Measuring Student Engagement
Using Learning Management Systems

by

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Ontario Institute for Studies in Education
Leadership, Higher & Adult Education
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Abstract

In less than two decades, learning management systems (LMS) have gone from being a rarity to having near-ubiquitous presence on Canadian college campuses. This wide-spread adoption of LMS technology has fundamentally changed the learning environment for today’s campus-based college student, yet there is a lack of research that investigates how students engage with the learning environments created by the prevalent use of these systems. The purpose of this study is to explore the relationship between campus-based students’ perceived level of engagement in LMS an online learning environment and their online behaviour as measured by log data for various LMS activities. Additionally, this study examined faculty members’ use of an LMS and the impact of that use on students’ engagement and students’ use of the LMS. The results of the analysis reveal no correlation between students’ online engagement as measured by the Student Engagement Questionnaire (SEQ) and frequency counts of LMS activities. Small correlations were found between students’ estimates of their LMS activity in discussion forums and their overall SEQ score. There was no difference in the mean SEQ score between groups of survey respondents based on faculty use of the LMS, but some differences in student estimates of their
activity in discussion forums were found between student respondents grouped by age and gender.

Keywords: student engagement, learning management systems, learning analytics
Acknowledgments

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Chapter 1

Introduction

In Pascarella and Terenzini’s (2005) review of the research on the post-secondary student experience from 1990 to 2002, there is no mention of learning management systems (LMS) and very little discussion of the Internet or the ubiquity of technology in students’ lives. How College Affects Students (Pascarella & Terenzini, 2005) remains a mainstay of higher education graduate programs, and the text can be found in many practitioner offices. This study updates our understanding of the student experience by investigating college students’ campus-based use of an LMS and what relationship this use has on their perceptions of their student engagement.

Several themes regarding the post-secondary student experience emerged from Pascarella and Terenzini’s (2005) research review. The authors conclude from their review of a decade of higher education research that sub-environments have more impact than institutions as a whole. The LMS is a local environment in that each face-to-face course has a unique online environment which could include posted lecture notes, class-specific discussion forums, group work rooms, and announcement pages. A second theme that emerged from Pascarella and Terenzini’s review was that active learning, collaboration, and supplemental instruction all play an important role in student learning. The tools in an LMS create the capacity for active learning via quizzes; collaboration via group wikis and discussion forums; and supplemental instruction via continuous availability of class materials, via lecture capture, and via improved access to faculty members and peers for assistance. Considering near-universal access to all of these tools, it is reasonable to expect, although research will be needed, that the teaching environment created by the LMS engages students and that this engagement can be measured by LMS log data. A third theme that emerged from Pascarella and Terenzini’s review involved the role of the faculty
member: the faculty member’s availability and helpfulness, quality and frequency of feedback, and concern for and rapport with students all had a significant impact on student experience. In an LMS, students may have an improved ability to access the faculty member teaching the course. In addition to communication while in the classroom, with an LMS, students have the ability to send their questions and concerns to faculty via email, chat functions, or forum posts. Through forums, students can also witness faculty interacting with other students and learn from such interactions. LMS activity data can record and track these interactions, but further research is needed to determine whether LMS activity data can provide an empirical measurement of this type of student engagement.

A second core piece of literature in higher education today is Chickering and Gamson’s (1989) “Seven Principles of Good Practice in Higher Education,” which has much in common with Pascarella and Terenzini’s research themes. When the principles were written, over twenty-five years ago, the authors could not have imagined the current educational landscape where face-to-face lectures are more often than not accompanied by an online repository of course content and active learning tools to review such content. It is interesting to reconsider the seven principles in light of the current technology-infused post-secondary learning environment.

As discussed above, an LMS facilitates student-faculty contact (the first principle) by offering a variety of new communication channels. An LMS also encourages student cooperation (the second principle) in that a variety of collaborative and networking tools are easily accessible to all students. These social technologies include collaborations such as wikis and blogs; networking tools like online communities; publishing abilities, including content sharing (video/audio) and social tagging; and real time collaboration through online meetings, desktop sharing and web conferencing (Shapiro & Gonick, 2008). Students who engage with LMS tools such as quizzes and discussion forums are using active learning skills (the third principle). The
fact that multiple users may be using the LMS at one time, together with faculty member monitoring of LMS use, means that students can receive feedback (the fourth principle) from both their peers and instructors in real time. Online quizzes in an LMS allow students to test their current state of knowledge in a course, and quiz results allow faculty members to monitor student understanding of concepts. Adjustments to learning opportunities can be made on a frequent basis. LMS discussion forums also make visible students’ knowledge construction and make possible peer and faculty feedback, which can serve to clarify understandings. The 24/7 availability of course content via an LMS maximizes time on task (the fifth principle). Students can reinforce concepts discussed in class by reviewing posted course notes, participating in discussions, or contributing to a group wiki. A common use of an LMS is to post the class syllabus as well as policies not only a given course but also for an academic division. Other administrative features of an LMS allow faculty members to post college-wide items such as the Student Code of Conduct and available student services and supports. These administrative features make explicit the high expectations (the sixth principle) of a faculty member teaching a course and of the institution as a whole. An LMS provides a learning context that is additional to and complementary to a classroom context. Campus-based students who have a comprehensive LMS attached to their course have the advantage of multi-modal forms of learning (the seventh principle). Students can review what is learned in class by reading the PowerPoint notes posted in an LMS after class, or they can review concepts via LMS quizzes or forum tools. Those students reluctant to speak in class have the opportunity to ask questions online in an LMS. Even though Chickering and Gamson could not have envisioned the learning environments created by the LMS of today, each of their principles of good practice in higher education remain highly relevant to these online environments.
The research themes generated from Pascarella and Terenzini’s review and Chickering and Gamson’s “Seven Principles of Good Practice” continue to be relevant. However, with learning management systems coming into near-universal use in the last two decades, the learning environment on today’s college and university campuses has fundamentally changed since the research leading to these themes and principles was conducted.

Before LMS were common, Kuh and Hu (2001) examined levels of technology use on campuses and found that use of information technology had a strong positive relationship with an overall measure of student engagement. A few years later, Laird and Kuh (2005) explored the relationship between technology and engagement, producing a correlational study which compared a technology scale based on 18 questions about students’ use of technology against the overall 2003 National Survey of Student Engagement (NSSE) results. The study found a strong positive relationship between using information technology for educational purposes and some (but not all) of the NSSE scales, such as active and collaborative learning and student–faculty interaction (Laird & Kuh, 2005). Neither Kuh and Hu’s study nor Laird and Kuh’s study makes any mention of LMS; instead, both ask about use of the Internet, email, and computers in general. It has been argued that the use of technology can be seen as both a form of student engagement and as a tool through which student engagement is enhanced or facilitated (Laird & Kuh, 2005; Nora & Snyder, 2008). However, these studies were examining technology as a means of engaging students, not specifically whether the technology itself was a measure of engagement. There remains a gap in the literature on student engagement. There is a need to study whether and how LMS activity as recorded in log data can serve as a measure of student engagement.

The construct of student engagement has been studied for close to two decades. The main tool for measurement is the NSSE, which uses students’ self-reports of their behaviors and
perceptions of their experiences at college or university. Student engagement is a multidimensional latent construct requiring study from a variety of different angles that call for different measures. The near-universal use of LMS has created a new set of data that could possibly serve to provide behavioural markers of student engagement. The problem is that there is little empirical research that has demonstrated a relationship between student activity within an LMS and other measures of student engagement.

Current measures of student engagement include behavioural markers such as class attendance, extracurricular involvement, and retention rates; psychological markers as represented by students’ perceptions of their connection to their peers, faculty members, and institutions; and cognitive markers such as course or assignment grades and term grade point averages (Kuh, 2009; Trowler, 2010; Zepke, Butler, & Leach, 2012). Survey instruments like the NSSE (United States and Canada) and the Student Experience Questionnaire (SEQ) (Australia) capture students’ perceptions of their behavioural, psychological, and cognitive engagement by asking students to report on their actions on campus (e.g. class participation, hours spent in clubs, and studying), emotional and social connections, and grades (Coates, 2010; NSSE, 2013; Pascarella, Seifert, & Blaich, 2010). When used with a campus-based traditional course, an LMS has the capacity to capture student activities such as logging into the system, viewing course materials, taking online quizzes, posting to discussion forums, and submitting assignments to a digital drop box. These activities have the potential to serve as measures of behavioural engagement (time spent logged on, materials viewed), psychological engagement (frequency of discussion posts, network analysis of discussion posts, number of emails sent and received, use of chat functions), and cognitive engagement (number of quiz attempts, content analysis of discussion forums). Further exploration is needed to discover if LMS log data can serve as a replacement for and/or can work in conjunction with current measures of student engagement.
This study explored LMS log data as a possible measure of student engagement that may complement student self-report data.

The remainder of this introductory chapter will explain the research problem and the purpose of the research. Next, a rationale for the study is provided, followed by the research questions. A hypothesis is given for each research question. The chapter concludes by delineating the major terms used throughout the thesis.

**Statement of the Problem, Purpose, and Rationale**

In less than two decades, learning management systems (LMS) have gone from being a rarity to having near-ubiquitous presence on Canadian college campuses (Dahlstrom & Bichsel, 2014; Green, 2013; Siemens, 2013). This wide-spread adoption of LMS technology has fundamentally changed the post-secondary learning environment for today’s college students, yet there is a lack of research investigating how the learning environments created by the prevalent use of these systems could potentially be used as a measure of student engagement (Coates, James, & Baldwin, 2005; Trowler, 2013). Institutions have invested heavily in the infrastructure, human resources, and faculty training necessary to implement LMS, but the ability of these learning environments to affect student engagement has not been empirically demonstrated (Baepler & Murdoch, 2010). Even more concerning is the fact that LMS data is starting to be used as an indicator of student engagement for institutional planning and accountability measurement purposes despite a lack of research correlating LMS usage data with other measures of student engagement (Coates, 2005; Dawson & McWilliam, 2008; Long & Siemens, 2011).

Coates (2005) made an excellent argument for using student engagement measures for quality assurance purposes. He argues that institutional data such as resources available and reputation have little to do with pedagogy and student learning outcomes. Similarly, using
teaching quality as a determinant of the quality of education received makes the false assumption that a quality instructor produces a quality learner. Even current quality indicators focused on students, such as retention and progression rates, are not ideal quality indicators because they are binary measures which fail to account for diverse educational pathways. Student engagement measures, however, take into account how and to what extent students are involved with and actively participating in activities that are likely to enhance learning outcomes. Coates (2005) stated that “student engagement data provides a means for determining the productivity of university education” (p.32). Coates’s argument is, however, somewhat theoretical, as student engagement can be difficult to accurately measure.

The student engagement measure Coates discussed in his article for use in quality assurance is the National Survey of Student Engagement (NSSE). He went on to write the Student Engagement Questionnaire (SEQ) for Australian students, which was based on the NSSE but also asked questions about campus-based students’ online experiences. In his book, *Student Engagement in Campus-based and Online Education*, Coates (2006) suggests that LMS use may bring order and structure to teaching processes by aiding in tracking and measuring the learning outcomes from these processes. He argued that information about student LMS use patterns, trends, and levels of engagement “can help educational managers and leaders design systems, institutions and learning contexts to lead and manage student learning” (p.109). Baepler & Murdoch (2010) also suggested that data from systems such as an LMS could provide a quality indicator by making visible the connections among teaching, assessment, and student effort, but the authors did not detail how to operationalize their idea. Macfadyen, Dawson, Pardo, and Gašević (2014) also argued that using educational data such as that from an LMS could address the need for quality assurance in education. The authors argued that LMS data could be used to assess individual student learning; when studied in the aggregate, this data could provide a
measure of institutional success in delivering on student learning outcomes. While there is much written about using LMS data for quality assurance, there is little research exploring exactly how LMS data can be used as a student engagement measure.

An American study in 2012 found that, while 70% of surveyed institutions agreed that analysing data from an LMS was a major priority for their school, most also suggested that data issues (quality, ownership, access, and standardization) were considerable barriers to going much beyond basic reporting (Bichsel, 2012). Even though intuitions are just beginning to use LMS data for quality assurance, there remains an urgent need to research the connections between LMS data and student engagement because the data are so abundant and technology moves at a rapid pace. It may not be too long before the data issues mentioned above are resolved.

The purpose of this study was to examine the relationship between students’ online engagement as measured by the SEQ and by their LMS activity, both as recorded by LMS software and as self-reported. Also investigated was the question of whether faculty member use of LMS affected students’ perceptions of their online engagement, affected LMS activity as recorded by LMS software, and affected LMS activity as estimated by students’ responses. Semi-structured interviews with faculty members were conducted to assist with the creation of groups of respondents based on how faculty members had set up and made use of the LMS.

Learning management systems have a near-universal presence on college and university campuses: in a recent American study, 85% of students reported using an LMS in at least one course and just over half (56%) of students reported using an LMS in most or all of their courses (Dahlstrom & Bichsel, 2014). A study at a large Canadian institution found similar usage, with 80% of students reporting LMS use in at least one class (Macfadyen & Dawson, 2012). In Dahlstrom and Bichsel’s (2014) study, a majority of students (72%) indicated a preference for learning environments that combined online and face-to-face study; compared to results from
previous years of the annual study, students’ expectations for these blended learning experiences had increased. LMS are a component of daily life for campus-based students, yet few studies have explored whether the data LMS generate can be used as a measure of student engagement. Baepler and Murdoch (2010) identified this research gap when they stated the need for “more comprehensive studies and research that combine survey information with actual student user data so that perceptions of use can be matched with actual usage statistics” (p. 6).

The NSSE is the single largest data source for research on student engagement in North America. The items on the instrument were created based on research findings that demonstrated a relationship between students’ behaviours or experiences (such as time on task, involvement in extra-curricular activities, being presented with challenging academic opportunities, and spending time with faculty members) and desired learning outcomes (Kuh, 2009). Because there was little research literature investigating the relationship between information technology and student engagement, there was no research foundation on which to create NSSE items pertaining to technology; therefore, the survey contains very few questions about technology (Laird & Kuh, 2005). The 2013 version of the NSSE had only three questions regarding students’ experiences with technology on campus. The three questions addressed how many courses the students had taken entirely online; how many hours students had spent socializing online; and how many times students had used email to communicate with an instructor (NSSE, 2013). More empirical research that explores LMS usage data and its relationship to student engagement is needed. If there is enough evidence that LMS activities are related to student engagement, there may be a justification for adding questions about students’ LMS behaviours to future iterations of the NSSE.

The majority of research into student engagement in online learning environments takes place in the context of fully online courses. In a recent journal article, Kuh (2009) asked, “What
are the distinctive features of engagement in on-line environments?” But his further refinement of this question made clear that he assumed online learning was distinct from learning in campus-based environments. He does not mention LMS or the fact that a large number of campus-based students take fully online or blended courses. Participants in fully online courses are limited to the online environment for all of their interactions with peers, faculty, and course material, whereas students in a blended environment have a choice of communicating in person or online. There is limited research focused on campus-based students who can use both an in-person classroom environment and an LMS to engage with peers, faculty, and course material. The research literature would benefit from studies which explore student engagement with LMS in addition to, or as an alternative to, in-person class participation.

In addition to addressing the need for research to develop a more robust concept of student engagement in a virtual learning environment, this research offers a Canadian college perspective as well as an update on current LMS technology. What current research there is on LMS use is almost exclusively conducted at universities, creating a need for research at the college level. Many colleges mandate LMS use and have near-universal use, whereas universities do not mandate how their faculty members teach and have much lower LMS usage. Several studies suggest that the voluntary nature of LMS use by faculty has an influence on use (Mo, 2011; Venkatesh & Davis, 2000). Conducting research at the college level may enhance knowledge about the nature of LMS use in mandated environments. Lastly, technology changes rapidly, and an LMS of only five years ago does not have the same functionality and user interface as those LMS which students are using today. The online environment created by an LMS on a college or university campus today may be too different to be compared to the environment under examination in studies conducted over ten years ago. Therefore, new research on LMS and their current functionality will contribute to the overall body of research literature.
Research Questions

1. What is the relationship between students’ engagement and students’ participation in LMS as measured by frequency of
   a. student logins?
   b. course content page visits?
   c. quiz attempts?
   d. discussion forum views?
   e. original discussion forum posts?
   f. discussion forum replies?

2. What is the relationship between students’ engagement and faculty members’ participation in LMS as measured by the
   a. number of faculty announcements?
   b. number of content pages available?
   c. number of assignments that must be submitted via digital drop box?
   d. number of quizzes available?
   e. number of discussion forum threads created by faculty?
   f. number of discussion forum replies by faculty?
   g. percentage of grades awarded for LMS participation?

3. What is the relationship between faculty participation in LMS and students’ participation in LMS?

Hypothesis

In order to hypothesize about the research questions, a mapping exercise was done to show the assumed relationships between the types of student engagement, SEQ items, student LMS data, and faculty LMS data. Table 1 explains these relationships. Some online student
engagement scales of the SEQ ask students to reflect on only one type of student engagement, while other scales are relevant to all three types of engagement.

H1 There will be a positive correlation between the average score of each scale of the Online Student Engagement SEQ, as well as the overall SEQ score, and the frequency counts of student LMS data.

H2 There will be a positive correlation between the average score of each scale of the Online Student Engagement SEQ as well as the overall SEQ score and the frequency counts of faculty LMS data.

H3 There will be a positive correlation between the frequency counts of student LMS data and the frequency counts of faculty LMS data.
<table>
<thead>
<tr>
<th>SEQ Scale</th>
<th>SEQ Item</th>
<th>Type of SE</th>
<th>Student LMS data</th>
<th>Faculty LMS data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Logins</td>
<td>Page visits</td>
<td>Quiz attempts</td>
</tr>
<tr>
<td>Online Engagement</td>
<td>FOL is a major part of my college education</td>
<td>P</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I used FOL to improve how I learn at college</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>FOL helped me to interact better with the college</td>
<td>P</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I used FOL to manage my college study</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Online Active Learning</td>
<td>I used online materials to improve my learning</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I used online materials to make lectures more meaningful</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I identified expected work standards using FOL</td>
<td>C</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I found that online materials challenged me to learn</td>
<td>C</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I used online feedback to improve my understanding of a topic</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Online Contact Teaching Staff</td>
<td>I used FOL to contact academic staff</td>
<td>B</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I found it easy to communicate with teaching staff online</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I had individual contact with academic staff online</td>
<td>B</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Online Social Interaction</td>
<td>Teaching staff participated in online discussions</td>
<td>B</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I found it easy to explain my ideas in online discussions</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I had helpful online discussions with other students</td>
<td>B</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I met new people when using the online learning system</td>
<td>P</td>
<td>x</td>
<td>x</td>
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</table>

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<table>
<thead>
<tr>
<th>SEQ Scale</th>
<th>SEQ Item</th>
<th>Type of SE</th>
<th>Student LMS data</th>
<th>Faculty LMS data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Academic Relevance</td>
<td>Using FOL made my study seem more relevant</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Using FOL made me feel part of the college</td>
<td>P</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Using online materials helped me put my study in real-world contexts</td>
<td>C</td>
<td>x</td>
<td>x</td>
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<tr>
<td></td>
<td>Using content pages</td>
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<td>Content pages</td>
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<td></td>
<td>Quizzes available</td>
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<td></td>
<td>Announcements</td>
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<td>Forum threads</td>
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<td>Forum replies</td>
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<td>Drop box</td>
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<tr>
<td>Online Teaching</td>
<td>Teaching staff used FOL to clarify what was required to do well</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Teaching staff used FOL in ways that improved the overall teaching</td>
<td>C</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Teaching staff made an effort to communicate with students online</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Teaching staff used FOL to provide students with extra assistance</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Teaching staff used FOL to tailor activities for students</td>
<td>B</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Teaching staff used FOL to discuss interesting issues</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Online Collaboration</td>
<td>I used FOL with other students around campus</td>
<td>B</td>
<td>x</td>
<td>x</td>
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<tr>
<td></td>
<td>I used FOL to do academic work with other students</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I used FOL to work with other students outside of class</td>
<td>B</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>I used FOL to communicate with other students</td>
<td>B</td>
<td>x</td>
<td>x</td>
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Notes: FOL is the name of the Learning Management System used at the college in the study. For Type of student engagement: P=psychological, C=cognitive, B=behavioural.
Terms

College. Throughout this thesis, the word “college” is used in the Canadian sense of a two- to three-year institution whose primary focus is technological and applied arts and sciences diplomas, e.g., the community college. When referring to colleges and universities, either both terms will be used or the more inclusive terms “post-secondary” or “higher education” are used.

Learning management system(s) (LMS). An LMS is an institution-wide, Internet-based platform that integrates a wide range of teaching, learning, and administrative tools for students and faculty (Coates et al., 2005; Malikowski, 2008). Other terms for LMS include learning platforms, course or content management systems, and virtual learning environments. Popular commercial systems include Blackboard, Desire2Learn, Sakai, and Moodle. A recent American study, the 2014 Educause Centre for Analysis and Research (ECAR) Study of Undergraduate Students and Information Technology, found that 99% of institutions have an LMS, with 86% of faculty reporting LMS use in their courses (up from 70% in 2013) (Dahlstrom & Bichsel, 2014; Dahlstrom, Walker, & Dziuban, 2013). LMS tools include online access to course content (lecture notes, readings, quizzes); tools for communication and collaboration (discussion boards, wikis, group chats, and email); and administrative tools (assignment drop box, grades, announcements) (Coates et al., 2005; Malikowski, Thompson, & Theis, 2007).

