Examination of the mean and standard deviations for the new reduced scales, found in Table 8, reveals that overall students in our sample report their SDL, CL, and SDLT as slightly more agreeable (means over 5) based on a 7-point Likert scale than their CLT (mean=4.27 on 7-point Likert scale). The SDL scale had the highest mean out of the reduced scales, which is a change from the original questionnaire where the CL scale had the highest mean. The CLT scale continues to be the lowest scale, on average, suggesting that, when a valid questionnaire is used, the same conclusion regarding the CLT scale can be made. The low mean score indicates that students may be less readily engaging in collaborative activities (e.g., sharing ideas, discussion, or working with peers) with technology than SDL with technology and SDL and CL without technology.

Students' perceptions of their learning were also examined across gender and grade. A one-way analysis of variance revealed that students' CLT varied across grades ($F(4,315) = 2.93$, $p = 0.02$). Despite reaching a level of statistical significance, the actual difference in mean scores across grades for CLT was small (i.e., eta squared 0.04). Post-hoc comparisons using the Tukey HSD test indicated that the perception of grade 5 students' CLT (M=2.7, SD=1.49) was significantly different from that of grade 7 students (M=4.38, SD=1.18), grade 8 students (M=4.30, SD=1.57), and from that of grade 9 students (M=4.33, SD=1.42) at a 0.05 level. Students in grade 5 report being less readily engaging in CLT.

Across gender, a statistically significant difference ($p = 0.046$) was found for the SDL scale. Girls reported a mean score of 5.43 (SD=1.06) on the SDL scale, whereas males reported a mean score of 5.20 (SD=1.02). The effect of gender was found to be small, with a Cohen's *d* of 0.22 SD. No significant difference was found among the other scales across genders. When the difference between genders was examined based on the students respective grades, only a significant difference between boys (M=5.10, SD=1.11) and girls (M=5.50, SD=1.11) was found among grade 8 students. Grade 8 students make up the largest subset of the sample, with 177 grade 8 students included. Within our sample, SDL, CL, SDLT, and CLT were significantly related to each other. Correlation coefficients are shown in Table 9.

Discussion

The principal aim of the present study was to examine the reliability and validity of a questionnaire created by Lee and colleagues (2014) assessing student perceptions of their SDL and CL with and without technology for use with Canadian junior high school students. Exploratory factor analysis confirmed a four-factor structure of the questionnaire. Confirmatory factor analysis was then used to test the validity and the reliability of the factorial structure of the questionnaire. The factorial model did not fit with our data suggesting that the original questionnaire developed by Lee and colleagues (2014) was not valid for use with our sample of Canadian junior high school students. In order to establish a valid and reliable questionnaire for use with our sample of Canadian junior high school students, four items (CLT4, SDL3, SDLT4, and CL5) were removed through a jackknifing procedure. The CLT 4 item, *In this class, my classmates and I actively work together to construct ICT-based documents (e.g. presentation slides, web pages),* initially loaded on the SDLT scale. Thus, its removal allowed for a parsimonious model fit and resolved the discriminant validity concerns with SDLT. Removing the CLT4 item reduced the correlation between the CLT and SDLT scales, allowing for the

SDLT scale to be sufficiently distinct from the CLT scale. Removing the SDL3 item ("In this class, I make plans for how I will study.") did improve model fit, but did not resolve any of the validity concerns within the model. However, removing the SDLT4 item, *In this class, I find out more information on the Internet to help me understand my lessons better.,* improved the convergent validity of the SDLT scale, implying that the SDLT4 item was not sufficiently related to the other items and was not adequately measuring the same construct. Last, by removing the CL5 item, *In this class, my classmates and I actively talk about what to do during group work.*, resolved concerns with convergent and discriminant validity of the SDL scale. It appears that the CL5 item was related to the SDL scale.

Our findings provide further evidence to support four separate components of students' perceptions of their learning as proposed by Lee and colleagues (2014) and others (Goh, Chai, & Tsai, 2013; Shell et al., 2005; Teo et al., 2010). Lee and colleagues (2014) found that the four components (SDL, CL, SDLT, and CLT) were positively related to each other. Through structural equation modeling SDL and CL were found to significantly and positively contribute to SDLT and CLT. Students who engage in SDL and CL in face-to-face non-technology supported environments are more likely to engage in SDL and CL in technology-support ICT learning environments (Lee et al., 2014). Positive relationships among the four components were also found among our sample.

The secondary goal of the study was to explore students' perceptions of their CL and SDL with and without technology among our sample. On a 7-point Likert scale (1-*strongly disagree* to 7-*strongly agree*), students reported that they engage in SDL (mean= 5.30) and CL (mean=5.21) without technology. When working with technology, they report engaging in SDL (mean=5.21), but report less engagement in the use of technology for CL (mean= 4.27, “neither agree or disagree to slightly agree”), indicating that students in our sample reported less readily engaging in collaborative activities with technology in their classroom.

Students’ perceptions of their learning with and without technology differ across gender and grades. Girls were found to have reported significantly higher scores on the SDL scale than boys. However, the effect of the differences in means across gender was small. When this difference was examined across grades, the significant difference among gender on SDL only remained for grade 8 students who make up the largest subset of the sample. Our sample did not have equal sample sizes across grades. This is a limitation of the study. Further research is needed to examine the gender differences among other grades with larger sample sizes.

When students’ perception of their learning was examined across grades, Grade 5 students’ perceptions of their collaborative learning with technology was found to be significantly below the ratings of grade 7, grade 8, and grade 9 students. These results suggest that there may be a developmental or curricular difference in the use of collaborative activities with technology that disappears by grade 6. Students in grades 5 made up only a small percentage (3.1%) of the overall sample of students. As with the examination of gender differences, the unequal representation of different grades within our sample is a limitation of the study. Additional research is needed to examine the differences in students’ perceptions of their learning across grades. No differences between grades were found among students’ perceptions of their SDL, CL, and SDLT.

When the findings from the present sample of Canadian junior high students were compared to the findings from Lee and colleagues (2014) from their sample of Singapore high school students, both differences and commonalities are found. Both the Singapore high school students and the Canadian junior high school students describe their SDL and CL without technology as slightly agreeable with means above 5 across both scales for both samples. Additionally, both Singapore high school students (mean=4.15, SD=1.52) and Canadian junior high school students (mean=4.27, SD-1.24) indicate that they are less readily engaged in collaborative activities without technology, with means corresponding best with the '*agree nor disagree'* options of the 7-point Likert scale. The Singapore high school students report that they do not readily engage in SDL with technology in their classrooms (mean=3.98, SD=1.51). However, Canadian junior high school students report that they do engage in self-directed activities with technology (mean=5.21, SD=1.24).

Summary and Conclusion

Today's students need to be prepared for the global knowledge society. CL and SDL have been recognized as necessary competencies that students need to acquire (Henry, 2015; Partnership for 21st Century Skills, 2011; Voogt & Roblin, 2012). This is the first study to explore of Canadian students' perceptions of their SD and collaborative learning with technology. The results reveal that students across Alberta are engaging in SDL and CL in their classroom. As SDL and CL positively predict the use of SDL and CL when using technology (Lee et al., 2014), this is a promising finding for the development of 21st-century competencies for use with and without technology. Students indicated that they engage less in collaborative activities (i.e., sharing ideas, discussion, working with peers) with technology. Students may benefit from additional support to use technology in collaborative tasks.

The reduced questionnaire may be a useful self-report instrument for assessing students' perceptions of their learning in ICT-supported classrooms. Caution should be applied to its use with a variety of samples, as the original questionnaire was not valid with our sample and the reduced questionnaire requires further validation across an array of samples.