Student engagement. Student engagement as a concept grew out of George Kuh’s (2009) work on the National Survey of Student Engagement (NSSE). The NSSE was based on Chickering and Gamson’s (1989) “Seven Principles of Good Practice in Higher Education” as well as Astin’s (1984) concept of student’s involvement and Pace’s (1979) notion of quality of effort. Kuh combined these three concepts and explained student engagement as a student’s involvement with and effort invested in an institution’s practices (Flynn, 2013).
of the student engagement literature conducted by Trowler (2013) defined student engagement as “the investment of time, effort and other relevant resources by both students and their institutions intended to optimise the student experience and enhance the learning outcomes and development of students, and the performance and reputation of the institution” (p. 3).

**Learning analytics.** Academic analytics is the process of analysing institutional data captured by an LMS for decision making and reporting purposes (Oblinger & Campbell, 2007). Academic analytics “describes the intersection of technology, information, management culture, and the application of information to manage the academic enterprise” (Goldstein & Katz, 2005, p. 2). Learning analytics is a specific branch of academic analytics focused on collecting student generated data and using predictive models to create tools, interventions, and visualizations that may affect student outcomes (Dawson & McWilliam, 2008; Wolff, Zdrahal, Nikolov, & Pantucek, 2013). Institutionally focused and rooted in business analytics, learning analytics may include data from student information systems and other institutional systems in addition to LMS data. The primary goal of learning analytics is understanding and optimising student learning and student learning environments (Long & Siemens, 2011).
Chapter 2

Review of the Literature

The last twenty years in higher education have been a time of rapid technological change—change so rapid that research into how students are affected by these technological changes has not kept pace (Junco & Cole-avent, 2008). This literature review is divided into four sections. The first section explains how technology has transformed campus life over the past twenty years, with particular attention to the role of learning management system (LMS) technology in this change. The second section of the literature review provides a detailed characterisation of student engagement and learning analytics—the two bodies of theory and practice that ground this research—and concludes with a brief discussion of student self-report data and its validity. Section three of the review delineates historical and current research on learning management systems, describing how LMS research began with studies of adoption and use and evolved into an examination of how LMS were used and what impact this use had on student outcomes. The fourth and final section discusses the role of faculty in creating an LMS environment that students are able and motivated to use.

Changed Campus Environment

Today’s college student may have a hard time imagining what life was like for a student in the mid-1990s. Mobile phones were large, they had antennae, and their main use was for making phone calls; they were expensive to own and operate, limiting their use mainly to business and restricting their ownership by students. E-mail had been introduced in the early 1990s, but its use was in its infancy. While the Internet existed, ownership of home computers was limited and, more importantly, home access to the Internet was far from common (Statistics Canada, 2010). LMS were used in the corporate world for training employees, but they had yet to be used at more than a handful of higher education institutions (Stern & Willits, 2011). Faculty members’
notes were not posted publically, which meant the most common record of a class lecture or discussion was the students’ notes taken in class. Students who had questions or needed a faculty member’s assistance were expected to attend office hours. Students conducted their group work in the library or the pub. The lack of portable technology and connectivity meant that students relied on face-to-face communication with each other and with their faculty members.

**Use of technology.** The student of two decades ago stands in contrast to the student of 2015 who, as will be explained below, likely owns at least two Internet-capable devices and lives in a home with both cable and wireless Internet. The majority of the courses such students take are organized through an LMS, providing access to their course content, peers, and faculty members at anytime from anywhere. This subsection describes how college and university campuses have changed in their use of technology in general and in their use of LMS specifically.

The availability of various Internet capable devices has had a profound impact on the campus learning environment. A majority of students are continually connected during their waking hours via smart phone, tablet, or laptop. Ownership of these devices is high, with over three quarters of students owning a smartphone and six out of ten students owning three or more Internet capable devices (Dahlstrom et al., 2013). Being connected to the Internet at all times, students have immediate and continuous access to social media, library databases, their institution’s learning management system (LMS), and search engines like Google. Even before entering the post-secondary system, students inhabit networked environments, and they bring to their college or university habits of engaging online with friends, family, and teachers (Jones, 2012). This infusion of technology into the campus-based student environment has several implications, including an increased number of student-student and student-faculty communication channels, opportunities to continue discussions from class into an online
environment, and the chance to review course materials from any location at any time (Sharpe, Beetham, & De Freitas, 2010).

Immersion in this technology-rich environment enables students to choose those technologies most suitable to their personal, academic, and social needs (Conole, de Laat, Dillon, & Darby, 2008). Web 2.0 tools and social networking enable easier access to credible content and expertise and provide a venue for sharing and collaboration (Wilen-Daugenti, 2009). New technologies have facilitated a move both towards individualized, customized learning and towards networked learning. Wilen-Daugenti (2009) argues that these technological changes have helped the higher education environment become more learner-centric, situated, and collaborative. Using a variety of new technologies to support campus-based courses provides opportunities for student input into course materials as well as collaboration and discussion (Rabe-Hemp, Woollen, & Humiston, 2009).

Some caution must be taken, however, in assuming that all students are Internet-connected and technologically savvy. The research literature is inconclusive in regards to students’ actual abilities in the digital realm. Conole et al. (2008) paint a picture of “a networked, extended community of learners using a range of communicative tools to exchange ideas, to query issues, to provide support, to check progress” (p. 521). On the contrary, Czerniewicz and Brown (2013) caution that it is only a small percentage of students who are first to adopt new technologies and who are actively engaging in multiple social and learning technologies. A full discussion of the nature of learners and their environments is beyond the scope of this literature review; however, it should be noted that student’s online behaviour is complex and varies in both quantity and quality. Students (and faculty) can no longer exist in a “non-digital bubble” (Sharpe et al., 2010). For example, students may be required to monitor an LMS several times daily, or they may be
expected to have access to the Internet for class participation (e.g., using smartphones for live polls in a lecture).

Technology has enabled greater flexibility in the delivery of courses to campus-based students. Whereas two decades ago the vast majority of students would fill their schedule with exclusively face-to-face classes, today’s students have the option of fully online, blended, or traditional courses. Students have had the ability to take courses by correspondence or via distance learning for many years; however, with distance education moving online, the popularity of filling a campus-based student schedule with at least one online course has increased significantly. In fact, nearly one in two students (47%) reported on the 2014 ECAR survey that they took a fully online course in the past year (Dahlstrom & Bichsel, 2014). Blended learning occurs when a portion of the course content is delivered online and a portion through face-to-face interaction. A growing model for course delivery involves requiring students to perform tasks in an LMS in lieu of class time. For example, a three-credit, three-hour-per-week class may require that students spend one hour per week on LMS and only two hours in the classroom. As will be discussed below, in many so-called traditional courses that are delivered face-to-face, there is a supplementary online component in the form of an LMS, through which course content is available, quizzes can be taken, assignments can be submitted via digital drop box, and students can discuss course content in an online forum.

**Use of learning management systems.** LMS are one of the main technologies that allow for the flexible course delivery and student-centered learning discussed above. Widespread ownership of Internet-capable devices and ubiquitous connectivity to the Internet have allowed the LMS to become a near-universal tool for campus-based students: in 2000, less than one in five American institutions of higher education had implemented an LMS (Green, 2013), but fifteen years later, nearly all institutions in the United States (99%) report using an institution-
wide LMS (Dahlstrom & Bichsel, 2014). This subsection will define what LMS are and describe their common tools and uses.

An LMS is an online institutional enterprise system used to structure and manage course material and interactions. The technology provides a rich set of learning supports including information tools that structure or elaborate on course content, cognitive tools that allow students to deeply process that content, and scaffolding tools that guide students’ learning process (Lust, Elen, & Clarebout, 2013). These systems have come to be used for fully online, blended, and campus-based courses. Some institutions have moved to mandatory implementation, requiring instructors to set up a site on the LMS for each course taught, regardless of delivery method. The ubiquitous use of LMS has blurred the line between distance learning and on-campus classes.

Where traditional distance learning courses provided limited opportunities for students to interact with instructors and classmates, an LMS may provide communication and collaboration tools which can facilitate these interactions for distance students. Similarly, in the traditional face-to-face classroom, students’ interactions with instructors and classmates often occurred only in the classroom, whereas an LMS allows for out-of-class, asynchronous communication and collaboration. LMS communication and collaboration tools can be used in similar ways in both fully online and blended courses.

Each LMS has unique properties, but common tools include those for communication (email, chat, forums), content management (document storage, assignment drop boxes, quizzes), administration (gradebook, class list, announcements), and collaboration (wikis, group workspaces) (Dahlstrom, Brooks, & Bichsel, 2014). There are two main types of LMS: those which are proprietary, such as Blackboard and Desire2Learn, and open course systems like Moodle and Sakai. Software for LMS has evolved in the last five years such that each LMS is no longer a prescribed “course-in-a-box”: faculty may choose from a myriad of tools and may also
design an LMS to include web 2.0 technologies that technically sit outside of it (Bates & Hampson, 2012b). With the incorporation of outside media and software into an LMS, it can play a facilitating role for students, assisting their focus and providing one place both to store information and to learn about new technologies (Hunt, Huijser, & Sankey, 2012).

A variety of studies provide an indication of how prevalent the use of LMS is in the United States. The 2014 ECAR Study of Undergraduate Students and Information Technology found that 99% of institutions have an LMS, with 86% of faculty reporting LMS use in their courses (Dahlstrom & Bichsel, 2014). The Campus Computing Project Report provides a lower estimate of LMS use by faculty, at 62%; however, in both cases the majority of faculty at each institution are reported to have implemented LMS in their courses (Green, 2013). The Educause report on LMS use in the United states found that a majority (83%) of students report using an LMS in at least one course, but only about half (56%) have used an LMS in most or all of their courses (Dahlstrom et al., 2014). Unfortunately, only one study could be found which provides insight into the use of LMS at Canadian institutions: Bates and Hampson (2012b) indicate that “there are only a couple of small public post-secondary education institutions in Canada that do not have an LMS deployed as of January 2012” (p. 3).

LMS play a significant role in the life of today’s college student. When asked for their preferred communication methods, students indicated that an LMS is nearly tied (64%) with face-to-face (70%) and e-mail (70%) communication (Dahlstrom et al., 2013). Students reported in the 2014 ECAR study that they value an LMS as critical to their student experience; however, paradoxically, they also report that they rarely make full use of it (Dahlstrom & Bichsel, 2014). Multiple studies suggest that students would prefer to see instructors make more and better use of the tools provided by an LMS (Dahlstrom et al., 2013; Sharpe et al., 2010; Weaver, Spratt, & Nair, 2008). Perhaps students sense that LMS have untapped potential. In general, students like
the LMS used by their institutions and would like to see “a mobile-friendly, highly personalized, and engaging LMS experience” (Dahlstrom & Bichsel, 2014, p. 23).

**Theoretical Foundations**

The student experience is so vastly different than it was twenty years ago that new theories of learning and engagement may be needed to fully account for these changes. In the absence of new theories, it may be possible to modify existing theories to accommodate new developments in technology. This section of the literature review describes the theoretical foundations of the present research, which is driven by the concept of student engagement. I propose that the concept of student engagement could possibly be refined or made more robust by exploring the impact of the introduction and common use of LMS on students. The present research is also influenced by the emerging field of learning analytics, which will be fully introduced and explained in this section.

This study drew from two different bodies of literature. First, it applied the theory of student engagement to explore how the student experience is facilitated and affected by LMS. The instrument used in this study, the Student Engagement Questionnaire (SEQ), is grounded in student engagement theory (Coates, 2006). While student engagement informed the set up and interpretation of this study’s results, a second field of inquiry, learning analytics, influenced the methodology for the study. In the next subsection of the literature review, student engagement will be defined and its outcomes explained. The following subsection will then discuss the definition and short history of learning analytics.

**Student engagement defined.** Student engagement as a unique concept in higher education began to appear in literature in the early 1990s, and the first National Survey of Student Engagement (NSSE) was conducted in 1998 (Trowler, 2010). However, the origins of student engagement can be traced back over three decades to the work of Robert Pace, Alexander
Astin, Arthur Chickering and Zelda Gamson (Coates, 2006). These researchers examined how student effort and institutional practices promoted student success and student involvement with campus environments.

In his book, Measuring Outcomes of College: Fifty Years of Findings and Recommendations for the Future, Pace (1979) introduced his concept of student quality of effort. Pace argued that students gained the most benefit from post-secondary education when they devoted time and energy to certain tasks that required extra effort. These tasks included (but were not limited to) studying, interacting with their peers and faculty members, and applying learning in different contexts. Pace (1979) developed the College Student Experiences Questionnaire (CSEQ) to identify the frequency and intensity with which students made use of campus facilities and took part in personal and social activities. The goal of Pace’s research was to “determine relationships between quality of effort and achievement, and the many elements that might help explain those relationships” (Pace, 1979, p. 6).

Astin’s (1984) theory of student involvement explained how students changed and developed over the course of their post-secondary experience as a result of co-curricular involvement. Astin’s theory was focussed on the interaction students had with their campus environments. Students’ backgrounds before entering college (inputs) interacted with their experiences, activities, and involvement opportunities while at school to produce students’ characteristics post-college (outputs). Astin (1984) made assumptions about the quantity and quality of student effort: first, he argued that involvement required psychosocial and physical energy, which is akin to Pace’s concept of quality of effort; second, he assumed that what students gained from their involvement was directly proportional to the extent to which they were involved (quantity of effort).
Where Pace focused on student initiative and Astin found the campus environment to be of prime importance, Chickering and Gamson (1989) looked at institutional behaviours and their influence on student success. The authors suggested seven principles for good practices grounded in teaching and learning research, urging faculty members, students, and administrators alike to encourage contact between students and faculty, to develop reciprocity and cooperation among students, to use active learning techniques, to give prompt feedback, to emphasize time on task, to communicate high expectations, and to respect diverse talents and ways of learning.

None of the authors listed above identified “student engagement” as a unique concept, although each discussed aspects of the idea. Through his work with the NSSE, Kuh was one of the first researchers to explicitly define student engagement. Kuh (2009) argued that student engagement had both a student focus and an institutional focus: student engagement was partly defined as the amount of time and effort students put into their studies and other educationally purposeful activities, but it was also partly defined by how institutions utilized resources, curriculum, and other learning opportunities to facilitate student participation. The interaction between student effort and institutional facilitation of student participation was a recurring theme as the literature attempted to define student engagement. Student engagement explicitly linked student behaviours with effective educational practice (Wolf-Wendel, Ward, & Kinzie, 2009), and it could be seen as a “mechanism for interpreting the relationships between students and their institutions” (Coates, 2006, p.15).

Krause and Coates (2008) described student engagement as the quality of effort students themselves devoted to educationally purposeful activities that contributed directly to desired outcomes. Similarly, Chen, Gonyea, and Kuh (2008) saw engagement as the degree to which learners were engrossed in their educational activities in addition to the degree to which these activities were positively linked to a host of desired outcomes. In developing the Australian
version of the NSSE (the AUSSE), Coates (2007) described engagement as involving active and collaborative learning; formative communication with academic staff; involvement in enriching educational experiences; and feelings of legitimisation and support by university learning communities. In summary, the three key elements of student engagement were (a) student effort, (b) student interaction with institutions, and (c) the connection between engagement and outcomes.

A recent review of the student engagement literature conducted by Trowler defined student engagement as “the investment of time, effort and other relevant resources by both students and their institutions intended to optimise the student experience and enhance the learning outcomes and development of students, and the performance and reputation of the institution” (Trowler, 2010, p. 3). This definition was student centered while also acknowledging the role of the institution in engagement. It differed from Kuh’s definition in that it included not only the “what” of student engagement, but also the “why.” Trowler’s definition of student engagement was used in the present research.

It is possible to argue that activity within an LMS might serve as a measure of student engagement because LMS log data contains a record of student behaviours as well as institutional practices. Student behaviours such as logging in, accessing course content, completing quizzes, submitting assignments, and taking part in discussions related to coursework are all captured in a potentially permanent record. The NSSE asks students to estimate the frequency of similar behaviours, but LMS log data tracks the behaviours as they happen. An LMS is also a record of institutional practice, in two ways: first, institutions choose which LMS software to purchase and implement and which features to train and encourage faculty to use; second, faculty LMS use is also recorded, both in terms of which functions are activated and the frequency with which faculty use each LMS function. If student engagement is a combination of
student behaviour and institutional practice, LMS log data could potentially serve as a new tool to measure student engagement.

Outcomes and student engagement. Student engagement has become a focus of study because of its correlation to both improved student outcomes and benefits to institutions. The research literature reviewed in this subsection explored five outcomes of student engagement: student experience, learning outcomes, student development, institutional reputation, and institutional performance (Trowler, 2010). Wolf-Wendel, Ward, and Kinzie (2009) also listed both student and institutional benefits of student engagement in their review of student engagement research, proposing that students who were engaged had improved learning outcomes, felt a sense of belonging within their institution, and demonstrated increased retention rates. Kuh (2009) asserted that student engagement was linked to important outcomes for students, such as cognitive development, psychosocial development, self-esteem, development of an internal locus of control, moral and ethical development, and persistence. Measures of student engagement could influence how institutions allocated resources and provided services intended to encourage student participation and persistence (Kuh, 2009).

Student engagement can be examined from the student perspective, or it can be studied from an institutional perspective. Examination from the student perspective means looking at students’ behaviours and the cognitive and psychological aspects of engagement. The bulk of student engagement research has used NSSE data, which is largely focussed on students’ behaviours and institutions’ instructional practices. The main focus of behavioural research was students’ time, effort, and participation (Kahu, 2013). Transactions between students and teaching and support structures within institutions were measured (Zepke & Leach, 2010). Studies using a cognitive lens focussed on how academic performance was affected by student engagement (both in and out of the classroom), which included individual students’ learning and
self-regulation (Kahu, 2013; Trowler, 2010). Coates (2007) used the term academic engagement to describe student use of active learning and deep involvement in their studies. Psychological engagement, sometimes referred to as affect, was used to refer to students’ feelings about their schools, their sense of belonging, and their and group affiliations (Kahu, 2013; Trowler, 2010). Adopting a psychological perspective meant looking at the social factors that influence engagement (Zepke & Leach, 2010). Social engagement was one aspect of student engagement which emphasized student relationships and identity (Coates, 2007). Lastly, there was a category of student engagement research whose unit of analysis was the institution: these studies explored how students provided feedback to institutions, how they were represented in institutional decision making, and how institutions supported student engagement through structures and programming (Trowler, 2010; Zepke & Leach, 2010).

Results from student engagement surveys have been correlated with multiple positive student and institutional outcomes, such as increased persistence, better academic performance, and increased graduation rates (Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008; H. Zhao, 2011). Student engagement scores, as measured by the NSSE, have been positively correlated to persistence between the first and second year of college or university (Kuh et al., 2008). The studies explored how student engagement scores were affected by institutional practices, which included first year orientation and transition programming, placement testing, first-year seminars, learning communities, intrusive advising, early warning systems, supplemental instruction, peer tutoring and mentoring, theme-based campus housing, internships, service learning, and effective teaching practices (Kuh et al., 2008; Kuh, Hu, & Vesper, 2000; Pike, Kuh, & McCormick, 2010; Zhao & Kuh, 2004). Comparisons between institutional practices and student outcomes were mediated by student engagement measures. It was argued that, if institutional practices led to student engagement and student engagement led to positive outcomes, then institutional practices
indirectly led to positive outcomes from higher education (Umbach & Wawrzynski, 2005). The implication was that high student engagement would lead to positive outcomes for students, which would indicate good institutional quality (Zhao, 2011). A recent study by Pascarella, Seifert, and Blaich (2010) affirmed the relationship between engagement and educational outcomes. The authors stated that “increases on institutional NSSE scores can be considered as reasonable proxies for student growth and learning across a range of important educational outcomes” (Pascarella et al., 2010, p. 21).

Student engagement is currently measured in Canada using survey instruments such as the NSSE, the College Survey of Student Engagement (CSSE), and Key Performance Indicator (KPI) Student Satisfaction Survey. There are currently 88 Canadian post-secondary institutions that have participated in the NSSE, a number up significantly from only eleven institutions in 2004, the first year NSSE was administered in Canada (NSSE, 2013). The NSSE has over 100 items, with 42 being specifically related to engagement. These 42 items have been aggregated into NSSE’s five established benchmarks of effective educational practice (Kuh, 2009). The first benchmark, Level of Academic Challenge (LAC), includes questions about preparing for class and course work that involves analysis, synthesis, judgments, or application of theory, as well as questions about the level of difficulty of readings and papers. The Active and Collaborative Learning (ACL) benchmark includes questions that ask students to reflect on their participation in class, class presentations, peer tutoring, group projects, and discussions of course material outside of class. The Student-Faculty Interaction (SFI) benchmark addresses discussions with faculty regarding course work, grades, and career plans; working with faculty on research; and receiving feedback. The Enriching Educational Experiences (EEE) benchmark encompasses all non-academic aspects of student life, including questions about co-curricular activities, exposure to diversity, use of technology, and community service. Lastly, the Supportive Campus
Environment (SCE) benchmark asks about student perceptions of campus culture, with items measuring quality of relationships within, and perceived levels of support from, the campus environment.