Tables

Table 1

Distribution of students in each grade per school

	School								
Grade	A	B	C	D	E	F	G	H	Total
5	0	4	0	0	5	1	0	0	10
6	0	8	0	0	1	0	0	0	9
7	22	0	0	11	2	17	0	0	52
8	39	10	50	7	3	0	68	0	177
9	34	4	0	16	0	0	0	18	72
Total	**95**	**26**	**50**	**34**	**11**	**18**	**68**	**18**	**320**

Table 2

Factor correlation matrix for 4 factors retained from PCA

Factor	**CL**	**SDL**	**SDLT**	**CLT**
CL	1.00	0.42	0.32	0.36
SDL	0.42	1.00	0.26	0.31
SDLT	0.32	0.26	1.00	0.36
CLT	0.36	0.31	0.36	1.00

Note: Oblimin rotation method used

Table 3

Factor loadings and descriptive statistics for SDL, CL, SDLT, and CLT scales and their corresponding items

	Factor loading	M	SD	Min.	Max.	Skewness	Kurtosis
Factor 1: SDL		5.13	1.06	2.25	7.00	-0.55	-0.06
SDL1: In this class, I think about different approaches or strategies I could use for studying the assignments.	0.74	5.25	1.35	1.00	7.00	-0.97	0.84
SDL2: In this class, I try to determine the best way to work on the assignments.	0.62	5.51	1.22	1.00	7.00	-1.18	1.59
SDL3: In this class, I make plans for how I will study.	0.79	4.61	1.60	1.00	7.00	-0.52	-0.47
SDL4: In this class, I try to check my progress when I study.	0.74	5.16	1.41	1.00	7.00	-0.81	0.21
Factor 2: CL		5.25	1.14	1.20	7.00	-0.94	0.85
CL1: In this class, my classmates and I actively work together to help each other to help each other understand the material.	0.86	5.35	1.49	1.00	7.00	-1.03	0.38
CL2: In this class, my classmates and I actively share ideas and information.	0.70	5.28	1.42	1.00	7.00	-1.06	0.86
CL3: In this class, my classmates and I actively work together to learn new things.	0.77	5.17	1.46	1.00	7.00	-0.86	0.10
CL4: In this class, my classmates and I actively discuss the ideas we have about things we are learning.	0.73	5.04	1.45	1.00	7.00	-0.90	0.26
CL5: In this class, my	0.57	5.41	1.422	1.00	7.00	-1.15	1.08

classmates and I actively discuss the ideas we have about things we are learning.							
Factor 3: SDLT		5.20	1.16	1.40	7.00	-0.84	0.33
SDLT1: In this class, I use the computer to get ideas from different websites and people to learn more about a topic.	0.80	5.35	1.44	1.00	7.00	-1.05	0.71
SDLT2: In this class, I use the computer to organize and save information for my learning.	0.80	5.62	1.50	1.00	7.00	-1.34	1.43
SDLT3: In this class, I use different computer programs to work on the ideas that I have learned.	0.69	5.14	1.60	1.00	7.00	-0.84	-0.08
SDLT4: In this class, I find out more information on the Internet to help me understand my lessons better.	0.52	5.13	1.65	1.00	7.00	-0.94	0.09
SDLT5: In this class, I use the computer to keep track of my learning progress.	0.68	4.75	1.72	1.00	7.00	-0.63	-0.55
Factor 4: CLT		4.58	1.33	1.00	7.00	-0.44	-0.16
CLT1: In this class, my classmates and I actively challenge each other's ideas in the online platforms.	0.88	4.06	1.76	1.00	7.00	-0.12	-0.93
CLT2: In this class, my classmates and I actively discuss our ideas online to come up with better ideas.	0.69	4.50	1.69	1.00	7.00	-0.51	-0.58
CLT3: In this class, my classmates and I actively communicate via online platforms (e.g. Forum, MSN, wiki) to learn new things together.	0.82	4.25	1.82	1.00	7.00	-0.32	-0.98
CLT4: In this class, my classmates and I actively work together to construct	**0.74***	5.52	1.57	1.00	7.00	-1.27	1.07

ICT-based documents (e.g., presentation slides, web pages).