The NSSE is used in Canada at all universities, but only three colleges in Canada have participated in the NSSE (NSSE, 2013). Canadian colleges have instead used a mixture of engagement surveys, such as the NSSE-derived Community College Survey of Student Engagement (CCSSE), the Pan-Canadian Survey of Canadian College Students, and the Ontario College Student Engagement Survey (OCSES) (Clark, Moran, Skolnik, & Trick, 2009). Student engagement questions have also been added to the Key Performance Indictors surveys (Zhao, 2011). There is a need for colleges in Canada to find a student engagement measurement tool that can be used on a country-wide scale.

Because LMS use has been mandated within the Ontario college system, there is potential for LMS log data to be amassed in vast quantities. The data itself is valuable for its tracking of students’ behaviours and interactions with their institutions as well as of the teaching behaviours of faculty members (Macfadyen, Dawson, Pardo, & Gašević, 2014). When studied in the aggregate, the LMS data could provide a system-wide representation of student and institutional activity. The NSSE asks students to report on their time, effort, and participation by providing an estimate on a survey, but an LMS records time on task in the form of time logged in, records effort in the form of clicks on content pages or quizzes attempted, and records participation in the form of logins and posts in discussion forums. The NSSE and other student engagement surveys also ask students to reflect on their sense of belonging at an institution, but an LMS can potentially demonstrate social engagement through social network analysis and other explorations of the networks made visible within LMS tracking systems (De Laat & Prinsen, 2014). As outlined above, student engagement, as measured by the NSSE, has been empirically
correlated with positive learning outcomes. As will be outlined below, LMS use and various LMS activities have been empirically demonstrated to be correlated with positive learning outcomes and social engagement. However, there is a lack of research which compares LMS data with student engagement measures such as the NSSE. LMS data alone may not have an application for quality assurance because there does not exist a foundation of empirical research which has clearly demonstrated a correlation between LMS data and student engagement. More research is required to explore the connection between student engagement as measured by NSSE (or other student engagement self-report surveys) and LMS use.

**Learning analytics.** Because 86% of faculty who teach campus-based classes have made use of an LMS each day in higher education, tens of thousands of data about student behaviour have been recorded (Dahlstrom & Bichsel, 2014): each student login, selection of a faculty-provided content link, post in a forum, or assignment placed in a drop box is tracked. The study of learning analytics has been defined as the “measurement, collection, analysis and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs” (Siemens & Gašević, 2012, p. 1). The data used in learning analytics can come from a myriad of sources, from student link selections to student access of LMS tools, from text contributions like blogs and wikis to social media participation in LMS through Facebook posts. Because of their enterprise nature, LMS have been one of the most common sources for data in learning analytics (Steven Lonn, Aguilar, & Teasley, 2013; Wolff et al., 2013).

Learning analytics is a very young field, as evidenced by the fact that conferences and journals dedicated to its exploration are all less than seven years old: the first Learning Analytics and Knowledge conference was held in 2011 (Siemens, 2010), and the Journal of Educational Data Mining published its inaugural issue in 2009 (Baker & Yacef, 2009). Learning analytics has
drawn from a diverse range of fields of study, including information science, information technology, data mining, information visualization, and psychology (Gašević, Dawson, & Siemens, 2015).

Learning analytics is more than simply the analysis of trace data recorded by LMS software. The definition of learning analytics given above indicates that the gathering and analysis of the data has a purpose, which is to optimize learning. The distinction between learning analytics and data mining is that the former uses patterns drawn from the data to create predictive models, which can then be used to inform student services programming and interventions, thereby improving student outcomes.

The best known application of learning analytics in education has been Course Signals, developed at Purdue University (Arnold & Pistilli, 2012). Course Signals combines LMS activity data with data from the institutional student information system, using a data-mining algorithm to identify students at academic risk. Visualizations in the form of green, orange, or red symbols on the LMS dashboard, available to faculty and students, assist with making assessments of students’ course progress.

Even before a body of research on learning analytics was available, Oblinger and Campbell (2007) suggested that the data being mined and analyzed could relate to student effort and student success. The authors were also hopeful that analytics would come to be “a valuable tool in institutional improvement and accountability” (Oblinger & Campbell, 2007, p. 3). Not even five years after Oblinger and Campbell popularized the concept of learning analytics, a body of research had grown significantly enough for Long and Siemens (2011) to claim that “analytics provides a new model for college and university leaders to improve teaching, learning, organizational efficiency, and decision making and, as a consequence, serve as a foundation for
systemic change” (p. 32). What follows next is a brief overview of selected learning analytics research.

Wolff et al. (2013) used predictive modelling to determine if students were at risk of failing a course. The authors discovered that it was indeed possible to predict student failure by looking for changes in the student’s activity in an LMS. The researchers collected LMS activity in the form of student selections (i.e., clicks) on links to forums, course content, and online tools. As with other learning analytics research, Wolff et al. (2013) used marks from assignments in addition to LMS activity data. They found that a unique predictive model needed to be created for each course in the study, as each course required a unique pattern of selections on links to LMS tools. After finding success predicting student failures using LMS activity and grades, Wolff et al. added demographics data and found that they improved prediction. Wolff et al. (2013) emphasized that the number of selections in the LMS was not as important to the predictive model as was the change in online behaviour (frequency and type of LMS tools accessed).

An Early Warning System was built using LMS logins to monitor the degree of student engagement with a course (Lonn et al., 2013). The warning system was created to support academic advisors in their assistance of undergraduate engineering and biology students. The advisors were seeking a method of tracking student performance early in the semester so they could help students before it was too late in the semester to recover. Lonn, Aguilar, and Teasley (2013) used information from the LMS Gradebook and Assignments tools in order to track students’ performance. The predictive model used an algorithm based on three rules: (1) whether a student's percent of points earned was at or above the thresholds of 85%, 75%, or 65%; (2) whether a student was 10% or 5% below the course average in percent of points earned; and (3) whether a student was below the 25th percentile in number of logins. The predictive model
produced three possible actions for advisors: “encourage” students to keep doing well, “explore” students’ progress in more detail, or immediately “engage” students to assess possible academic difficulties. The pilot project for the early warning system had some initial successes, but the team experienced challenges related to collaborating with their institution’s information technology department. Providing sufficiently timely information to academic advisors also proved difficult, with delays of six or seven days commonly occurring.

The youth and complexity of learning analytics means the field is experiencing growing pains. In a review of the studies in learning analytics to date, Gašević, Dawson, and Siemens (2015) argued that learning analytics needed to be better grounded in the research on learning and teaching: the tools used for both data mining and predictive modeling were not created with learning or teaching theories in mind. An example of this is the Course Signals program, which indicated when students had decreased LMS activity or experienced a reduction in grades; however, learning analytics does not indicate why the student is not succeeding, nor does it provide remedial steps to fix the situation. Gašević, Dawson, and Siemens (2015) also pointed out that learning analytics had been almost exclusively focused on the investigation of the operations performed for learning and that it needed to include the context and products of learning. The authors believed that the “growth of the field of learning analytics will only occur if the information we seek to collect and understand is framed in robust theoretical models” (Gašević et al., 2015, p.68). While the authors suggested that teaching and learning models would inform the field of learning analytics, the present research argues that student engagement theory will also provide learning analytics with a robust foundation.

Learning analytics is a potential new tool for examining student engagement. As Coates and McCormick (2014) stated in the opening to their book on student engagement, “capturing data on students’ engagement can enhance knowledge about learning processes and furnish
nuanced and useful diagnostic measures for learning enhancement activities” (p. 3). One advantage of student engagement surveys could be the direct application of the information gained from survey results to the improvement of institutional programs and activities (Coates, 2005). Senior academic leaders at Ontario’s universities have reported that they see the NSSE as a tool for promoting institutional improvements in the quality of the student experience (Jones, 2007). Each of the above statements about student engagement survey data can also be applied to data collected through learning analytics methods. There is great potential in combining the self-report nature of student engagement surveys with the trace data from computer systems used in learning analytics. This last section of the theoretical foundation section of the literature review will expand on this idea of using self-report data alongside computer generated data.

**Self-report data.** The validity of student’s self-reports of their learning has been a subject of debate in the literature. Empirical research has demonstrated very little correlation between student self-reports of learning and either longitudinal studies or direct measures of learning (Bowman, 2011; Pascarella, 2006; Porter, 2013). However, Gonyea and Miller (2011) argued that self-report data is a good approximation of student behaviour as long as researchers regarded the data generated from self-reports as attitudinal in nature. Researchers using self-report data should have been “clear that the data are from self-assessments of learning and are more closely related to students’ perceptions and attitudes about their learning experiences” (Gonyea & Miller, 2011, p. 109). Other researchers disagreed and stated that self-reports had no construct or criterion validity (Bowman, 2010; Porter, 2013). Porter (2013) posited that students were not cognitively capable of answering survey responses accurately and instead used a belief sampling model when responding: instead of recollecting actual memories and events, students used their own beliefs, feelings, and prior judgments about the question in formulating their response (Porter, 2013). Porter (2013) argued that a student’s background and interests prior to entering
college played a dominant role in answering survey items. Researchers seem to have agreed that self-reported data are not an accurate reflection of true learning; however, they have differed on whether this misalignment invalidates the data’s use in academic research.

**LMS Research**

The first studies of learning management systems appeared in the mid-1990s and were focused on user adoption of the new technology. Many of these early studies used the technology acceptance model (TAM) or its variants as a framework. The second wave of LMS research set out to determine the extent to which students or faculty were using an LMS. Next, the research evolved to looking at how LMS were used and what impact their use had on student outcomes. Recent explorations of LMS examine applications of learning analytics in the form of predictive modelling. The next subsection of this literature review provides a brief summary of the short history of LMS research.

**LMS adoption.** Initial LMS studies were based on a theoretical model known as the technology acceptance model (TAM), the key constructs of which included the perceived usefulness and perceived ease-of-use of a technology (Davis, 1989). Perceived usefulness, as a construct, described judgments users made about whether the technology would benefit them in some way; perceived ease-of-use described how easy users thought the technology was to master. Eleven years later, the TAM model was updated to include social influence factors, such as desire to conform to the norm and degree of voluntarism in adopting the technology (Venkatesh & Davis, 2000). The same authors further modified the TAM and renamed it the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). This final model was built upon the idea that individuals’ reactions to using technology influenced their intentions to use, which affected their actual use of technology. The
UTAUT is a complex model that considers a multitude of factors (shown in Figure 1), each of which influence both the intention to use and the actual use of technology.

![UTAUT Model](image)

In all of its iterations, the UTAUT model implied that a critical factor to successful adoption of a new technology was students’ personal beliefs and attitudes (Daskalakis & Tselios, 2013). Satisfaction with the LMS was shown to contribute to a user’s intention to continue using an LMS (Roca, Chiu, & Martinez, 2006). Gender and age both had an influence on the acceptance and use of technology, but Venkatesh et al. (2003) hypothesized that these two demographic variables worked in concert and proposed that the effect of gender on effort expectancy was transitory and could decrease over time. In their review of technology use at the post-secondary level, Nora and Snyder (2008) found that student attitude affected performance: students who perceived the online tools as useful had more positive outcomes. The same review found that students who held positive learning goal orientations were more satisfied with the online environment (Nora & Snyder, 2008).
Specific tools within an LMS have also been found to influence students’ attitudes and satisfaction and, therefore, their use of LMS technology. Naveh, Tubin, and Pliskin (2010) found that course content was the most significant factor in relation to student satisfaction. The authors also found that discussion forums promoted use and satisfaction, especially among first-year students (Naveh, Tubin, & Pliskin, 2010). Somewhat to the contrary, Landry, Griffeth, and Hartman (2006) concluded that course content, announcements, and quizzes were used more often and were seen by students as more useful than discussion forums, email, and links to external websites. Malikowski (2008) also asserted that students perceived LMS features related to course content as more useful than those related to course communication and assessment.

**LMS use.** An early line of inquiry using TAM examined factors that influence LMS use. The research found that students may have been more likely to use an LMS if they perceived the LMS to be easy to use (Costen, 2009), to have a benefit to themselves personally (Klobas & McGill, 2010; Landry et al., 2006; McGill & Klobas, 2008; Presley & Presley, 2009), and to have value to their instructors (Klobas & McGill, 2010; McGill & Klobas 2008). Outside factors, such as accessibility of computers, quality of LMS infrastructure, and availability of support, were not found to influence student use (McGill & Klobas 2008). Presley and Presley (2009) found that ease of use, perceived usefulness, and students’ attitudes had a strong relationship to intention to use and actual usage of the LMS.

A second line of inquiry in early LMS studies focused on which features in an LMS were being used by students. A major finding of this research was that students used LMS primarily to access course content (Beer, Clark, & Jones, 2010; Lonn & Teasley, 2009; Malikowski, 2011; Salajan, Schonwetter, & Cleghorn, 2010). One study found that commuter students made more use of interactive features (email, forums) than did students who lived on campus (Lonn & Teasley, 2009). Malikowski (2011) studied student behaviour in an LMS at one university by
analyzing activity within 842 course websites over a three year period; the major finding of this study was that the LMS was used primarily to transmit information to students and used only occasionally for student interaction. The study was conducted from 2005 to 2007, a time when social media and other web 2.0 tools were just beginning to surface, so it could be that LMS are used differently now.

In presenting a model for research into how LMS is used for learning, Malikowski, Thompson, and Theis (2007) organized LMS tools used by faculty into the following five categories: transmission of course content; evaluation of students; evaluation of courses and instructors; creation of class discussions; and computer-based instruction. Their review of the research literature showed that the tools for transmitting content were the most frequently made available by faculty and the most often used by students; conversely, class discussions received low to moderate use, tools for evaluating students were used infrequently, and the other types of tools (for evaluating courses and instructors and computer-based instruction) were barely used at all. The Malikowski, Thompson, and Theis (2007) model was considered in choosing variables for this study, which focused on those variables falling into the model’s top three most-used LMS features: frequency of page visits falls under the category of course content; quiz attempts falls under the category of student evaluation; and discussion forum views, original discussion forum posts, and discussion forum fall under the category of class discussions.

Dawson and McWilliam (2008) made similar choices to Malikowski, Thompson, and Theis when they categorized LMS tools according to each tool’s intended purpose. The four groups were: administration (announcements, file manager, tracking, and calendar); assessment (gradebook, assessments, and assignments); engagement (discussion forum, chat, and e-mail); and content (bookmarks, content page, file, search, notes, and syllabus). LMS activity data
collected from over 1000 students in a science class were analyzed based on these four categories.

**LMS activity.** After initial studies on factors influencing the adoption of LMS and which tools within the LMS were being used, the focus of LMS research shifted to exploring outcomes of student behaviours within LMS. Several studies have explored the relationship between LMS activity variables, as measured by either student self-reports or LMS log data, and different measures of student success and engagement. The next subsection will describe several studies that sought to examine the relationships between LMS activity and student grades, students’ sense of belonging, and student engagement.

**LMS activity and grades.** Several researchers have found a positive relationship between frequency of LMS use and students’ grades. Some studies specifically identified the use of one LMS tool, such as Dawson and McWilliam’s (2008) study of forum discussions, which concluded that “there is a greater likelihood of achieving better grades if one actively and productively engages with forum activities” (p. 29). Pulford (2011) reported similar findings: students who used Blackboard to read discussion posts and ask questions of tutors had statistically significantly higher grades on assignments than those who did not have Blackboard discussion forums available. Gašević, Dawson, and Siemens (2015) reported on a study which combined data from nine undergraduate courses in an Australian university and found that only the number of logins and views in discussion forums were significant predictors of academic achievement.

Other studies found a relationship between grades and overall use of the LMS. In a quasi-experimental study, Alonso, Manrique, Martinez, and Vines (2011) compared grades of 693 engineering undergraduates who took a specific course either as a traditional face-to-face lecture in the 2006, 2007, or 2008 academic years or via a blended learning class deployed in the 2009 academic year. The authors found that the mean grade of those in the blended learning class was
statistically significantly higher than students in the three previous years of face-to-face lecture classes (Alonso et al., 2011). A longitudinal study from 2007 to 2010 of 131 courses at an American university found that students earning a final grade of D or F used the LMS an average of 39% less than students earning a grade of C or higher (Fritz, 2011). Mogus, Djurdjevic, and Suvak (2012) extracted from Moodle the total number of the course content views, forum views, and assignment uploads of 111 students and found a positive correlation between this LMS activity and student grades. In his study of 273 students in seven blended courses which looked for relationships between LMS use and final grades, Vaughan (2014) reported a positive correlation between final grades and use of Blackboard as measured by total page hits. Two additional studies associating grades and LMS activity are described in further detail below.

Beer, Clark, and Jones (2010) examined aggregated data from two different LMS (Blackboard and Moodle) and the student administrative system to create a database of student demographic, grade, and LMS usage data from 2714 undergraduate online courses. The authors hypothesized that students who visited the LMS more frequently and for longer periods of time would be more engaged than those who visited less often. The authors used total hits to the LMS site, average number of different page visits per login session and average time spent logged on as variables representing LMS activity. The analysis showed that students who had a higher number of selections on LMS links had higher grades. This finding is in line with the traditional idea that higher class attendance in a classroom results in higher grades.

In their ground breaking study, Macfayden and Dawson (2010) extracted all available LMS data from five sections of a fully online undergraduate biology course using the Blackboard LMS at a large urban Canadian university. For each student in the study, counts for frequency of usage of course materials, discussions, assessments and administrative tools were collected for an entire term. The tracking data included total time spent on assessments and assignments, and
total time online. The authors found correlations between the LMS data and recorded academic grades. They state that, “three measures of student online activity (number of forum postings, mail messages sent, and assessments completed) function as significantly predictive variables of student final grade” (Macfadyen & Dawson, 2010, p. 597). The forum postings represented the primary means for students to communicate with their peers. Those who engaged in academic discussions by posting more frequently in the forums were shown to have higher grades. Similarly, the mail messages served as the students’ method of contacting their faculty members. Those who made extensive use of the email system could be seen as paying attention to the “administrative matters related to their learning” (Macfayden & Dawson, 2010, p. 597). Finally, the assessments (or quizzes) were offered as a form of review and were optional for students. Therefore, those who completed the assessments could be seen as showing an active engagement in their learning.

In addition to actual grades, research has shown that increased use of LMS improved students’ perceptions of their learning (Carvalho, Areal, & Silva, 2011; McGill & Klobas, 2008). A limitation of much of the research cited above is a lack of control over other possible moderating variables such as motivation, prior achievement, or aptitude. The main issue with correlational studies of student LMS use and course achievement is that it is difficult to determine if the higher grade resulted from students’ work ethic and ability to take advantage of all study tools available or the use of the LMS in and of itself (Mo, 2011).

_LMS activity and sense of belonging._ Students have indicated that they do find a sense of belonging in virtual environments. In a qualitative study of students’ perceptions of their online environments, Annala et al. (2012) reported that students saw their online environments as “beneficial in strengthening the sense of belonging to the university, in networking and in enhancing active citizenship” (p. 84). The 2013 ECAR Study of Undergraduate Students and
Information Technology reported that 65% of respondents agreed/strongly agreed that technology helps them feel more connected to what is going on at their institution. A similar number of respondents (58%) agreed that technology fosters connections between themselves and other students and themselves and their instructors (63%) (Dahlstrom et al., 2013).

In an essay aiming to connect the concepts of learning analytics, higher education data mining, and LMS audits, Baepler and Murdoch (2010) make the assertion that it is “possible to measure affective attributes among students with simple data logs” (p. 4). Several research studies have had positive results supporting this claim. Using Rovai’s Classroom Community Scale, Black, Dawson and Priem (2008) reported that LMS data logs (i.e., clicks) were a good predictor of sense of community. The frequency of posts in the weekly class discussions was also positively correlated to perceptions of social presence. Macfayden and Dawson (2010) used social network analysis to create visualizations of student discussion forum postings which lead them to conclude that LMS tracking variables from communication tools are significant indicators of a student’s sense of belonging, and thus engagement. Dixson (2010) concluded that participation in discussions may assist students in developing social presence.

A number of additional studies have established a correlation between sense of community in an online environment and positive educational outcomes. Rovai (2002) studied an online course for graduate students in education and found evidence that the students felt connected to their virtual classroom community. The students who reported a stronger sense of community tended to possess greater perceived levels of cognitive learning (Rovai, 2002). Rovai (2002) posits that “online learners who have a stronger sense of community and perceive greater cognitive learning should feel less isolated and have greater satisfaction with their academic programs, possibly resulting in fewer dropouts” (p. 328). Drouin and Vartanian (2010) had a similar finding that when a sense of community was present, students reported higher levels of
satisfaction and learning. Studying students in a fully online class, Sutton and Nora (2009) found that students’ academic performance was directly affected by their ability to develop relationships with fellow students. Lastly, Picciano (2002) found a positive correlation between students’ perceptions of online social presence and higher grades on an end of term paper.

*LMS activity and student engagement measures.* Few studies could be found which seek to explore the relationship between LMS activity and student engagement measures. These studies found either a minimal correlation between the engagement measure and LMS activity or no difference between the mean student engagement scores of different groups. Three recent studies used two different student engagement measures. Using the NSSE based Classroom Survey of Student Engagement (CLASSE) in order to compare mean engagement scales with hits on Blackboard course sites, Vaughan (2014) found that the “engagement in effective educational practices” scale was moderately correlated to hits, while three other scales (level of academic challenge, student-faculty interaction, active and collaborative learning) showed small correlations with Blackboard hits. Dixson (2010) created an Online Student Engagement Survey (OSES) and conducted an analysis of variance, comparing groups of students based on their self-reported LMS activity, which she categorized as active or passive. While she found no difference in LMS activity between those who had high engagement scores and those who had low scores, those who reported using discussions more frequently also had higher engagement scores. Hamane (2014) used Dixson’s OSES and found a weak positive relationship between students’ perceived level of engagement and students’ frequency of logins: students who had high frequencies of discussion forum posts and replies had higher perceived levels of engagement (Hamane, 2014).

Close to two decades of studying LMS in higher education have led to several discoveries about the nature of students’ use of this technology. Students were more likely to use an LMS if
they could see a clear benefit to themselves personally and if they were easily able to understand its functionality. Both faculty and students used the course content storage and organization functions of the LMS most often. Students, however, indicate in annual surveys their desire for increased use of the LMS. The more often students used the LMS, the more likely it was that they received higher grades than students who made less use of the LMS. If an LMS had built-in discussion forums and group work functions, students could report feeling a sense of community in their class as a result of the LMS. Finally, while correlations have been found between LMS use and grades and a sense of belonging, there has not been a large enough base of studies to correlate student engagement measures and LMS use.

In many of the studies reported in this section, the researchers mentioned that several outside factors affected student use and acknowledged that a limitation of their studies was an inability to control for all confounding variables. Faculty use of LMS influenced how students were able to interact with course content and the instructors themselves, and so this literature review will conclude with a discussion of the role of faculty in creating a learning environment via an LMS and how this may have an effect on students’ use of the system.

**Role of Faculty in Students’ Use of an LMS**

The near-universal use of LMS has transformed the faculty-student dynamic in part because LMS tools enable students to communicate easily with each other and with faculty as well as to seek out, share, and create academic resources. Faculty have been called on to adjust and modify their pedagogy in order to integrate new technologies into their current teaching practice. The following subsection of this literature review will explore the effect of changing technology on the professoriate and will conclude with a review of recent research exploring the moderating effect faculty have on student use of the LMS.
**Students’ access to communications and resources.** The use of an LMS has increased the communication opportunities for students in the form of email, discussion forums, chat functions, and announcements (Laird & Kuh, 2005; Mo, 2011). Students have been given the choice to raise their hand in class, to attend posted office hours, to send an email, or to read and write LMS forum posts. These new options provide two advantages: first, students can reach out to faculty or other students at their convenience; and second, students can choose their preferred channel of communication. The flexibility afforded by technology has resulted in an increased volume of communications between faculty and students (Mo, 2011). This increased volume may result in increased workload, but there are also positive outcomes for faculty. Faculty have the opportunity with LMS to more closely monitor students’ learning by seeing students’ thoughts made public (Dixson, 2010). Faculty also have the advantage of getting to know and to have deeper conversations with more students, even within a large lecture class (Coates, 2006).

Students have increasingly relied on sources other than faculty members for information and knowledge (Benfield & de Laat, 2010; Jones, 2012), and the concepts of networked learning and connectivism help illustrate students’ breadth and depth of access to people and information. Jones (2012) described networked learning as occurring when technology enables students to connect with each other and their faculty members as well as with resources, both people and information, outside of the college or university they are attending. Students may draw on their network to help prepare for an exam or write an assignment. The network may include people that the student has never met, people who live in a different country, and people who have no immediate connection to the student other than the shared quest for knowledge (Benfield & de Laat, 2010). Siemens (2004) coined the term connectivism to describe a way of learning which, like constructivism, purports that knowledge is constructed as a learner attempts to understand their experiences; in connectivism, however, networks are of primary importance. Nurturing and
maintaining connections is needed to facilitate continual learning because knowledge is created when novel connections between diverse resources are made (Siemens, 2004). In both networked learning and connectivism, the boundaries between what is part of and what is separate from the curriculum become porous (Czerniewicz & Brown, 2013).

What does this increase in access to knowledge mean for faculty? Technology has made accessible to students information that once was the purview of faculty or librarians. Students adept at using Internet search engines or institutional library websites can find virtually any resources needed for an assignment; students can also reach out to their networks and find answers—or find resources that will lead to answers—within minutes. If faculty members are no longer the keepers of knowledge, they still have a very large role to play in helping students to analyze critically these newly accessible resources (Barr & Tagg, 1995; Coates, 2006). Faculty members need to shift from being content providers to being facilitators who guide students in the ways to best seek out, judge, and analyze information.

**Challenging current pedagogy.** LMS technology is causing faculty and others in higher education to re-think and re-consider their beliefs about knowledge, teaching, and learning. Several studies have found that pedagogical beliefs of faculty have influenced their level of technology adoption and in what manner they use it (Lameras, Levy, Paraskakis, & Webber, 2012; Parker & Bianchi, 2008; Trowler, 2010). Those holding constructivist beliefs have seen technology as an opportunity to enhance student-student and student-teacher interactions and collaborations, allowing for knowledge to be shared and co-constructed. Those who have seen knowledge as being located in the collective have used LMS for concept exploration, dialogue, and collaboration (González, 2010). Another view, more in line with instructivist thinking, has treated technology as prescriptive and controlling, that is, as having a large influence over the ways instructors and students think about content (Parker & Bianchi, 2008). Those who conceive
of knowledge as external to students have used LMS as a content repository for information storage and retrieval.

While LMS have great potential, the majority of LMS use has been at a basic content storage and organization level, which could be due in part to pedagogical beliefs. Dahlstrom et al. (2013) reported that of the 70% of faculty using an LMS in 2013, half were using only the basic components (announcements and lecture note postings). Weaver et al. (2008) reported that the majority of LMS use in their study had a teacher-centred, content-focused approach. Reporting on Harasim’s work, Bates and Hampson (2012a) suggested that most faculty have simply moved their lectures online rather than transforming their pedagogy. A good summary of the unused potential of LMS has been provided by Conole et al. (2007), who found that technology was touted as an agent of pedagogical change but that these changes were not reflected in practice.

Lameras et al. (2012) conducted a phenomenographic investigation into blended computer science courses. Although the study was small (25 faculty members), the results illustrated how pedagogical beliefs could be more influential in LMS use than a particular LMS’s features. The study found four categories of LMS use by faculty members: (A) information transfer; (B) application and clarification of concepts; (C) exchange and development of ideas and resource exploration and sharing; and (D) collaborative knowledge-creation and development of process awareness and skills. The authors labeled categories A and B together as “teacher-focused, content-oriented,” and these uses seemed to reflect instructivist beliefs, suggesting that knowledge could be mediated via an LMS through “on-line documents, examples, exercises and provision of feedback” (Lameras et al., 2012, p.154). Category C was considered student-focused and content-oriented, while category D was student-focused and process-oriented. Categories C
and D seemed to reflect constructivist beliefs, suggesting that knowledge development could be facilitated via the LMS mainly through dialogue and collaboration (Lameras et al., 2012).

The Lameras et al. study researched faculty use of the LMS from the faculty’s perceptive. Several studies have used students as the focus of study in examining faculty use of LMS. The research literature has mixed findings regarding whether faculty use of an LMS influences student use of the LMS. Beer, Clark, and Jones (2010) found that students in courses where faculty were active participants in the LMS had higher grades compared with students in courses where faculty made less use of the LMS. Similarly, Gašević et al. (2015) described the results of a yet unpublished study which found that the relationship between LMS activity data and student grades was moderated by factors related to instruction. Dixson (2010) also identified a significant correlation of student course engagement with both instructor presence and student presence. However, Stamm (2013) found no relationship between instructor activity and student LMS activity. Gašević et al. (2015) posit that the different ways in which faculty use LMS could help explain the variation in correlations between LMS activity data and student achievement.

This section of the literature review has demonstrated that the introduction of the LMS has played a role in the ongoing “shift in pedagogy from an orientation to teaching to an emphasis on student learning” (Hunt et al., 2012, p. 182). Through LMS, institutions of higher education have provided students with increased access to communication and resources, empowering them with the ability to be in touch with the people and information they need, when they need it. The affordances of LMS lend themselves easily to constructivist ideology. Faculty continue to have a strong role in encouraging students LMS use and in guiding their behaviours within an LMS (Klobas & McGill, 2010; McGill & Klobas 2008). Faculty use of LMS could influence student use of LMS, but more research is needed in this area.
Summary

Today’s college student attends school at two campuses simultaneously: one physical, one virtual. The ubiquity of Internet-capable devices, wireless connectivity, and LMS enable students to merge these two worlds into a fluid student experience. The ability to access course content, peers, and faculty from any place at any time provides students with new opportunities for organizing their academic studies and collaborating with others. This literature review has examined how recent developments in technology (in general) and LMS (specifically) have impacted the ways students engage with their course content, peers, faculty members, and institutions.

LMS have multiple and diverse functions. Because LMS are enterprise systems, institutions usually purchase a large array of tools which faculty can choose to activate. LMS tools have been used for three main purposes: communication, collaboration, and content storage and distribution. Research has discovered that the vast majority of faculty have used the content functions of LMS and that very few have used the collaboration functions.

The ubiquitous use of LMS on Canadian college and university campuses has generated a vast amount of data, much of which reflects student behaviours that are related to student engagement. LMS are able to track the numerous transactions that take place between students, faculty members, and institutions (Zepke & Leach, 2010). Coates (2007) described student engagement as having four key components, each of which has the potential to be made visible through data in an LMS. The “active and collaborative learning” of students can be represented by their actions (logins and clicks to course content and quizzes) and their group work (discussion forums, wikis, groups meeting rooms). “Formative communication with academic staff” is tracked in discussion forums, class announcements, and emails. An LMS facilitates “involvement in enriching educational experiences” through discussion forums; through links to
websites; through LMS tools such as wikis or quizzes, where course knowledge can be applied; and finally through e-portfolios. Lastly, some research has shown that discussion forums could foster in students the “feeling [of being] legitimated and supported by university learning communities.” It is important to further explore the relationship between the data captured in various LMS and what is reflected in students’ self-reports so that institutions may determine the extent to which it is appropriate to use LMS data as a measure of student engagement.

Student engagement has been linked to positive student outcomes in the areas of learning, social integration, and student retention. This literature review included several studies which found a correlation between LMS use and similar student outcomes. There is a positive correlation between student LMS use and grades and between use of LMS discussion forums and a sense of belonging. What is less clear from the research literature is the relationship between LMS activity and specific student engagement measures. The current study uses students’ self-reported estimates of their behaviours in an LMS and students’ answers to SEQ questions about their online student engagement. Self-report data can complement computer generated data; indeed, using multiple indicators for institutional assessment is good research practice (Gonyea & Miller, 2011).

The second field of research examined in this literature review was learning analytics. The volume of data being recorded by LMS in higher education is vast and learning analytics provides a framework within which to mine, analyze, and utilize this data. Being a young field, learning analytics is still forming its theoretical foundations. Student engagement is one area of thinking about students that can inform learning analytics. Researchers examining student engagement can also benefit from learning analytics. Much of what we know about student engagement comes from student self-reported data, but mining and analyzing LMS data can potentially provide a new perspective on student engagement.
The theory of student engagement and the field of learning analytics provide the foundation for this research. Student engagement offers a framework in which to examine how student behaviour and institutional practice within a learning management system may affect student outcomes. Past practice in learning analytics not only informs this study’s research design but also assists with interpreting its results.

The next chapter of this dissertation will provide details on the quantitative correlational research design of this study. The chapter will explain the setting, participants, and research instrument used. The methodology was informed by the research described in the literature review.
Chapter 3

Methods

In this chapter, I describe and justify the quantitative correlational research design for the study of student engagement in learning management systems (LMS). I will describe the methods for the research, including a discussion of the study’s setting and participants, and how the participants were selected. This chapter also includes explanations of the survey instrument used, the creation and analysis of the variables, and the internal and external validity of the research.

The aim of the study was to examine the relationship between students’ online engagement as measured by the Student Engagement Questionnaire (SEQ) with LMS activity, both as recorded by LMS software and as reported by estimates from survey responses. Faculty participation in the LMS was also examined in order to explore its impact on students’ perceptions of their online engagement, on LMS activity as recorded by LMS software, and on LMS activity as estimated by students’ responses.

Sample

Setting. The study took place at a publically funded, urban Ontario College of Applied Arts and Technology, where 16 666 full time equivalent students were enrolled in the 2014 – 2015 academic year. The college offers bachelor degrees, advanced diplomas, diplomas, and graduate certificates in the areas of Arts, Business, Design, Health Sciences and Human Services, Information Technology, Manufacturing, and Transportation. The 174 programs of the college are offered at six different campus locations, both in person and online.

The college uses the Desire2Learn enterprise LMS. In its 2014 Strategic Mandate Agreement with the government of Ontario, the college identified technology-enabled learning as one of its primary strengths, citing 1539 fully online, 11 800 blended, and 20 870 web-
facilitated courses in the 2012 – 2013 academic year (SMA, 2014). The college’s policy on eLearning explicitly stated that all courses were expected to be supported by a Desire2Learn LMS course website. The minimum level of usage was outlined in the eLearning policy: at a minimum, instructors were required to post the course syllabus, college health and safety information, and some course content. Instructors were expected to post regular announcements, explain communication expectations and regulations, provide details about assignments, and maintain an up-to-date gradebook. As of February, 2015, 99% of faculty members at the college maintained an LMS course site for each course they taught (L. Young, personal communication March 21, 2015).

The Desire2Learn LMS offered course instructors the following tools:

- **Announcements:** a space for messages that all class participants could read.
- **Attendance:** a digital attendance list allowing instructors to track student presence in a physical classroom.
- **Blog:** a space for either private or public journal entries.
- **Calendar:** a shared calendar used to post deadlines, due dates, etc.
- **Chat:** a real-time conversation tool used for communication between instructors and students or between students.
- **Classlist:** a list of class participants, with hyperlinks to each participant’s email address.
- **Collaborate:** an online conferencing system capable of video and screen sharing.
- **Content sharing:** a repository of course content, including instructors’ PowerPoint presentations, handouts, etc.
- **Discussion forums:** a space for threaded, asynchronous messages that all class participants could write, read, and respond to.
• Drop box: a digital drop box allowing students to upload and submit assignments or projects and allowing instructors to grade and comment on students’ submissions.

• Grades: a digital grade book allowing instructors to post marks for each assignment, project, and exam and giving instructors the option to make class averages visible to all class participants.

• Groups: a space for group work, with capabilities for shared editing.

• Quizzes: a space for instructors to set up practice or for-credit quizzes for students.

In addition to the above tools, available to students in individual courses, the Desire2Learn software offered students two cross-course tools. The E-portfolio tool was, in essence, a website generator that could display a student’s work; a completed e-portfolio could be sent as a URL to prospective employers or anyone else for whom a student wished to demonstrate their learning. The second cross-course tool was the Locker tool, which was an online storage space.

Population. The study had two target populations. Because faculty permission was required to access LMS course sites and recruit students, the first target population was faculty at the college. In March of 2012 (the most current published statistics), 441 full-time faculty worked at the college. A count of part-time faculty was not available. Both full-time and part-time faculty were invited to participate in the study. A total of 26 faculty members participated in the study; twenty were full-time, six were part-time. Seventeen (65%) of the participating faculty members were female and nine (35%) were male. Female faculty members were slightly over-represented in the sample, as the college ratio for female to male faculty was 47% to 53%. All participating faculty taught courses at the main college campus. The 26 faculty participating in the study provided permission for access to 48 courses.

The second target population for the study was students enrolled in the 48 winter 2015 semester courses to which participating faculty had given LMS access permission. The total
enrollment of the 48 courses was 1618 students. By the end of the recruitment period, 322 unique students had completed the survey instrument. However, 103 students were removed from the sample because they did not provide a student number and/or course code and could not be matched with LMS activity data. Five additional students were removed from the sample because they had not responded to more than 50% of the survey questions, leaving a final sample of 214 students.

Demographic information about the sample was available from two sources: demographic questions on the survey instrument and course-related information. This next section explains the gender, age, language spoken at home, and program level of student respondents. The sample contained 71.9% female students. Female students were over-represented in this sample, as the college had an approximately equal number of male and female students in the 2014 – 2015 academic year (C. Spicer, personal communication, June 29, 2015). Table 2 compares the age ranges of the sample with those of the general college population. One quarter of the students in the sample (24.9%) were under 19 years old, 43.7% were between 20 and 24 years of age, and the remaining students (31.5%) were over 25 years old. The sample was representative of the college in the 20 – 24 age group, but it underrepresented students under 19 years old and overrepresented students over 25 years old. The higher number of older students could be partially explained by the specific courses that were part of the study: four of the courses in the sample were in Health Sciences, a field which required a preparatory year of study and which therefore saw older students beginning the program; and four of the courses in the sample were graduate certificate courses, which saw older students enter the program from the workforce or after a first credential.
Table 2

<table>
<thead>
<tr>
<th>Age</th>
<th>Sample</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-19</td>
<td>24.88 %</td>
<td>33.97 %</td>
</tr>
<tr>
<td>20-24</td>
<td>43.66 %</td>
<td>46.41 %</td>
</tr>
<tr>
<td>25 and over</td>
<td>31.46 %</td>
<td>19.62 %</td>
</tr>
</tbody>
</table>

*Source: C. Spicer, personal communication, June 29, 2015*

The majority of student respondents in the sample, 62.6%, were in level 2, the second semester of their first year, having started at the college in September, 2014. A much smaller group, 16.8%, were in their first level, meaning they started at the college in January, 2015. The third largest group of students in the sample, 13.6%, were in level 4, the second semester of their second year. The breakdown of respondents in the sample was roughly representative of the overall college population (15.4% in level 1; 47.9% in level 2; and 23.2% in level 4) (C. Spicer, personal communication, June 29, 2015).

The study successfully recruited student participants from all academic divisions at the college; however, there was no participation from students attending classes at the regional campuses. Table 3 illustrates how the sample compared with the general college population. Students in the Health Sciences, Human Services, and Nursing faculty were over-represented. The source of this overrepresentation may have been the participation of a large class (283 students) in the Pre-Health Sciences program, as well as participation by all nine courses in the Personal Support Worker program. Another explanation is that I had previously worked as an academic advisor in the Health Sciences, Human Services, and Nursing faculty: when a general call for participation was issued to the entire college, these faculty members may have agreed to participate due to a personal connection.
Table 3

Academic Schools of Study of Sample Population Compared to College Population

<table>
<thead>
<tr>
<th></th>
<th>Sample</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts, Media, and Design</td>
<td>14.20%</td>
<td>26.75%</td>
</tr>
<tr>
<td>Business</td>
<td>16.00%</td>
<td>24.37%</td>
</tr>
<tr>
<td>Continuing Education</td>
<td>.90%</td>
<td>.20%</td>
</tr>
<tr>
<td>Health Sciences, Human Services, and Nursing</td>
<td>65.80%</td>
<td>24.64%</td>
</tr>
<tr>
<td>Technology</td>
<td>3.20%</td>
<td>19.47%</td>
</tr>
<tr>
<td>Regional campuses</td>
<td>0</td>
<td>4.60%</td>
</tr>
</tbody>
</table>

Source: C. Spicer, personal communication, June 29, 2015

The majority of study participants (87.4%) indicated that English was their primary language spoken at home. Less than 1.5% of respondents spoke each of Chinese and Spanish at home. The remaining 8.5% of respondents spoke a variety of languages other than English, Chinese, or Spanish at home. Neither the ethnicity nor the primary language spoken at home was tracked by the college where the current study was conducted; therefore, a comparison between the sample and the college population as a whole could not be made.

Sampling procedure. Creswell (2009) suggested a sample size yielding at least 30 scores for each variable in a correlational analysis. All faculty members at the college who taught courses in the winter 2015 semester were asked to participate, with a goal of recruiting at least ten faculty members with class sizes ranging from 30 to 90 students.

Convenience sampling was used for recruitment. In the first stage of recruitment, all faculty members were contacted via email and via the college internal employee portal. Follow up emails (one per week) were sent in the three weeks after the initial invitation to participate. The sample was limited by faculty members’ willingness to take part in the study, which required granting the researcher full access to their course through the LMS. To be eligible to participate
In the study, the faculty member must have made use of at least three of the following LMS functions: Announcements, Content sharing, Discussion forums, Drop box, Grades, and Quizzes.

Once a faculty member agreed to take part in the study, student participants were recruited via an in-class presentation, which introduced the research and informed students that an invitation to participate be sent to them via email after the presentation was over. Within a day of completing each in-class presentation, this researcher sent emails inviting students in the class to participate. The email contained a link to the University of Toronto’s survey tool. The opening page of the survey tool was an information letter, and informed consent was sought before students could proceed to the survey. Students were sent two reminder emails: the first reminder was sent two weeks after the invitation email, and the second reminder was sent one week after the first.

The research underwent ethics review at the University of Toronto as well as at the college. All data were kept confidential and no participants were identified publically at any point. At the time of the study, I was an employee of the college; however, I was not a faculty member and was not actively teaching any courses. Neither faculty nor student research participants could be adversely affected by or could favorably benefit from participating in the research. There was no conflict of interest between being a member of the college’s Office of the Registrar and conducting research at the college.