* CLT4 loads onto the SDLT scale rather than the CLT scale

Table 4

Regression weights, CR and AVE for each factor of the measurement model

Factor	Item	Regression weights	CR	AVE
SDL	SDL1	.61	0.76	0.44
	SDL2	.66		
	SDL3	.68		
	SDL4	.71		
CL	CL1	.69	0.85	0.54
	CL2	.73		
	CL3	.85		
	CL4	.80		
	CL5	.59		
SDLT	SDLT1	0.64	0.79	0.43
	SDLT2	0.80		
	SDLT3	0.71		
	SDLT4	0.41		
	SDLT5	0.71		
CLT	CLT1	.74	0.83	0.49
	CLT2	.78		
	CLT3	.72		
	CLT4	0.54		

Table 5

Correlation matrix with square root of the AVE in bold

Factor	SDL	CL	SDLT	CLT
SDL	**0.66**			
CL	0.67	**0.73**		
SDLT	0.47	0.43	**0.65**	

CLT	0.54	0.64	0.65	**0.7**

Table 6

Summary of model fit indices for each resulting model of the jackknifing procedure

Model	**X^2 (df, p)**	**X^2/df**	**NFI**	**CFI**	**RMSEA (90% CI)**
CLT4 removed	238.35 (113, 0.00)	2.11	0.89	0.94	0.06 (0.05-0.07)
SDL3 removed	212.26 (98, 0.00)	2.17	0.90	0.94	0.06 (0.05-0.07)
SDLT4 removed	173.04 (84, 0.00)	2.06	0.91	0.95	0.06 (0.04-0.07)
CL5 removed	136.72 (71, 0.00)	1.93	0.93	0.96	0.05 (0.04-0.07)

Table 7

CR and AVE for each factor of the resulting jackknife procedure model

		SDL	**CL**	**SDLT**	**CLT**
CLT4 removed	CR	0.76	0.85	0.79	0.81
	AVE	0.44	0.54	0.44	0.59
SDL3 removed	CR	0.85	0.69	0.79	0.81
	AVE	0.43	0.54	0.44	0.59
SDLT4 removed	CR	0.69	0.85	0.80	0.84
	AVE	0.43	0.54	0.510	0.57
CL5 removed	CR	0.79	0.85	0.80	0.81
	AVE	0.49	0.59	0.51	0.59

Table 8

Descriptive statistics for SDL, CL, SDLT, and CLT scales and their corresponding items

	M	SD	Min.	Max.
Factor 1: SDL	5.30	1.05	2.33	7.00
SDL1	5.25	1.35	1.00	7.00
SDL2	5.51	1.22	1.00	7.00
SDL4	5.16	1.41	1.00	7.00
Factor 2: CL	5.21	1.21	1.25	7.00
CL1	5.35	1.49	1.00	7.00
CL2	5.28	1.42	1.00	7.00
CL3	5.17	1.46	1.00	7.00
CL4	5.04	1.45	1.00	7.00
Factor 3: SDLT	5.21	1.24	1.00	7.00
SDLT1	5.35	1.44	1.00	7.00
SDLT2	5.62	1.50	1.00	7.00
SDLT3	5.14	1.60	1.00	7.00
SDLT5	4.75	1.72	1.00	7.00
Factor 4: CLT	4.27	1.24	1.00	7.00
CLT1	4.06	1.76	1.00	7.00
CLT2	4.50	1.69	1.00	7.00
CLT3	4.25	1.82	1.00	7.00