**Procedures**

**Instrument.** The SEQ was developed by Coates (2006) specifically to explore both online and general engagement of campus-based students. The instrument consisted of two parts: measures of online student engagement, and measures of more general student engagement. The first part of the survey was comprised of 29 items, which represented seven scales. The online scales of the SEQ are: Online Engagement, Online Active Learning, Online Academic
Relevance, Online Teaching, Online Collaboration, Online Social Interaction, and Online Contact with Staff. The second part of the survey was comprised of 43 items, which represented nine general engagement scales that were somewhat parallel to the online scales: constructive teaching, collaborative work, teacher approachability, supportive learning environment, student and staff interaction, active learning, academic challenge, complementary activities, and beyond class collaboration. The general engagement scales had much in common with the NSSE benchmarks because the NSSE informed the creation of the SEQ. Only the 29 items of the online student engagement scales were used in this study.

The development of the SEQ began with a review of the framework of the NSSE survey instrument which guided a structured review of online learning research (Coates, 2006). Analyses of data gathered from semi-structured interviews with students formed the basis of the draft survey items. The SEQ was first administered to over 1000 students at multiple institutions in Australia in order to “validate and operationalize the proposed qualities of online and general engagement” (Coates, 2006, p. 71). Congeneric measurement modelling was used to validate the SEQ scales. The residual statistics from the congeneric modelling confirmed that the scales explained most of the item variance (Coates, 2006). Several estimates of internal consistency were computed for each scale when Coates (2006) performed a pilot study with the survey instrument. Cronbach’s alpha (α) for the scales ranged from .69 to .80, and the congeneric reliability (ρ) was slightly higher with a range from .76 to .84. The multilevel reliability estimate (η) was also computed with the scales ranging from .93 to .96. To establish construct validity, Coates (2006) used several measures, including the root mean square error of approximation (RMSEA), the goodness of fit index (GFI), and the Tucker-Lewis index (TLI). The statistical measures supported an assertion that the survey item scales generated data that were a good fit to the student engagement constructs as defined by Coates defined.
Variables. The study used three quantitative sources of data along with qualitative data from interviews with faculty members. The first set of variables were derived from student self-reported survey data collected using the online engagement scales of the SEQ (Coates, 2006). The SEQ scales and overall score provided a measurement of students’ perceptions of their online engagement. The second data were derived from the frequency counts recorded by LMS software during the winter 2015 semester: this LMS activity data is a measurement of students’ behaviour within the LMS. The third data set, also measuring LMS activity, was formulated from six items added to the SEQ survey, which asked students to estimate their activity in the LMS. Table 4 summarizes all of the variables to be examined in this study. The results from each set of data are fully delineated in this next section of this chapter.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Instrument</th>
<th>Variable type</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online engagement</td>
<td>Student Engagement Questionnaire (SEQ) (Coates, 2006)</td>
<td>Ordinal response data converted to interval scores by taking the average of all items in one scale</td>
<td>Online Engagement Online Active Learning Online Academic Relevance Online Teaching Online Collaboration Online Social Interaction Online Contact with Staff</td>
</tr>
<tr>
<td>LMS activity</td>
<td>Desire2Learn LMS frequency counts</td>
<td>Numeric variables on a ratio level of measurement</td>
<td>student LMS logins course content page visits quiz attempts discussion forum views original discussion forum posts discussion forum replies</td>
</tr>
<tr>
<td>Estimates of LMS activity</td>
<td>Six survey items</td>
<td>Ordinal response data</td>
<td>estimated logins estimated gradebook checks estimated quiz attempts estimated posts read estimated posts written estimated replies to posts</td>
</tr>
</tbody>
</table>

Online engagement. The online student engagement scales of the SEQ were chosen because the items of the survey covered the behavioural, cognitive, and psychological aspects of
student engagement discussed in the literature review. The Online Engagement and Online Collaboration scales were behavioural because the items were focussed on students’ actions within the LMS. Several of the scales had a cognitive focus: the Online Active Learning, Online Academic Relevance, and Online Teaching scales asked students about the role of the LMS in promoting their learning and in helping them provide context to new information. The Online Social Interaction scale explored a psychological aspect of student engagement by asking students to reflect in how the LMS helped them connect to each other and to their faculty members.

The Online Engagement scale consisted of four items that focussed on the degree to which students had incorporated LMS use into their university study. The Online Active Learning scale contained five items regarding the extent to which students actively used the LMS to enhance their learning. The four Online Academic Relevance scale items measured the degree to which students had used the LMS to provide context for and increase the relevance of their university study. The six Online Teaching scale items concerned students’ perceptions of whether faculty used the LMS effectively in their teaching. The four Online Collaboration scale items measured students’ use of the LMS in collaborative work with their peers. The Online Social Interaction scale contained four items regarding how students used the LMS to experience a range of salient interactions with others. The Online Contact with Staff scale consisted of three items that measured the degree to which students had contact with faculty online (Coates, 2006).

For each student, a score was created for each scale by calculating the mean of their responses to each of the scale’s items (Coates, 2006). This simple approach was used to convert the ordinal response data from the survey into interval scores that could be used for inferential statistical analysis. To determine the reliability of the individual SEQ scales, Cronbach’s alpha was calculated for each scale. Each scale had a Cronbach’s alpha greater than 0.70. A comparison
(see Table 5) of the Cronbach’s alpha values from the current study’s sample with Coates’ (2006) sample provides a good indication that the current study was a valid use of the SEQ.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>A Comparison of Cronbach’s Alpha Values From the Current Study and Coates (2006) Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEQ Scale</td>
<td>Current study</td>
</tr>
<tr>
<td>Online Engagement</td>
<td>.71</td>
</tr>
<tr>
<td>Online Active Learning</td>
<td>.81</td>
</tr>
<tr>
<td>Online Social Interaction</td>
<td>.79</td>
</tr>
<tr>
<td>Online Collaboration</td>
<td>.80</td>
</tr>
<tr>
<td>Online Teaching</td>
<td>.86</td>
</tr>
<tr>
<td>Online Academic Relevance</td>
<td>.87</td>
</tr>
<tr>
<td>Online Contact with Staff</td>
<td>.77</td>
</tr>
</tbody>
</table>

For all analysis, missing data was treated as a pairwise deletion. A visual examination of the data using frequency tables and boxplots revealed seven outliers for the LMS activity variable ‘frequency of logins.’ One respondent was at the lower extreme (only two logins) while another six respondents had over 298 logins, a number well over three standard deviations away from the mean. Data analysis was run including and excluding outliers: because there was no significant difference in the result, the outliers were included in the final analysis.

If one survey item was missing for a scale, a total was not calculated and the result was treated as missing. For most scales, less than 3% of the values were missing. For the overall SEQ score, a total was not calculated if any one of the survey items were missing. As a result, 15% of the values of the overall SEQ score were missing. I considered mean substitution and multiple imputation procedures to handle the missing overall SEQ score data, but decided to exclude the data in order to avoid potentially changing the value of correlations.

**LMS activity data.** To measure student behaviour in the LMS, students’ activity data was retroactively mined from the winter 2015 semester (Baepler & Murdoch, 2010). Specifically,
counts were made of students’ LMS logins, course content page visits, discussion forum views, original discussion forum posts, discussion forum replies, and quiz attempts. These particular items were chosen based on previous research into the use of LMS data as an indicator of engagement. This research was discussed in the literature review, which included Malikowski et al’s (2007) model for researching LMS, the indicators of engagement project (Beer et al., 2010), and several other studies which explored the relationship between behaviour in an LMS and student engagement (Dawson & McWilliam, 2008; Hamane, 2014; Steven Lonn et al., 2013; Wolff et al., 2013).

Students’ activity within the LMS was captured by the Desire2Learn software each time a student selected a link to an LMS tool (i.e., clicked on the item in the LMS). Logins represent the number of times a student entered their user name and password to login to the LMS as a whole (not just to access the LMS for a particular class). The Desire2Learn software recorded logins at a system level and only kept data for 30 days. The number of logins recorded for each student in the study represented their system logins from February 28 to April 29, 2015. Page views were calculated as a percentage by dividing the number of course content pages accessed (i.e., clicked on and opened to view) and by the total of all content pages available for the course. Quiz attempts were also calculated as a percentage value: number of quizzes a student completed divided by the total number of quizzes available.

Discussion forum terminology consisted of four main terms: thread, post, reply and read. A thread was a major stream or topic for discussion and had to be created by a faculty member. A post was an original piece of writing created by a student and posted to a thread. There can be multiple posts in one thread. A reply was a written response to a post which appeared under that post within a thread. Finally, the term “read” referred to the record created by the Desire2Learn software representing the number of times a student selected a link to a post or reply within a
thread. Participation in discussion was a variable calculated from discussion forum reads, original discussion forum posts, and discussion forum replies by, first, summing the posts/replies written by a student with the posts/replies read by a student and, second dividing this sum by the total number of posts/replies in the class discussion forums across all threads. Participation in discussion is a percentage representing the portion of the total discussion a student chose to be involved in. For some courses the discussion was broken into groups. In these cases, the total posts/replies used in the calculation were for the group within the class rather than for the class as a whole.

*Estimates of LMS activity.* Six items were added to the SEQ survey asking respondents to estimate their activity within the LMS. The questions focussed on LMS logins and four commonly used LMS tools: discussion forums, drop box, grades, and quizzes. Respondents were given six choices to describe the frequency with which they logged into the LMS: more than three times per day, twice per day, once a day, four to six times per week, one to three times per week, or less than once per week. Respondents were given five choices to describe the frequency with which they posted to discussion forums: more than 10 posts, 5 to 9 posts, 1 to 4 posts, did not start any new posts, or “course did not have discussions available.” They were given a further six choices to describe the frequency with which they read or replied to posts: all, most, some, very few, did not read/reply to any, or “course did not have discussions available.” Regarding the frequency with which they checked their grades on the LMS, respondents were given five choices: every week, every other week, once each month, once per level or semester, and “I never check my grades on FOL”. Finally, the frequency with which respondents completed quizzes was described according to four choices: always do quizzes, sometimes do quizzes, never do quizzes, or “course did not have quizzes available.”
Only positive responses were included in the analysis. Respondents who indicated that a particular LMS function was not available in their course were removed from the analysis. There was a difference between a student who chooses not to use an LMS function that is available to them and a student who does not use the function because the faculty member has made it available for the course.

Faculty participation in LMS. Because faculty members played such a large role in the design of the learning environment, LMS activity data were collected to measure faculty participation in the LMS. To get a measure of the extent to which faculty made use of the LMS, simple counts were completed for five common LMS functions: the number of announcements posted in the “News” section of the homepage; the number of individual course content pages shared in the “Content Browser”; the number of discussion threads set up for student use; the number of assignments required to submitted through the drop box; and the number of quizzes made available. Lastly, if a faculty member assigned grades for LMS use, the percent of the total course grade awarded for LMS use was counted. These counts provided the basic information to begin categorizing faculty use of the LMS.

Eleven interviews were conducted with faculty members to help shape the categories of faculty LMS use utilized in the one way ANOVAs. These semi-structured interviews asked faculty members to reflect on how students in their courses engaged with the LMS and, when possible, to compare teaching using an LMS to teaching before the LMS was a popular tool at the college. Faculty members were asked to explain the benefits and challenges of using the LMS and to delineate what factors they took into consideration when selecting which tools to enable on their course LMS sites.

Using a typology method of qualitative analysis (Gibson & Brown, 2009; Patton, 2002), I reviewed the notes from each interview, looking for patterns in the faculty members’ responses.
Because I was familiar with the categories of LMS use described by Dawson and McWilliam (2008) and Malikowski, Thompson, and Theis (2007), I used a top-down approach to create the different groups of respondents based on faculty set-up and use of the LMS. I was not, however, committed to using the same categories as the above authors and, therefore, also used a bottom-up approach to ensure interview responses were represented in the final groupings of respondents. Patterns found in interview responses were used in conjunction with the LMS tool counts and the faculty usage data recorded by the LMS software to create the categories for grouping respondents.

The interviews revealed that faculty members had different conceptualizations for the role an LMS could play in a course. Some faculty members spoke at length about the administrative and organizational purpose of the LMS, emphasizing that the LMS provides structure, helps students prepare for class, and establishes expectations. One faculty member explained how she used the LMS to assist her with managing student excuses for late assignments. Another faculty member spoke of the ease with which he could port a course from one year to the next, making minor adjustments for the new set of students. A second theme emerging from the interviews was that of evaluation. Faculty members spoke of using the quiz function to gauge student understanding as well as to replace in-class mid-term exams. One faculty member remarked that he did not understand why every instructor did not use quizzes instead of in-class tests, as the LMS quiz tool saved so much marking time. A third emergent theme focussed on the communication and interaction tools in the LMS and how they could be used for efficiency: if multiple students asked the same question, for example, an answer could be posted in a forum or via an announcement. Faculty members appreciated the ability of the LMS to assist with extra-curricular learning. One faculty member told of how she posted links to interesting websites and
articles or to job postings in order to help her students apply class material to other areas of their life.

Based on the frequency data of LMS tools use—as well as qualitative judgements based on viewing each LMS class site and on interview responses—the faculty participating in the study were placed into four categories of LMS use. The categories used in the current study were similar to the ones used by Dawson and McWilliam (2008): Administrative, Evaluation, Interaction, and Evaluation & Interaction. These categories described the main focus of LMS use for each faculty member. Faculty members placed in the Administrative group used the LMS only to post course content and to make class announcements. Those in the Evaluation group posted course content, made announcements, and also used the quiz function. The Interaction group consisted of faculty members who used the LMS to post content, make announcements, and facilitate discussion using forums. The last group, labeled Evaluation & Interaction, made use of all of the LMS functions mentioned previously. The drop box function of the LMS is a primarily administrative tool and, therefore, did not play a role in determining the groups for analysis.

**Data Collection.** The survey was conducted exclusively online using the University of Toronto’s survey tool, “Survey Wizard 2.” The survey link was available to respondents from the time of the class presentation (early March, 2015) until one week after final examinations ended for the winter 2015 semester (May 8, 2015). In order to match respondents’ survey data with their LMS activity, respondents were asked to identify themselves (by providing a student number) and their class (by providing a course code) on the survey. There were 214 student respondents who provided enough data to be included in the analysis.

The survey responses indicating course code required manually checking and correcting. Many respondents provided only their program names, provided partial course names without a
code, or provided course names and codes different from the courses through which they were sent the invitation to participate. At the college where the study was conducted, students were block registered in a group of courses for their program; therefore, it was possible for me to match student respondents with their appropriate course even if they had only provided me with program names and student numbers. If a student respondent provided me with a course that was not one of the courses formally part of the survey, I was able to reference all courses in a program and to find the course within that program that was part of the study. I used student identification numbers to verify which course student respondents were registered in while completing the survey.

There existed an overlap in class enrollment for some student respondents. Of the 214 survey respondents, 80 were enrolled in more than one participating course in the study. For example, within a single Health Sciences program, two courses from level two participated in the study. For these student respondents, more than one set of LMS data was collected. The LMS data for each student respondent in these two courses were examined and shown to possess similar patterns. For these students, an average of LMS activity was used in the final dataset. This averaging of the data was justified for several reasons. First, the Desire2Learn software measures logins only to the system, not an individual class, meaning that one of this study’s variables was already on a global scale. Second, when asked to identify their courses on the survey, many student respondents provided their program name or different courses despite the fact that their course codes were in the titles of the emails inviting them to participate in the study. The inability to identify which courses they had in mind when answering the survey seemed to indicate that students think globally about their LMS experience. Lastly, the patterns of behaviour within the LMS were consistent across courses.
All data—both survey responses and LMS activity data—were analyzed using the statistical software SPSS, version 22. Student identification numbers were replaced in the SPSS data set with codes. The final data set in SPSS contained five variables for LMS activity (logins, page visits, participation in discussion, drop box usage, and quiz attempts); six variables for student estimates of LMS activity (logins, discussion forum reads, forum replies, forum posts, grade checks, and quiz attempts); seven variables for the SEQ scales and one for the overall SEQ score; and four demographic variables (gender, age, language spoken at home, and program level).

Several new variables were added to the data set for the analysis. Four additional variables were created while adjusting student estimates of their frequency of reading, replying, and posting to discussion forums and attempting quizzes to remove responses which indicated those LMS functions were not available in the respondents’ course LMS. Another new variable was created while transforming the data from the question about language spoken at home into a binary response of English or any other language. Lastly, in order to conduct the one-way ANOVA tests, three ordinal variables were created to establish groups within the dataset. A review of faculty LMS use data revealed three categories of discussion forum use: no discussion available; discussion available with grades assigned for participation; and discussion available with no grade assigned for participation. A new variable called “discussion type” was created to split the data according to use of discussions. A second grouping of the data was done by login frequency. The variable created for this group simply divided the sample into three equal parts based on the LMS activity variable of logins: low (2 – 66 logins), medium (67 – 110), and high (111 – 414). The variable created for faculty LMS use was described above. The new variable “faculty user type” classified faculty members’ LMS use as Administrative, Evaluation, Interaction, or Evaluation & Interaction.
Analysis of survey data. Previous research (Beer et al., 2010; Dawson & McWilliam, 2008; Lonn et al., 2013; Wolff et al., 2013) used correlational research designs to explore student engagement within LMS. However, in each of the studies cited, the researchers correlated LMS activity with students’ grades. The present research used a similar design but replaced students’ grades with students’ perceptions of their online engagement, as measured by the SEQ.

The first research question of this study considered the relationship between student engagement and student participation in LMS as measured by frequency of student logins; course content page visits; discussion forum views; original discussion forum posts; discussion forum replies; and quiz attempts. To address this question, a bivariate correlation analysis compared mean SEQ scale and overall scores with LMS log data. A second bivariate correlation compared respondents’ estimates of their LMS activity with mean SEQ scale and overall scores. The rationale for using students’ estimates was to examine whether students’ intentions or perceptions of their activity differed from their actual use and whether these intentions played a role in engagement.

To examine the first research question from a different perspective, I conducted a second set of analyses using a series of one-way ANOVAs in order to compare the differences in mean SEQ scale and overall scores between student respondents grouped according to their login activity and to their participation in discussion forums. I also looked for differences in LMS activity among respondents grouped by faculty LMS use. The use of analysis of variance in studies exploring student engagement and LMS activity is well established. Dixson (2010) compared engagement scores of students who engaged in passive LMS activities with those who engaged in active LMS activities. Vaughan (2014) divided his sample into quartile groups based on scores in the Active and Collaborative Learning scale of the Classroom Survey of Student Engagement (CLASSE) and then compared differences in course grades. Lastly, Pulford (2011)
compared the difference in course grades among groups with varying frequencies of Blackboard discussion forum posts read.

The second research question of this study queried the relationship between students’ engagement and faculty members’ participation in LMS, as measured by the number of faculty announcements; the number of content pages available; the number of discussion forum threads created by faculty; number of discussion forum replies by faculty; the number of assignments that must be submitted via drop box; the percentage of grades awarded for LMS participation; and the number of quizzes available. A bivariate correlation was not part of the analysis for this research question because the data for the faculty LMS use was nominal and not interval. When I tried to create a composite measure using frequency counts, I found there were too many qualitative differences between the different course LMS sites and therefore an interval composite measure felt false. Instead, I conducted a one-way ANOVA comparing mean SEQ scale and overall scores between groups of respondents based on the faculty member’s LMS site use.

This study’s third and final research question explored the relationship between faculty members’ participation in LMS and students’ LMS usage data. As with the second hypothesis, a bivariate correlation was not performed because the faculty use of LMS data was nominal. Two one-way ANOVA analyses were conducted: the first compared mean scores of LMS activity across the four faculty usage groups, and the second compared student estimates of their LMS activity across the four faculty usage groups.

**Limitations and Delimitations**

There are several limitations to this study—some due to research design and others more technological. The methods used for recruitment of participants and the choice to limit the scope of online engagement to the LMS environment were two delimitations created by research design
choices. Desire2Learn data capture was also constrained by this LMS’s software capabilities. Each of these factors will be discussed further in this section.

Non-probability convenience sampling was used, which means that the results cannot be applied to the general population. Because the data collection for the survey took place online, those who responded to the survey could have been predisposed to higher levels of engagement. Class presentations performed to recruit participants should have encouraged those who are not regular users of the LMS to participate in the survey, but error due to participant self-selection was possible.

This study explored student engagement exclusively within the LMS environment. However, students and faculty members also used social media and third-party open-source software within their courses (Jones, 2012; Long & Siemens, 2011). Even when the LMS provided links to these sites, the data captured reflected only that students selected the site link and not for how long or to what extent they engaged with its contents. Any conclusions reached could be limited to the LMS environment; however, the Internet can be a nebulous and fluid place where one system flows into another. A delimitation of this study is that students engaged online in multiple places, of which the LMS was only one.

Similarly, there were multiple factors which could have affected students’ online engagement within the LMS and which were not accounted for in the research design. Student characteristics such as previous experience with technology and access to the Internet may have impacted online student engagement (Bhati, Mercer, Rankin, & Thomas, 2009; Hargittai, 2008). While the LMS data was matched to each individual participant’s SEQ survey responses, the research design did not control for the fact that research participants were from different programs at the college. Some programs were particularly gendered (e.g., airplane maintenance or nursing) and each program used the LMS in diverse way. The variability of faculty
engagement in the LMS (e.g., ability to design the LMS course pages for engagement, in-class orientation to LMS, expectations of LMS use, or grade-dependent LMS activity) may also have impacted student engagement. Data were collected and analysis conducted on faculty members’ LMS use in order to begin to address some of these confounding variables.

The last challenge in using LMS data relates to both the software data capture capacity and the quantitative nature of learning analytics. The proprietary Desire2Learn LMS used in the study had limited reporting functionality. For example, logins were only recorded in 30-day intervals; historical logins were not recorded. In addition, some changes faculty made to the site were not captured in a retroactive analysis of student LMS activity. For example, faculty had the ability to set an expiry date for announcements they made or to delete course content that was previously posted. Any deleted announcements or content could not have been included in the frequency data collected.

LMS data could show how often a student logged in, which content items they accessed, or how many assignments or quizzes they had completed, but it could not show the depth or quality of their engagement with the content or the level of effort they put into completing an assignment or quiz (Beer, 2010). LMS analytics could not tell us how students were interacting with the course, only the fact that they were present. Just as students could be in a lecture hall and not pay attention, so too students could have accessed content provided in the LMS only to print it off and not read it, or they could have clicked through a quiz mindlessly.

Summary

This chapter has described in detail the methods used to explore the relationship between students’ LMS activity and student engagement. This researcher employed a correlational design using data collected from a semester’s worth of LMS log data and students’ estimates of their LMS activity in addition to their responses to the SEQ (Coates, 2006). Both qualitative and
quantitative data were used in grouping student respondents appropriately so that a series of analyses of variances could be conducted. In Chapter 4, the results of the analyses are presented.
Chapter 4

Results

This chapter begins with a review of the variables used in the analysis first outlined in the methods chapter. A detailed explanation of how the variables were used in the analysis follows. Lastly, the results of the analysis are described in order, according to their corresponding research questions and method of analysis.

Data for the current study, collected in the winter 2015 term at the College of Applied Arts and Technology in Ontario, were analyzed using three main techniques. First, demographics of the sample and basic characteristics of the data were explored using descriptive statistics. Second, a series of bivariate correlations were used to explore possible relationships between the Student Engagement Questionnaire (SEQ) responses, LMS student activity data, and students’ estimates of their LMS activity. Lastly, several one-way ANOVA tests examined the differences between groups in the sample based on demographics, faculty members’ LMS use, students’ login activity, and students’ participation in discussions in the LMS.

The bivariate correlations and one-way ANOVA analysis aimed to answer the following three research questions:

1. What is the relationship between students’ engagement and students’ participation in LMS as measured by frequency of student logins, course content page visits, discussion forum views, original discussion forum posts, discussion forum replies, and quiz attempts?

2. What is the relationship between students’ engagement and faculty members’ participation in LMS as measured by the number of faculty announcements; number of content pages available; number of discussion forum threads created by faculty; number of discussion forum replies by faculty; number of assignments that must be
submitted via drop box; number of quizzes available; and percentage of grades awarded for LMS participation?

3. What is the relationship between faculty participation in the LMS and students’ participation in the LMS?

Variables Used in the Analysis

Demographic data. Detailed demographic information for the sample was presented in the methods chapter. In this next section, the survey results will be compared by gender, age, and language spoken at home.

Gender. As shown in Table 6, for five of the seven SEQ scales, there were no significant differences between male and female respondents. However, for the Online Active Learning and Online Contact with Staff scales, and the overall SEQ score, a one-way ANOVA showed a difference in the means between the genders, where male students had lower means than female students. There was also a difference in the mean number of page visits and quiz attempts between male students and female students, where male students again had lower mean values. Finally, there was a significant difference in the means of the estimates students provided for creating new forum posts, replying to forums posts, and checking grades. Male students had higher means (lower estimated frequency) for creating new forum posts and for checking grades; however, male students had a lower mean (higher estimated frequency) for replying to forums posts. The measures of association (Eta Squared < .07) showed the effects size to be small for each variable.
### Table 6

**Differences in the Means of Various Variables Between Male Students and Female Students**

<table>
<thead>
<tr>
<th>Variable</th>
<th>df (between, within)</th>
<th>F</th>
<th>Sig.</th>
<th>Male M (n=60)</th>
<th>Female M (n=154)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Active Learning</td>
<td>1, 202</td>
<td>7.495</td>
<td>.007</td>
<td>3.03</td>
<td>3.30</td>
</tr>
<tr>
<td>Online Contact with Staff</td>
<td>1, 205</td>
<td>14.436</td>
<td>.000</td>
<td>3.14</td>
<td>3.52</td>
</tr>
<tr>
<td>Overall SEQ</td>
<td>1, 180</td>
<td>4.379</td>
<td>.038</td>
<td>2.84</td>
<td>3.03</td>
</tr>
<tr>
<td>Page visits</td>
<td>1, 212</td>
<td>7.096</td>
<td>.008</td>
<td>49.49</td>
<td>59.35</td>
</tr>
<tr>
<td>Quiz attempts</td>
<td>1, 107</td>
<td>6.591</td>
<td>.012</td>
<td>95.37</td>
<td>98.77</td>
</tr>
<tr>
<td>Est. Check grades</td>
<td>1, 212</td>
<td>3.922</td>
<td>.049</td>
<td>1.48</td>
<td>1.28</td>
</tr>
<tr>
<td>Est. Forum replies</td>
<td>1, 176</td>
<td>15.008</td>
<td>.000</td>
<td>3.67</td>
<td>4.28</td>
</tr>
<tr>
<td>Est. Original forum posts</td>
<td>1, 177</td>
<td>7.107</td>
<td>.008</td>
<td>3.16</td>
<td>3.51</td>
</tr>
</tbody>
</table>

**Age.** Of the 214 respondents, 53 were under 19 years old, 94 were between the ages of 20 and 24, and 67 were over 25 years of age. There were no significant differences in the SEQ scale means or overall scores among the age groups. As determined by a one-way ANOVA, there was a significant difference between age groups in the variables regarding page visits \((F (5, 207) = 2.992, p = .012)\), participation in discussions \((F (5, 52) = 4.382, p = .002)\), and estimated forum reads \((F (5,175) = 3.518, p = .005)\). Only the participation in discussion variable shows a strong effect size (Eta Squared = .296); the other two variables had a smaller effect size (Eta Squared < .09). A Games-Howell post-hoc test revealed that the mean value for participation in discussions was significantly higher for students in the oldest age group, 46 – 55 (84.84), when compared with students in the younger age groups, 17 – 19 (29.39), 22 – 24 (30.75), and 25-35 (29.26). A Games-Howell post-hoc test revealed that the mean value for page visits was significantly higher for students in the 25 - 35 age group (62.53) when compared with the 17 – 19 age group (48.24). A Games-Howell post-hoc test revealed that the mean value for estimated forum posts read was significantly lower for students in the 36 - 45 age group (1.87) when compared with students in the younger age groups, 17 – 19 (3.13), 22 – 24 (3.28), and 25-35 (3.31).
Language spoken at home. Neither students’ ethnicity nor their primary languages spoken at home was tracked by the college where the current study was conducted; therefore, a comparison between the sample and the college population as a whole could not be made. However, it is worth noting that several variables demonstrated a significant difference in the means between those whose first language was English and those whose first language was not English. Table 7 summarizes the results of a one-way ANOVA comparing the two groups. For both the Online Social Interaction and the Online Academic Relevance scales, those whose first language was not English had a significantly higher mean than those whose first language was English. The mean number of logins to the LMS was also significantly higher for non-native English speakers. Lastly, the mean estimates of English speakers’ forum replies and posts read was significantly higher (meaning a lower frequency) than for non-native English speakers.

Table 7
Differences in the Means of Various Variables Between English Speakers and Others

<table>
<thead>
<tr>
<th>Variable</th>
<th>df (between, within)</th>
<th>$F$</th>
<th>Sig.</th>
<th>English $M$ (n=187)</th>
<th>Other $M$ (n=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Social Interaction</td>
<td>1, 206</td>
<td>8.137</td>
<td>.005</td>
<td>2.1497</td>
<td>2.6154</td>
</tr>
<tr>
<td>Online Academic Relevance</td>
<td>1, 206</td>
<td>7.152</td>
<td>.008</td>
<td>2.9158</td>
<td>3.3974</td>
</tr>
<tr>
<td>LMS logins</td>
<td>1, 212</td>
<td>7.537</td>
<td>.007</td>
<td>93.80</td>
<td>129.63</td>
</tr>
<tr>
<td>Est. Forum replies</td>
<td>1, 176</td>
<td>12.049</td>
<td>.001</td>
<td>4.2065</td>
<td>3.4783</td>
</tr>
<tr>
<td>Est. Forum posts read</td>
<td>1, 180</td>
<td>5.369</td>
<td>.022</td>
<td>3.1203</td>
<td>2.5000</td>
</tr>
</tbody>
</table>

Note. The measures of association for each variable above showed a small effect size (eta squared < .06).

Student Engagement Questionnaire (SEQ) response data. Table 8 provides a summary of the descriptive statistics for the SEQ response data. Students were given four choices (1 = never, 2 = rarely, 3 = sometimes, and 4 = often) on each of the 29 items.
Table 8
Descriptive Statistics for Student Engagement Questionnaire (SEQ) Response Data

<table>
<thead>
<tr>
<th>SEQ Scale</th>
<th>Valid N</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Engagement</td>
<td>211</td>
<td>3.41</td>
<td>0.61</td>
<td>-1.202</td>
</tr>
<tr>
<td>Online Active Learning</td>
<td>204</td>
<td>3.23</td>
<td>0.64</td>
<td>-1.106</td>
</tr>
<tr>
<td>Online Social Interaction</td>
<td>208</td>
<td>2.21</td>
<td>0.79</td>
<td>0.254</td>
</tr>
<tr>
<td>Online Collaboration</td>
<td>211</td>
<td>2.32</td>
<td>0.85</td>
<td>0.123</td>
</tr>
<tr>
<td>Online Teaching</td>
<td>211</td>
<td>3.25</td>
<td>0.59</td>
<td>-0.900</td>
</tr>
<tr>
<td>Online Academic Relevance</td>
<td>208</td>
<td>2.98</td>
<td>0.87</td>
<td>-0.598</td>
</tr>
<tr>
<td>Online Contact with Staff</td>
<td>207</td>
<td>3.42</td>
<td>0.65</td>
<td>-1.197</td>
</tr>
<tr>
<td>Overall SEQ Score</td>
<td>182</td>
<td>2.98</td>
<td>0.53</td>
<td>-0.574</td>
</tr>
</tbody>
</table>

Notes. For all scales, the minimum was 1.00 and maximum was 4.00. For the overall SEQ score, the minimum was 1.17 and maximum 4.00. Kolmogorov-Smirnov tests of normality for all scales and the SEQ score were significant meaning the assumption of normality is met.

Student LMS activity frequency data. This study included two measurements of student LMS activity. The first, labelled throughout this section as “LMS activity,” was the frequency counts recorded by the LMS software when a student logged in or selected links for certain LMS tool. The second measurement used for student LMS activity, labelled throughout this section as “student estimates,” was based on the six questionnaire items asking students to estimate the frequency with which they used a select number of LMS functions.

LMS activity as recorded by Desire2Learn software. As outlined in the methods chapter, with the exception of the login variable, LMS activity variables are stated as a proportion: the number of items the student viewed, completed, or participated in divided by the total number of items available on the LMS course site. Table 9 lists the descriptive statistics which describe the character of student LMS activity. Respondents in the study had a mean number of 98 logins over the 30-day period from February 28 to April 29, 2015. These students accessed a mean of 57% of the available course content pages and participated, on average, in 38% of the discussions to which they had access. Respondents had a mean drop box submission rate of 83% and a mean quiz completion rate of 99%.
Table 9
Descriptive Statistics for Students’ LMS Activity From LMS Software

<table>
<thead>
<tr>
<th></th>
<th>Valid N</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logins</td>
<td>214</td>
<td>98.32</td>
<td>64.36</td>
<td>2.112</td>
<td>2</td>
<td>414</td>
</tr>
<tr>
<td>Page visits</td>
<td>214</td>
<td>56.69</td>
<td>24.42</td>
<td>-0.001</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Drop box submissions</td>
<td>156</td>
<td>83.15</td>
<td>24.91</td>
<td>-1.655</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Quiz attempts</td>
<td>110</td>
<td>98.85</td>
<td>11.35</td>
<td>-6.383</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Participation in discussion</td>
<td>58</td>
<td>37.54</td>
<td>32.47</td>
<td>0.561</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Note. Kolmogorov-Smirnov tests of normality for all measures were significant.

The missing values in Table 9 require explanation. Because faculty members could choose how to set up their classes in the LMS, not every LMS function was used in each class. The statistical calculation for the LMS activity data used only those courses in the sample that had that LMS tool enabled. Every class in the sample had an LMS site to which a faculty member posted content. Therefore, login and page visit variables are not missing values. Fewer faculty members used the drop box and quiz functions, and slightly more than two in five faculty members in the sample used the discussion forum function. The missing values for participation in discussion, drop box submissions, and quiz attempts represent courses where students were unable to use this LMS function because it was unavailable to them.

An examination of the minimum values reveals that some students had the opportunity to use certain LMS functions but chose not to use them. Every student in the sample logged into the LMS during the winter term; as the minimum shows, one student logged in only two times. This student had very minimal LMS activity. The minimum value for page visits and quiz attempts is zero because this one student chose not to engage in either of these two LMS functions. The minimum value of zero for participation in discussion represents eleven students (almost 20%) who chose not to participate in forums despite the fact that they were enabled in their course LMS.
**LMS activity as estimated by students in responses to a survey.** Six of the 39 items on the survey conducted online asked students to estimate their LMS activity. The survey responses were not consistent across LMS functions because the frequency with which students used various tools varied depending on the tools. This section describes the questions students were asked in order to estimate their LMS activity.

**Table 10**

*Descriptive Statistics for Student LMS Activity as Measured by Student Estimates*

<table>
<thead>
<tr>
<th></th>
<th>Valid N</th>
<th>Mode</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated logins</td>
<td>214</td>
<td>1</td>
<td>1.70</td>
<td>1.11</td>
<td>1.813</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Estimated grade checks</td>
<td>214</td>
<td>1</td>
<td>1.34</td>
<td>0.66</td>
<td>2.128</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Estimated quiz attempts</td>
<td>213</td>
<td>1</td>
<td>1.45</td>
<td>0.89</td>
<td>2.041</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Estimated posts read</td>
<td>214</td>
<td>4</td>
<td>3.48</td>
<td>1.56</td>
<td>0.114</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Estimated posts written</td>
<td>214</td>
<td>4</td>
<td>3.67</td>
<td>0.94</td>
<td>-0.764</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Estimated replies to posts</td>
<td>213</td>
<td>5</td>
<td>4.42</td>
<td>1.13</td>
<td>-0.611</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

*Note.* Kolmogorov-Smirnov tests of normality for all measures were significant.

Students were given six choices to describe the frequency with which they logged into the LMS: more than three times per day, twice per day, once a day, four to six times per week, one to three times per week, or less than once per week. The vast majority of student respondents, 91.1%, estimated that they logged into the LMS at least once per day, with 62.1% estimating that they logged in three or more times each day. Not one student respondent indicated that they logged in less than once a week, but the LMS activity data collected ranged from two logins to 414 logins over a 30-day period, meaning that some students logged in far less than once each week.
Students were given five choices to describe the frequency in which they checked their grades on the LMS: every week, every other week, once each month, once per level or semester, or “I never check my grades on FOL.” As seen in Figure 3, a mode of one indicates that a majority of respondents checked their grades on the LMS each week. Three-quarters of respondents indicated that they checked their grades each week, and not one respondent indicated that they never checked their grades on the LMS.
Students were given four choices to describe the frequency with which they attempted to complete available quizzes: always do quizzes, sometimes do quizzes, never do quizzes, or course did not have quizzes available. As seen in Figure 4, a mode of one is interpreted to mean that most students did all or most of the quizzes available to them. Just slightly under three-quarters of respondents, 73.7%, estimated that they always did every quiz available to them. A number of student respondents, 8.4%, indicated that their course did not make use of the quiz tool in the LMS.

Figure 4. Students’ self-reported estimates of how often they attempted to complete quizzes in the LMS.

Students were given five choices to describe the frequency with which they posted to discussion forums: > 10 posts, 5 – 9 posts, 1 – 4 posts, did not start any new posts, or course did not have discussions available. As seen in Figure 5, 48.1% of respondents reported not posting original posts to a thread, 35.5% of respondents reported posting at least one original post in a thread. The remaining 16.4% of respondents claimed that their course did not have a discussion forum.
Students were given six choices to describe the frequency with which they read or replied to posts: all, most, some, very few, did not read/reply to any, or course did not have discussions available. Figure 6 demonstrates that students estimated reading posts at a higher rate than replying to posts. The mode estimate for reading posts was 4, meaning most student respondents estimated that they read very few posts. The data were more equally distributed than the estimates for logins or quizzes or starting new posts. Just under one third of respondents, 30.4%, reported reading all or most posts, 44.4% indicated reading some or very few, while 10.2% reported not reading any posts at all. Indeed, the breakdown of respondent answers reveals that far fewer students estimated replying to all or most posts (4.2%). About the same number (43.0%) indicated replying to some or very few posts, and many more students estimated not replying to any posts (36.2%). The number of respondents reporting that discussions forums were not available in their course was consistent across responses for starting new posts (16.4%), reading posts (15.0%) and replying to posts (16.4%).
The section above reports the descriptive statistics for the students’ responses to six items on the online survey. Students were asked to provide estimates of their behaviour in the LMS for a particular class (the class through which they were contacted via email). However, it became clear through the analysis that student respondents were estimating their behaviour within the LMS globally. As will be explained in the next section, these student estimates do not consistently align with recorded faculty and student LMS activity.

**Faculty LMS activity.** To get a measure of the extent to which faculty members made use of the LMS, simple counts were completed for five common LMS functions. Most faculty members (89.6%) made use of the announcement function, with the mean number of posts being just over nine. All faculty members in the study posted course content on their LMS site, and the mean number of pages was 63. Just over three-quarters (77.1%) of faculty members used the drop box for a mean number of 4.78 assignments. Over half (62.5%) of the faculty members in the study used the quiz function, with the average number of quizzes being over five. Discussion was used less frequently (43.8%), and faculty members created just over seven threads per course. Most faculty members in the study did not assign grades to students for using the LMS.
Those faculty members that did assign marks (41.7%) most often used the quiz function in place of tests. The second most frequent assignation of marks for LMS use rewarded posts and replies in the discussion forums. The average percentage of course marks assigned by faculty members for LMS participation was 7.0%, but there was wide variance. Faculty members who used the LMS quiz function instead of offering an in-class midterm assigned up to 30% of the course grade for LMS activity. Some faculty awarded less than 5% of the course grade, or awarded “bonus marks,” for participation in discussion.

**Table 11**

**Descriptive Statistics for Faculty LMS Activity**

<table>
<thead>
<tr>
<th>% faculty using LMS function</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Announcements</td>
<td>89.58</td>
<td>9.11</td>
<td>4.30</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>Content Pages</td>
<td>100.00</td>
<td>63.42</td>
<td>42.77</td>
<td>0.813</td>
<td>13</td>
</tr>
<tr>
<td>Drop box</td>
<td>77.08</td>
<td>4.78</td>
<td>3.81</td>
<td>0.744</td>
<td>1</td>
</tr>
<tr>
<td>Quizzes</td>
<td>62.50</td>
<td>5.53</td>
<td>4.10</td>
<td>1.055</td>
<td>1</td>
</tr>
<tr>
<td>Discussion Threads</td>
<td>43.75</td>
<td>7.62</td>
<td>11.38</td>
<td>3.448</td>
<td>1</td>
</tr>
<tr>
<td>Grades Assigned</td>
<td>41.67</td>
<td>6.98</td>
<td>12.44</td>
<td>2.424</td>
<td>2</td>
</tr>
</tbody>
</table>

*Notes.* Kolmogorov-Smirnov tests of normality for all measures were significant. Only data from faculty using the LMS function were used to calculate the descriptive statistics shown in this table.

**Comparing student and faculty LMS activity.** Before doing any further statistical analysis, I compared the data collected from the three variables discussed above: student LMS activity as recorded by software; student LMS activity as represented by student estimates reported on a survey; and faculty LMS activity as recorded by software. Table 12 provides a summary of the percentage of use for each variable. The numbers do not align for each function of LMS. Faculty members were shown to use the drop box function in 77.1% of courses in the study. Students had similar frequency of use at 72.9%. However, 62.5% of faculty in this study used the quiz function, yet only 50.9% of students had data recorded in the LMS software for the quiz function.
function. When asked to estimate their use of quizzes, 91.5% of respondents gave an estimate, whereas only 8.4% indicated that their class did not have a quiz function. This is much lower than the 37.5% of faculty in the study who did not use the quiz function. The trend is similar for the discussion function of LMS. In this study, 43.8% of faculty members used the discussion function, but only 27.1% of students participating in the study showed LMS activity in the discussion forums. However, when asked to estimate their use of discussion forums, an average of 84.1% of respondents gave an estimate of discussion forum use.