Table 9

Correlation matrix between SDL, CL, SDLT, and CLT for the reduced questionnaire

	SDL	**CL**	**SDLT**
SDL			
CL	0.523**		
SDLT	0.354**	0.340**	
CLT	0.366**	0.495**	0.447**

** Significant at the 0.01 level

Figures

Figure 1

Scree Plot for the Exploratory Factor Analysis

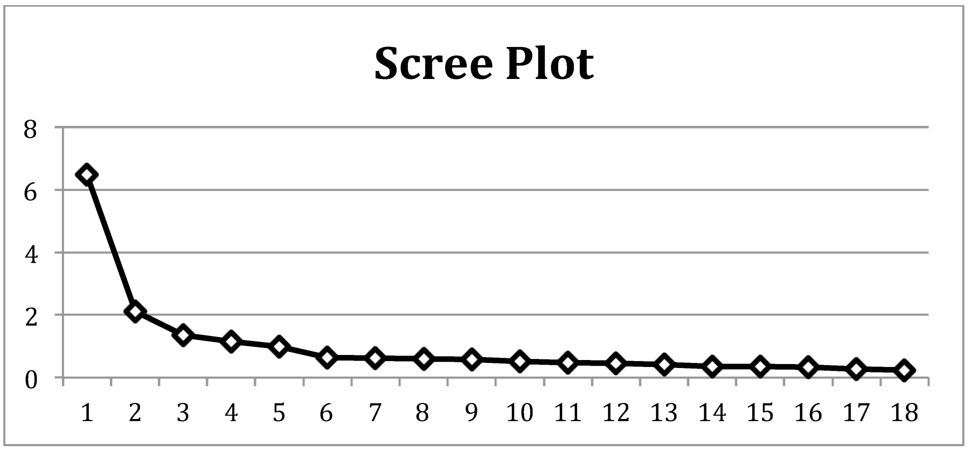

Figure 2

Inter-factor correlations and the square root of the AVE for each resulting model

CLT4 removed model				
Factor	SDL	CL	SDLT	CLT
SDL	**0.66**			
CL	0.67	**0.73**		
SDLT	0.47	0.43	**0.66**	
CLT	0.50	0.61	0.55	**0.77**

SDL3 removed model				
Factor	SDL	CL	SDLT	CLT
SDL	**0.66**			
CL	0.69	**0.73**		
SDLT	0.48	0.43	**0.66**	
CLT	0.50	0.61	0.56	**0.77**

SDLT4 removed model				
Factor	SDL	CL	SDLT	CLT
SDL	**0.66**			
CL	0.69	**0.73**		
SDLT	0.48	0.43	**0.71**	
CLT	0.50	0.61	0.55	**0.75**

CL5 removed model				
Factor	SDL	CL	SDLT	CLT
SDL	**0.70**			
CL	0.69	**0.77**		
SDLT	0.48	0.40	**0.71**	
CLT	0.50	0.59	0.55	**0.77**

Note: the square root of the AVE is the diagonal number in the correlation matrix.

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Appendix A: Student questionnaire

1. In this class, I think about different approaches or strategies I could use for studying the assignments. (SDL1)
2. In this class, my classmates and I actively work together to help each other understand the material. (CL1)
3. In this class, I find out more information on the Internet to help me understand my lessons better. (SDLT4)
4. In this class, I make plans for how I will study. (SDL3)
5. In this class, my classmates and I actively work together to learn new things. (CL3)
6. In this class, my classmates and I actively discuss the ideas we have about things we are learning. (CL4)
7. In this class, my classmates and I actively communicate via online platforms (e.g., Forum, MSN, wiki) to learn new things together. (CLT3)
8. In this class, my classmates and I actively challenge each other's ideas in the online platforms. (CLT1)
9. In this class, I try to determine the best way to work on the assignments. (SDL2)
10. In this class, I use the computer to get ideas from different websites and people to learn more about a topic. (SDLT1)
11. In this class, my classmates and I actively share ideas and information. (CL2)
12. In this class, I use the computer to organize and save the information for my learning. (SDLT2)

13. In this class, my classmates and I actively discuss our ideas online to come up with better ideas. (CLT2)
14. In this class, my classmates and I actively talk about what to do during group work. (CL5)
15. In this class, I use different computer programs to work on the ideas that I have learned. (SDLT3)
16. In this class, I try to check my progress when I study. (SDL4)
17. In this class, I use the computer to keep track of my learning progress. (SDLT5)
18. In this class, my classmates and I actively work together to construct ICT-based documents (e.g., presentation slides, web pages). (CLT4)

Appendix B: Measurement model of reduced questionnaire following jackknifing procedure