Table 12
Percentage of Faculty and Student Using LMS as Measured by Frequency Counts and Survey Responses

<table>
<thead>
<tr>
<th>LMS Function</th>
<th>% faculty use</th>
<th>% students use</th>
<th>% estimate of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>content pages</td>
<td>100.0</td>
<td>100.0</td>
<td>Not available</td>
</tr>
<tr>
<td>drop box</td>
<td>77.1</td>
<td>72.9</td>
<td>Not available</td>
</tr>
<tr>
<td>quizzes</td>
<td>62.5</td>
<td>50.9</td>
<td>91.6</td>
</tr>
<tr>
<td>discussion forums</td>
<td>43.75</td>
<td>27.1</td>
<td>84.1</td>
</tr>
</tbody>
</table>

It seemed that the students answered the survey with their LMS experience as a whole in mind rather than regarding the particular courses through which they had been invited to participate. Further evidence of this global thinking was demonstrated through students’ failure to include on the survey the names and codes of the courses through which they had been invited, despite the fact that these names and codes were included in the subject line of the email invitations. Instead, the majority of respondents included their program names or different courses in response to this question. What is more, when asked to estimate the frequency of their discussion forum activity and quiz attempts, students overwhelmingly overestimated their activity. This could mean they were thinking of other courses that included this function in their LMS—and not thinking of the courses through which they were contacted and for which LMS activity was gathered (especially when these latter courses did not have LMS discussion or quiz functions available).
Research Questions

The previous section of this results chapter has shown how Student Engagement Questionnaire (SEQ) results, LMS activity, and students’ estimates of their LMS activity differed among groups of students with different demographics. Basic descriptive statistics were provided and the differences between recorded LMS activity and students’ estimates of their activity were listed. The groupings used for the ANOVA tests were also explained. The next section will delineate the results of the analysis according to each research question.

What is the relationship between students’ perceived level of online engagement and students’ LMS usage data? The first hypothesis of this study predicts a positive correlation between the average score of each scale of the Online SEQ’s items and the frequency counts of student LMS data. In order to test this hypothesis, two different bivariate correlations were run. First, a correlation compared students’ perceived level of online engagement, as measured by the mean score on each of the scales and the overall score of the SEQ survey, with students’ LMS usage as measured by data recorded by Desire2Learn software. Next, students’ perceived level of online engagement was correlated with students’ LMS usage as measured by estimates of their own LMS activity. Respondents were divided into groups based on their login activity, the presence of a forum in the class, and faculty LMS use.

Correlation: SEQ scores and LMS activity data. Scatterplots were created for each pair of variables in the bivariate correlation. The plots did not reveal any relationship between the SEQ data and LMS activity data. Because the data were not normally distributed, Spearman’s Rho was used in the bivariate correlation instead of Pearson’s Correlation coefficient. A Spearman’s Rho coefficient of less than .25 was considered too weak to indicate correlation of practical importance. Calculating R-squared to get an estimate of effect size, a Spearman’s Rho coefficient of .25 meant that the LMS activity data only accounted for 6.25% of the variance in SEQ scores.
Table 13 presents the correlation matrix for LMS activity data and SEQ survey data. There was a statistically significant correlation between Online Contact with Staff and frequency of logins ($r_s (207) = .14, p < .05$), but the correlation was too small to be of practical importance. The same can be said of the correlations between Online Academic Relevance and drop box submissions ($r_s (156) = -.16, p < .05$). No significant correlations were found between the SEQ scores and the LMS activity data.

**Correlation: SEQ scores and student estimates of LMS activity.** No significant correlations were found between the SEQ survey scales or overall scores and students’ estimates of the frequency with which they checked their grades or the number of their quiz attempts. The overall SEQ score and all but one SEQ scale (Online Contact with Staff) had a statistically significant Spearman’s Rho correlation coefficient. However, the size of these correlations ranged from -.14 to -.24, meaning that the estimated frequency of logins accounted for between 1.96% and 5.76% of the variance in SEQ survey scales and overall scores. These correlations between SEQ survey scores and estimated frequency of logins were too weak to be of practical importance. Table 14 presents the correlation matrix for LMS activity data and student respondents’ estimates of their LMS activity.

Multiple significant correlations were found between the SEQ scales and student estimates of their activity within the discussion forums. Five of the seven scales of the SEQ were significantly correlated to students’ estimates of how often they read discussion forum posts. Online Active Learning ($r_s (171) = .268, p < .01$); Online Collaboration ($r_s (178) = .270, p < .01$); and Online Academic Relevance ($r_s (176) = .261, p < .01$) were weakly correlated with students’ estimates of reading discussion forum posts. Online Engagement ($r_s (177) = .313, p < .01$) and the overall SEQ score ($r_s (155) = .433, p < .01$) were moderately correlated to students’ estimates of how often they read discussion forum posts. Lastly, there was a strong correlation between
Online Social Interaction \((r_s (175) = .511, p < .01)\) and students’ estimates of how often they read discussion forum posts.

Online Social Interaction \((r_s (171) = .585, p < .01)\) was strongly correlated with students’ estimates of their frequency of replying to discussion forum posts. Online Collaboration \((r_s (173) = .322, p < .01)\) and the overall SEQ score \((r_s (152) = .358, p < .01)\) were moderately correlated with students’ estimates of their frequency of replying to discussion forum posts. Online Social Interaction, \(r_s (172) = .453, p < .01\) was moderately correlated and the overall SEQ score, \(r_s (152) = .266, p < .01\) weakly correlated with students’ estimates of how often they created an original post in a discussion thread.

Even though the magnitude of the correlation varied, the Online Social Interaction scale was either strongly or moderately correlated with each student estimate related to discussion forums (reads, replies, and posts created). This was also true of the overall SEQ score, which moderately correlated to estimates of posts read and replied to and weakly correlated to estimates of posts created. One additional SEQ scale, the Online Collaboration scale correlated to both estimates of posts read and estimates of posts replied to.
Table 13
Correlation Matrix of LMS Activity Data and SEQ Scale and Overall Scores

<table>
<thead>
<tr>
<th></th>
<th>logins</th>
<th>page visits</th>
<th>drop box</th>
<th>quiz attempt</th>
<th>discussion</th>
<th>OE</th>
<th>OAL</th>
<th>OSI</th>
<th>OC</th>
<th>OT</th>
<th>OAR</th>
<th>OCS</th>
<th>SEQ overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>logins</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>page visits</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td>.16</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>discussion</td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OAL</td>
<td>.09</td>
<td>-.03</td>
<td>-.14</td>
<td>.13</td>
<td>-.02</td>
<td>.64**</td>
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<tr>
<td>OSI</td>
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<td>-.13</td>
<td>-.08</td>
<td>.03</td>
<td>.10</td>
<td>.41**</td>
<td>.49**</td>
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<td>-.03</td>
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<td>.07</td>
<td>-.08</td>
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<td>.12</td>
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<td>.30**</td>
<td>.47**</td>
<td>.34**</td>
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<tr>
<td>SEQ overall</td>
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<td>-.12</td>
<td>.10</td>
<td>.01</td>
<td>.74**</td>
<td>.80**</td>
<td>.75**</td>
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<td>.76**</td>
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<td>.56**</td>
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</table>

Note. * p < .05 ** p < .01.
Table 14
Correlation Matrix of Student Estimates of LMS Activity and SEQ Scales

<table>
<thead>
<tr>
<th>logins</th>
<th>grades</th>
<th>quiz</th>
<th>reads</th>
<th>replies</th>
<th>posts</th>
<th>OE</th>
<th>OAL</th>
<th>OSI</th>
<th>OC</th>
<th>OT</th>
<th>OAR</th>
<th>OCS</th>
<th>SEQ</th>
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</tr>
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<td>.09</td>
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<td>.11</td>
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<td></td>
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</tr>
<tr>
<td>OE</td>
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<td>-.10</td>
<td>-.02</td>
<td>-.31**</td>
<td>-.20**</td>
<td>-.19*</td>
<td>1</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>OAL</td>
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<td>-.09</td>
<td>-.09</td>
<td>-.27**</td>
<td>-.16*</td>
<td>-.12</td>
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<td>-.05</td>
<td>-.11</td>
<td>-.21**</td>
<td>-.12</td>
<td>-.06</td>
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<td>.51**</td>
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<td>.41**</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>OAR</td>
<td>-.16*</td>
<td>-.10</td>
<td>-.02</td>
<td>-.26**</td>
<td>-.23**</td>
<td>-.16*</td>
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<td>.48**</td>
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</tr>
<tr>
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<td>-.11</td>
<td>-.10</td>
<td>-.12</td>
<td>-.03</td>
<td>-.02</td>
<td>.35**</td>
<td>.43**</td>
<td>.27**</td>
<td>.30**</td>
<td>.47**</td>
<td>.34**</td>
<td>1</td>
</tr>
<tr>
<td>SEQ overall</td>
<td>-.24**</td>
<td>-.11</td>
<td>-.11</td>
<td>-.43**</td>
<td>-.36**</td>
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<td>.79**</td>
<td>.75**</td>
<td>.67**</td>
<td>.76**</td>
<td>.80**</td>
<td>.56**</td>
</tr>
</tbody>
</table>

*Note.* *p* <.05 **p* <.01.
The significant correlation coefficients shown in table 14 are negative; however, for each correlation found, the direction of the relationship is positive. The reason for this discrepancy is in the way the survey items regarding estimates of LMS activity were worded: the survey responses were positioned from most to least active in the LMS, that is, the survey items represented the highest estimated frequency as the first choice and decreasing estimated frequency with each following choice. Therefore, a higher mean represents a lower estimation of the frequency of LMS behaviour. The SEQ scores, however, are opposite, with a higher score meaning a greater self-reported level of student engagement. The higher a student’s estimation of frequency of reading forum posts, the higher that student’s mean score on five of the seven SEQ scales and on the overall SEQ score. Similarly, those respondents who estimated higher rates of reading, replying to, and creating new discussion forum posts also had higher Online Social Interaction scale scores and overall SEQ scores.

**ANOVA: SEQ scales compared to students LMS login activity.** Because no significant correlation was found between the SEQ data and student logins to the LMS, I decided to examine if there was a difference in SEQ results among groups of students based on their login activity. I divided the sample into three equal groups based on their login activity as recorded by the Desire2Learn software: students in the bottom third, who logged into the LMS 2 to 66 times, were placed in the low group; those with 67 – 110 logins were placed in the medium group; and those with 111 – 414 logins were placed in the high group. Analysis was run with and without outliers, and because the results did not change significantly, the outliers were kept in the final analysis.

There was a significant difference between groups on the Online Active Learning scale as determined by a one-way ANOVA ($F(2, 201) = 4.403, p = .013$). Neither the remaining scales of the SEQ nor the overall SEQ score showed significant differences between groups. The measures
of association for the Online Active Learning scale showed the effect size to be small (Eta Squared = .042). A Games-Howell post-hoc test revealed that the mean Online Active Learning scale score was significantly higher for students in the medium login group (3.39) compared with students in the low login group (3.07). There was no significant difference between the mean Online Active Learning scale score of low and high groups or medium and high groups.

**ANOVA: SEQ scales compared to students’ discussion forum activity.** No significant correlation was found between the SEQ data and student discussion forum activity, but there were significant correlations between student estimates of their reads, replies and posts. Therefore, I decided to examine if there was a difference in SEQ results between groups of students based on their discussion activity. Based on an inspection of the faculty use of the LMS, I divided the sample into those students who were in courses that had no LMS discussion forum available; those in courses that had a discussion forum but in which no grade was assigned for posting; and those in courses that had a discussion and who were graded for their posts and replies.

There was a significant difference between groups on the Online Social Interaction scale as determined by a one-way ANOVA \((F(2, 205) = 7.994, p = .000)\). Neither the remaining scales of the SEQ nor the overall SEQ score showed significant differences between groups. The measures of association for the Online Social Interaction scale showed the effect size to be small (Eta Squared = .067). A Games-Howell post-hoc test revealed that the mean Online Social Interaction scale score was significantly lower for students in courses that had no LMS discussion forum available (2.02) compared with students in courses that had a discussion forum and who were not graded (2.36) or were graded (2.53) for posts and replies. There was no significant difference between the mean Online Social Interaction scale score of students who were graded for forum activity and those who were not graded.
What is the relationship between students’ perceived level of online engagement and faculty participation in LMS? The second hypothesis for the study predicts a positive relationship between the average score of each scale of the Online Student Engagement SEQ items and the frequency counts of faculty LMS data. A bivariate correlation was not part of the analysis for this research question because the data for the faculty LMS use was nominal and not interval. The attempt to create a composite measure using frequency counts revealed that there were too many qualitative differences between the different course LMS sites; therefore, an interval composite measure felt false. Instead, I conducted a one-way ANOVA comparing SEQ data between groups of respondents based on the set up of the LMS site.

ANOVA: SEQ scales and faculty LMS use. As noted above, the sample was divided into groups based on faculty LMS use. Faculty members placed in the Administrative group only used the LMS to post class announcements and to share course content. Those in the Evaluation group posted announcements, shared course content, and also used the quiz function. The Interaction group consisted of faculty members who used the LMS to post announcements, to share course content, and to facilitate discussion using the LMS forums. The last group, labeled Evaluation & Interaction, made use of all of the LMS functions mentioned previously.

A one-way ANOVA was used to compare the mean SEQ score and the mean score for each SEQ scale across the four different groups. There was a significant difference between groups for the Online Social Interaction \((F (3, 204) = 5.221, p = .002)\). The means of the other scales and the overall SEQ score where not significantly different among the four groups.

The measure of association for the Online Social Interaction scale (Eta Squared = .071) showed a small effect size. A Games-Howell post-hoc test revealed a significant difference in the means between the Administrative and Interaction groups and between the Administrative and Evaluation & Interaction groups. The mean Online Social Interaction scale score for those in the
Administrative group (2.05) was significantly lower than for those in the Interaction (2.65) and Evaluation & Interaction (2.50) groups.

**What is the relationship between faculty participation in LMS and students’ LMS usage data?** The third and final hypothesis for the study predicts a positive relationship between the frequency counts of student LMS data and the frequency counts of faculty LMS data. As with the second hypothesis, a bivariate correlation was not performed because the faculty LMS use data was nominal. Two one-way ANOVA analyses were conducted: the first compared mean scores of LMS activity across the four faculty usage groups, and the second compared student estimates of their LMS activity across the four faculty usage groups.

**ANOVA: Faculty use and LMS activity.** A one-way ANOVA was used to compare the mean LMS activity across the four faculty usage groups (Administrative, Interaction, Evaluation, and Evaluation & Interaction). There was a significant difference among groups regarding the mean value of page visits and participation in discussions.

There was a significant difference among groups regarding the mean value of page visits \( (F(3, 210) = 10.387, p = .000) \). The measures of association (Eta Squared = .129) showed the effect size to be moderate. A Games-Howell post-hoc test revealed that the mean number of page visits in the Evaluation group (70.07) was significantly higher than in the Administrative group (52.32) and the Evaluation & Interaction group (48.71).

There was a significant difference between groups regarding the mean value of participation in discussions \( (F(1, 56) = 7.711, p = .007) \). The measures of association (Eta Squared = .121) showed the effect size to be moderate. The Administrative and Evaluation groups did not set up discussion forums for their courses; therefore, there were no respondents in these groups. The students in the Interaction group (54.93) had a significantly higher mean value of participation in discussion than those students in the Evaluation & Interaction group (30.33).
ANOVA: Faculty use and students’ estimates of their LMS activity. There was a significant difference among groups for four of the six student estimates of their LMS activity, as determined by a one-way ANOVA. No significant differences were found for students’ estimates of their number of logins or for how often they attempted available quizzes.

There was a significant difference in the means among groups for the variable of checking grades ($F(3, 210) = 5.124, p = .002$). The assumption of homogeneity of variances was violated for this variable; however, a Welch test showed the difference in checking grades means to remain significant ($4.79, p = .005$). The measures of association (Eta Squared = .01) showed the effect size to be small. A Games-Howell post-hoc test revealed that the mean estimation of frequency of checking grades for the Evaluation group (1.46) was significantly higher than for the Evaluation & Interaction group (1.12). The lower the mean, the higher the student estimation of frequency of checking grades. These results indicated that students in the Evaluation & Interaction group estimated that they checked their grades more often than those students in the Evaluation group.

There was a significant difference in the means among groups for reading discussion forum posts ($F(3, 178) = 4.365, p = .005$). The assumption of homogeneity of variances was violated for this variable; however, a Welch test showed the difference in checking grades means to remain significant ($4.39, p = .007$). The measures of association (Eta Squared = .069) showed the effect size to be small. A Games-Howell post-hoc test revealed that the mean estimation of frequency of reading forum posts for the Administrative group (3.34) was significantly higher than for the Evaluation & Interaction group (2.51). The lower numerical mean indicated higher student estimation, meaning that students in the Evaluation & Interaction group estimated that they read discussion forum posts more often than those students in the Administrative group.
There was a significant difference in the means among groups for replying to discussion forum posts ($F(3, 175) = 13.325, p = .000$). The assumption of homogeneity of variances was violated for this variable; however, a Welch test showed the difference in checking grades means to remain significant ($20.622, p = .000$). The measures of association (Eta Squared = .247) showed the effect size to be strong. A Games-Howell post-hoc test revealed significant differences in the mean estimation of frequency of replying to forum posts between all groups except the Interaction and Evaluation & Interaction groups. Students in the Administrative group (4.59) had a significant higher mean (indicating a lower frequency of posting replies) than the Evaluation group (4.18), the Interaction group (3.41), and the Evaluation & Interaction group (3.49). Those in the Evaluation group had a significantly higher mean (estimated that they replied to posts less often) than those in the Interaction group.

There was a significant difference in the means among groups for posting to discussion forum posts ($F(3, 174) = 18.993, p = .000$). The assumption of homogeneity of variances was violated for this variable; however, a Welch test showed the difference in checking grades means to remain significant ($12.719, p = .000$). The measures of association (Eta Squared = .186) showed the effect size to be strong. A Games-Howell post-hoc test revealed significant differences in the mean estimation of frequency of creating new forum posts between the Administrative and Interaction groups and between the Administrative and Evaluation & Interaction groups. Students in the Administrative group (3.76) had a significant higher mean (indicating a lower frequency of new posts) than the Interaction group (2.76) and the Evaluation & Interaction group (3.05).

**Summary**

This chapter has presented the results of the bivariate correlation and analysis of variance analyses. Descriptive and inferential statistics were provided for data collected from the SEQ
survey, for recorded LMS data, and for students’ estimates of their LMS activity. Data were grouped and analyzed according to how faculty members made use of the LMS. The final chapter of this thesis will relate these results to the current literature and offer suggestions for future research.
Chapter 5

Discussion and Conclusion

Since the early 1990s, higher education has undergone a technological transformation, including the widespread adoption of learning management systems (LMS), which has fundamentally changed the learning environment for today’s college and university students. Research into how students are engaging with their peers, with their institutions, with the academic work of post-secondary education began in the late 1970s and early 1980s with the work of Pace, Astin, Chickering, and Gamson, but the concept of student engagement was not fully developed until the late 1990s, with the introduction of the National Survey of Student Engagement (NSSE). For nearly twenty years student engagement has been measured by means of student self-reports, such as the NSSE and the Student Engagement Questionnaire (SEQ). Because of the near-universal use of LMS today, an enormous amount of data on student’s academic activities is being generated. This data could potentially be used to illustrate behavioural, psychological, and cognitive markers of student engagement. While some empirical research has demonstrated a relationship between students’ activity within LMS and students’ academic achievement (Beer et al., 2010; Dawson & McWilliam, 2008; Steven Lonn et al., 2013; Wolff et al., 2013), the problem is that far fewer studies have explored the possible connection between LMS activity and student engagement (Black et al., 2008; Dixson, 2010). The purpose of this study was to contribute to the research literature by investigating the relationship between student engagement, as measured by the SEQ, and LMS activity, both as recorded by LMS software and as estimated by students.

The final chapter of this thesis will discuss the findings of the research, beginning with an overview of one semester’s worth of student LMS log data collected from the students and faculty members who took part in the study. Next, this chapter will discuss each research
question in the contexts of this study’s results and of related research literature. The three research questions were:

1. What is the relationship between students’ SEQ scores and students’ LMS usage data (logins, course content page visits, discussion forum views, posts, and replies, and quiz attempts)?

2. What is the relationship between students’ SEQ scores and faculty participation in LMS (announcements posted, content pages shared, assignments collected via drop box, discussion forum threads created, forum replies posted, grades awarded for LMS participation, and quizzes made available)?

3. What is the relationship between faculty participation in LMS and students’ LMS usage data?

This chapter then explores differences in the results between groups of student respondents based on student demographics. After all of the results are considered, the chapter offers an examination of the implications and limitations of the research, concluding with suggestions for future research.

**Discussion of Results**

**Student and faculty LMS activity.** The main analysis in this study compared student engagement as measured by the SEQ with engagement as recorded through LMS activity data. However, the data captured from one semester’s worth of LMS activity reveals some interesting patterns in and of itself. The LMS was accessed frequently by student respondents in the study. The mean number of logins per student within the study was 98. The logins recorded by the LMS software matched the students’ estimates of their login frequency, roughly three times per day. There was, however, a large variance in the number of logins, as some students logged in only twice in the thirty days and some logged in over 400 times. The fact that a majority of
respondents logged into the LMS multiple times daily shows that the LMS was an integral part of the college experience for the students in the study. That is, student interactions with the LMS were a major form of institutional interface for these students.

Although the students had a presence within the LMS daily, data collected about their behaviour demonstrated that the students in the study were not using very many of the course resources available in the LMS. All faculty members in this study posted course content in the LMS, with the average number of content pages posted being 63 and the number of pages ranging from 13 to 177. On average, students accessed only 57% of the LMS course content links available to them. This was a surprising result, as faculty members’ interviews responses referenced students’ demand that faculty post course content online: faculty members recounted how students would send angry emails if lecture PowerPoint slides were not posted immediately after class. There are several possible explanations for the low level of course content being accessed by students. It could be that students were sharing content outside the LMS (one student downloading lecture slides, for example, and emailing them to others). Faculty also reported that some students took pictures of slides on their phones. It could be that students were accessing course content in these and other ways instead of through the LMS. The LMS used in the study had a smartphone application through which students could access course content on their phones. The app was fairly new at the time of the study, so while I was assured that student activity was captured regardless of how it was accessed by students, it is possible that LMS activity was not captured, or was captured differently, when accessed via the app instead of via the LMS website.

A majority of faculty members made use of the LMS functions for submitting assignments via drop box (77%) and creating quizzes online (63%). When these functions were available to students in the LMS, almost all students made use of them. When required to submit their
assignments via drop box, students complied 83% of the time. The drop box was often set up to close at the assignment’s deadline, making submission of late assignments via the LMS impossible. The 27% of students who did not use the drop box function even though it was active in their LMS site could have consisted, in part, of students who would have used the function but were unable because they missed assignment deadlines. Just over half of the faculty members in this study created quizzes in the LMS for their courses. The students in this study took full advantage of the quizzes available to them, with the average student completing 99% of the quizzes on their class LMS site.

In the case of both the drop box and the quiz functions, students received a grade based on the actions they took in the LMS. Students thus had an external motivation to use the LMS. The quiz function in an LMS may be used for studying or review, but only one faculty member in this study used it for this purpose and, in this class, use of the quiz tool was limited. For the vast majority of courses in this study, the LMS quizzes formed a part of the students’ final grades. Similarly, the assignments that students were asked to submit via drop box often represented a significant portion of their final grades. The very high use of these two LMS functions in particular suggests that students will use the LMS when such use (or lack thereof) directly affects their academic achievement. Previous research (MacFayden & Dawson, 2010; Mo, 2011), using quiz completion as a variable for engagement with the LMS, focused on courses in which quizzes were ungraded; this research argued that attempting quizzes despite not receiving a reward showed students’ investment in the learning process. It is possible that students’ quiz behaviour recorded by the LMS showed little correlation with SEQ scores because the quizzes were graded.

Discussion forums were the LMS feature least used by both the faculty members and the students in this study. Less than half (44%) of faculty members activated the discussion forum
function in the LMS, posting an average of seven threads per forum. Of those students who had an active discussion forum on their LMS class site, only 38% participated by reading, posting, or replying to threads in the discussion. The lack of forum availability could begin to explain why no correlation was found between LMS activity and student engagement as measured by the SEQ. A number of researchers (Annala et al., 2012; Baepler & Murdoch, 2010; Dixson, 2010; Macfadyen & Dawson, 2010) have reported that discussions play a major role in creating a sense of belonging and, thus engagement in the LMS. If few faculty members are making discussions available, and few students are using those discussions when they are made available, there is little opportunity for engagement.

Much the same as other studies (Beer, Clark, & Jones, 2010; Lonn & Teasley, 2009; Malikowski, 2011; Salajan, Schonwetter, & Cleghorn, 2010), this study found that the faculty members’ primary LMS use was sharing course content. However, while course content was widely available, students on average accessed less than 60% of the pages. This study did find that students logged into the LMS several times each day and that they were active users of functions with a grade attached to their use. Discussion forums were used infrequently by faculty—and, even when available, forums engendered little participation from students. This investigation shows that students may log into an LMS but will not necessarily make full use of all available tools. One possible explanation for this discrepancy was that students in the study had to log into the LMS system in order to access their institutional email. I was not able to track emails read or sent, and such email use was not part of this study. It is quite possible that students logged into the LMS to use their email and not to take advantage of any course-specific LMS tools.

**Student engagement and LMS activity.** The first research question in this study explored the relationship between students’ SEQ scores and students’ LMS use data (logins, course
content page visits, discussion forum views, posts, and replies, and quiz attempts). No significant relationship was found, using bivariate correlations and one-way ANOVAs, between SEQ data and recorded LMS activity. There was a relationship between SEQ data and students’ estimates of their LMS activity—specifically, their estimates related to discussion forums. This section of the chapter will review the results in the context of relevant research literature.

The hypothesis for the first research question stated that there would be a positive correlation between the average score of each scale and average overall score of the Online SEQ and the frequency counts of student LMS data. However, the results showed no statistically significant correlations between the SEQ scores and LMS frequency counts of logins, page views, drop box submissions, participation in discussions, or quiz attempts. Having found no correlations, I further explored the data using analysis of variance. I divided the sample into three equal groups of students based on the frequency of logins and found that the mean Online Active Learning (OAL) scale score for students with the lowest number of logins was statistically significantly lower than the mean OAL scale score for students in the middle of the three groups. The effect size was small, and I did not find a difference between students in the low and high login groups, leading me to conclude that there was not a meaningful difference in the student engagement scores between groups of student respondents based on their login frequencies.

Because the research literature suggested a connection between LMS discussion forums and student engagement, a second analysis of variance compared the SEQ scores of groups of respondents who had no discussion available in their course and the SEQ scores of those who did have discussions available. There was no difference in the overall SEQ score on six of the seven scales of the student engagement instrument. Students who had no discussion available in their LMS course site had a lower score on the Online Interaction Scale than those who had discussions available. This is a logical finding since discussions create opportunities for students
to interact in online environments. However, overall, the results indicate that there is no relationship between student engagement scores and recorded LMS discussion forum activity.

Previous research has found a relationship between LMS activity and grades, but very little research has attempted to make the connection between student engagement and LMS activity. Several researchers have established a connection between students’ use of discussion forums and student achievement (Dawson & McWillaim, 2008; Gašević et al., 2015; Pulford, 2011), while others have found a relationship between grades and overall LMS use (Alonso et al., 2011; Beer et al., 2010; Macfadyen & Dawson, 2010; Mogus et al., 2012). Of the few studies that have attempted to compare LMS activity and student engagement scores, results indicated either a minimal correlation between the student engagement measure and LMS activity or no differences between the mean student engagement scores of different groups of students.

Vaughan (2014) compared the mean student engagement scores of the Classroom Assessment of Student Engagement (CLASSE) with student page visits to Blackboard course sites and found the “engagement in effective educational practices” scale was moderately correlated to page visits; meanwhile, three other scales (level of academic challenge, student-faculty interaction, active and collaborative learning) showed only small correlations with Blackboard page visits. Dixson (2010) compared scores on the Online Student Engagement Survey (OSES) between groups of students with different levels of self-reported LMS activity. The author found no difference in LMS activity between those with high engagement scores and those with low scores; however, she did find that those who reported using discussions more frequently also had higher engagement scores. Hamane (2014) found a weak positive relationship between students’ engagement scores on the OSES and students’ login frequencies. Students who had high frequencies of discussion forum posts and replies also had higher student engagement scores (Hamane, 2014).
Similar to Hamane and Dixson, this study found that those students who participated more in discussions also had higher mean scores on the Online Social Interaction scale—but, unlike Hamane’s and Dixon’s studies, this study found no difference in the overall measure of student engagement accord to SEQ score. It is difficult to compare the current research with previous studies by Hamane, Dixon, and Vaughan, as their studies used different survey instruments. Vaughan (2014) used the NSSE-based CLASSE, while Hamane (2014) and Dixon (2010) used the OSES, which Dixon created. I used the Online SEQ created by Coates (2006). All three instruments are based on the NSSE, but the OSES was additionally derived from the Student Course Engagement Questionnaire (SCEQ), which asserts that student engagement consists of four types: skills engagement, emotional engagement, participation/interaction engagement, and performance engagement. These factors are different from those underlying the NSSE-derived instruments, which focus on active and collaborative learning; participation in challenging academic activities; communication with academic staff; involvement in enriching educational experiences; and feeling legitimated and supported by university learning communities (Coates, 2007).

In answering the first research question, regarding the relationship between SEQ scores and students’ LMS usage, the main focus of this analysis was on the data recorded by the LMS software. Because no correlations were found between SEQ scores and use data (and only small differences in the means of one of seven of the SEQ scales could be found between groups based the presence of a discussion), a second analysis was conducted to examine LMS use through students’ estimates of their LMS activity. In this analysis, no statistically significant correlations were found between the SEQ scales or overall SEQ score and the students’ estimates of their logins, their course content page visits, their grades-checking frequencies, or their quiz attempts. However, students’ estimates of how often they read, replied to, or posted to discussion forums
did have a positive correlation with the overall SEQ score. Students’ estimates of how often they read forum posts seemed to be a good indicator of engagement, as these estimates correlated to five of the seven SEQ scales as well as to the overall SEQ score.

Why is it that a correlation could not be found between SEQ scores and students’ recorded LMS activity in discussion forums despite a correlation between SEQ scores and students estimates of their discussion activity (particularly how often they estimated they read posts)? The answer could lay in the fact that this study collected data per student from only one or two LMS course sites when particular students could have been enrolled in seven or eight courses with LMS sites during the semester. The LMS data collected only captures discussion forum activity in one or two LMS sites, whereas such students’ estimates of their discussion forum activity were likely given with all of their courses in mind. Even though students in this study were asked to answer the questionnaire based on specific courses, most seemed to answer while considering their global LMS experiences. It is possible that those who estimated higher levels of discussion were indeed using discussions more frequently but that the LMS use data from other courses was not considered in this study.

Previous research has found a relationship between students’ use of discussion forums and students’ sense of belonging. Using Rovai’s Classroom Community Scale, Black, Dawson, and Priem (2008) reported that activity within the LMS in general was a good predictor of sense of community. Picciano (2002) reported that the frequency of posts in the weekly class discussions was positively correlated to perceptions of social presence. Macfayden and Dawson (2010) used social network analysis to create visualizations of student discussion forum postings, which led them to conclude that LMS data generated from discussion forum activity are significant indicators of a student’s sense of belonging. Each of these studies refer only to sense of belonging and not specifically to student engagement; however, sense of belonging is a
significant aspect of engagement (Trowler, 2010; Wolf-Wendel et al., 2009). This study found a relationship between estimates of discussion forum participation and overall SEQ scores. It is possible that student use of discussion forums improves interaction and, thus, a sense of belonging, which in turn improves overall student engagement.

An interesting finding in this study is that students’ estimates of the frequency with which they read discussion forums had a positive relationship to most of the SEQ scales in addition to the overall SEQ score, unlike the estimates of replies and posts which were only correlated to the overall SEQ score. Students’ estimates of how often they read forum posts was correlated to the SEQ scales Online Engagement, Online Active Learning, Online Social Interaction, Online Collaboration, and Online Academic Relevance. Other studies have explored the idea that simply reading posts can engage students. Seddon, Postlethwaite, and Lee (2011) argue that students who read discussion posts (but do not post or reply) are still drawing value and participating in the course community, which could lead to improved engagement. Drouin and Vartanian (2010) found that students who felt they had more opportunities to communicate with peers and faculty members reported higher levels of connectedness. Similarly, Webb, Jones, Barker, and van Schaik (2004) found evidence that posting questions improved grades but that passive participation (just reading and not posting) also had a positive impact on grades.

In summary, this study’s first research question investigated the relationship between students’ engagement scores, as measured by the Online SEQ survey instrument, and students’ LMS use, as measured by data recorded by Desire2Learn LMS software. No meaningful correlations were found and, what is more, no differences in mean SEQ scores were found among student respondents grouped by number of logins or by whether the course had a discussion forum. These findings support previous studies which found weak or no correlation between LMS use data and student engagement measures. Because no correlations were found
between SEQ scores and recorded use data, a second bivariate correlation analysis was performed with students’ estimates of LMS use. A significant, positive correlation was found between the student engagement measure, the SEQ, and students’ estimates of how often they read, replied to, or posted to discussion forums. The global perspective possibly used by student respondents could explain why estimates of discussion participation correlated with SEQ scores while recorded discussion activity did not correlate with SEQ scores. The research literature has shown that discussion forums assist students with feeling connected and thus engaged in online environments. The next two sections in this chapter will examine the impact of faculty members’ LMS use on student use and engagement.

**Student engagement and faculty LMS use.** The second research question of this study examined the relationship between students’ SEQ scores and faculty participation in LMS as measured by counts of announcements posted, content pages shared, assignment submissions via drop box required, discussion forum threads created, grades awarded for LMS participation, and quizzes made available. For the analyses, the 214 student respondents were divided into four groups based on faculty LMS use. These categories describe the main focus of LMS use for each faculty member. The Administrative group contained 93 students enrolled in courses whose LMS sites only provided announcements and course content pages. The Evaluation group, with 63 students, consisted of those in courses whose LMS sites provided quizzes in addition to announcements and course content. The 17 students in the Interaction group were in courses whose LMS sites provided discussion forums in addition to announcements and course content. The last group, the Evaluation and Interaction, was comprised of students whose faculty members had enabled all the LMS tools measured in this study (announcements, course content pages, discussion forums, and quizzes). Faculty participation in the LMS was explored by comparing—between each of these groups—aggregate SEQ data, recorded LMS activity, and
students’ estimates of their LMS activity. A comparison of the four groups with SEQ data revealed only one significant difference: student respondents in the Administrative group had lower mean Online Social Interaction scale scores than those in the Interaction and Evaluation & Interaction groups. This finding is logical since students in the Administrative group did not have discussions available to them and would, therefore, be less likely to have opportunity for online social interaction.

There were no differences between groups on six of the seven online engagement scales or on the overall SEQ score. Between the Administrative group and the Interaction and Evaluation & Interaction groups, the biggest difference in faculty members’ LMS use was the availability of discussion forums. The Administrative group had no discussions available; the Interaction group had discussions available but not quizzes; and the Evaluation & Interaction group had discussions and quizzes available. Taken as a whole, the analysis of variance between different groups of students based on faculty LMS use demonstrates that students’ perceptions of their online engagement, as measured by the SEQ, were not influenced by faculty members’ LMS use. Very few faculty members in the study made use of the discussion forums, and in courses where a forum was available fewer than four in ten students participated. It is possible that the presence of a forum may impact student engagement, but such an effect may not have been demonstrated in this study due to the infrequency of its participants’ forum use. It is also possible that the groups used in the analysis were not different enough from one another to demonstrate impact. That is, the different tools used across groups may not have been used with enough frequency to make the effects of these LMS course sites profoundly different.

Student engagement is a complicated construct which includes investment from both students (their effort and time) and institutions (practices, resources, and staff and faculty time). This investment is intended to optimise the student experience, learning outcomes, and the
overall performance of the institution (Trowler, 2010). Data drawn from a learning management system captures student time and effort in the form of their academic work performed in a class (frequency of discussion forum involvement) as well as institutional investment in the form of faculty activity within the LMS (active participation in discussion forums). This study found no relationship between student engagement (SEQ scores) and faculty LMS use. This could be evidence that the institutional investment aspect of student engagement is not being captured by LMS data. As mentioned above, it could also be a result of this study’s very small sample, in which few faculty members enabled LMS discussion forms and even fewer students participated in those forums available to them.

In summary, no relationship was found between faculty activity recorded within the LMS and student engagement. While it seems intuitive that faculty members would influence student LMS use through how they choose to set up their courses sites and how they interact with students online, the data in this study does not support making this connection. If student LMS use does not affect student engagement, then the effect of faculty influence on student engagement in the LMS may also not be detected by LMS activity data.

**Student and faculty use of the LMS.** This study’s third research question was an inquiry into the relationship between faculty participation in the LMS and students’ LMS activity. The key question was whether a faculty member could influence student LMS use through the tools they chose to enable and through how actively they participated in and monitored the LMS course site. As with the second research question, an analysis of variance was conducted to examine the differences between groups of student respondents based on faculty members’ LMS use. Two analyses were conducted, one measuring student LMS activity using recorded LMS data and one using students’ estimates of their LMS behaviours. From these analyses three interesting results emerged. The means of two variables for recorded LMS activity (course
content page visits and participation in discussion) were found to be significantly different between groups. Student estimates of how often they read, replied to, or posted to discussion forums were also significantly different between groups. Each result will be discussed in turn.

The Evaluation group had a higher mean number of course content page visits than both the Administrative and Evaluation & Interaction group. Students in the Evaluation group accessed an average of 70% of the course content available to them, whereas students in the Administrative group accessed 52% of course content pages and those in the Evaluation & Interaction group accessed 48% of course content pages. One possible explanation for the difference between the Administrative and Evaluation groups is that students in the Evaluation group accessed course content more often because they were online doing quizzes. Online LMS quizzes can be done at any time from any Internet-capable device, which means students can consult textbooks, notes, or other resources while answering quiz questions; students could, therefore, be searching through course content pages in the LMS either in preparation for or simultaneously with attempting online quizzes.

The finding that students in the Evaluation & Interaction group only accessed 48% of course content pages while those in the Evaluation group accessed 70% of pages cannot be explained by the possibility of students’ accessing content to assist with quiz attempts. A closer look at the raw data reveals that this finding may be a result of an anomaly in the data. The average number of course content pages across all LMS course sites used in this study was 63. Courses placed in the Evaluation group had a much smaller average, at only 39 course content pages, whereas courses in the Evaluation & Interaction group had an average number of 91 course content pages. Since the variable used for page visits was the ratio of pages accessed to the total number available, it is likely that student respondents in the Evaluation group showed a higher percentage of course content page visits because they had fewer pages to visit.
The Interaction group had a higher mean for the participation in discussion variable than the Evaluation & Interaction group. The other two groups of student respondents (Administrative and Evaluation) did not have discussions available, so only these two groups were compared. The students in the Interaction group, on average, participated in 54% of the discussion forums available to them whereas student respondents in the Evaluation & Interaction group only participated in 30% of the discussion forums available to them. While this finding is statistically significant, a closer examination of the raw data revealed that this difference is likely due to the behaviour of a small number of respondents in two courses in the Evaluation & Interaction group. In one class, which included five students taking part in the study, all five respondents did not participate in discussion. In another class, which included three student respondents, the faculty member used the discussion forums much like announcements, frequently posting information without explicitly inviting students to comment on or interact with the material. These three respondents participated very little in discussion, reading 2 to 3% of the posts and not replying or posting at all in the discussion. Roughly 20% of the student respondents in the Evaluation & Interaction group had little to no discussion activity. The students in these two courses may have contributed to a lower average than would have been true for the rest of the Evaluation & Interaction group. Given the patterns in the data, I suggest that there is not a meaningful difference between the groups in terms of participation in discussion.

When groups of student respondents were compared by faculty LMS use, differences between students’ estimates of their discussion forum activity were found. Students in the Administrative group had lower estimates of their reads, replies, and posts than students in all other groups. The effect size was strongest for estimates of forum replies. Students in the Administrative group estimated that they posted fewer replies than did those in all other groups. Those in the Evaluation group gave lower estimates of replies than those in the Interaction group.
Students in the Administrative group also gave lower estimates for the frequency of new posts than did those in the Interaction group and those in the Evaluation & Interaction group.

Recall that student respondents whose course LMS sites did not have a discussion forum available nevertheless provided estimates of their forum activity, likely because they were considering their LMS experience globally when responding to the survey and, thus, were estimating discussion activity in a course whose LMS data were not collected as part of this study. The finding that student respondents in the Administrative and Evaluation groups estimated less discussion forum activity than the other groups is logical given that these respondents were enrolled in at least some courses without LMS forums. Actual online discussion activity as recorded by the LMS did not show significant differences between groups based on faculty LMS use, but students’ estimates of their behaviours in discussions did have significant differences between these groups. It could be that students’ perceptions of their behaviours are more heavily influenced by faculty LMS use than by their actual behaviours. However, it could also be possible that the estimates from all 214 respondents were a more robust representation of students’ behaviours in discussion forums than the data collected from the 58 respondents who had forum activity recorded by the LMS software. The estimates provided approximations of students’ behaviours across courses, whereas the recorded LMS activity provided snapshots of students’ discussion activities in individual courses.

Student respondents in the Administrative group were enrolled in courses whose faculty members only made use of the announcement and course content LMS tools. In general, student respondents in the Administrative group viewed fewer course content pages, participated less frequently in online discussions, and estimated lower frequencies of their reads, replies, and posts in discussion forums. It would appear that faculty LMS use does have some effect on student LMS use when student use is measured by self-reported estimates. However, little
difference in LMS activity was found between other groups of student respondents. For example, students in this study who were enrolled in courses whose faculty members used discussion forums, drop box, and quizzes in addition to announcements and course content showed little to no difference in LMS activity from those students enrolled in courses that had LMS discussion forums but no drop box or quizzes.

Few other researchers have examined the relationship between faculty members’ LMS use and students’ LMS use; however, there has been research on faculty LMS use and other variables. Dixson (2010) suggested that “instructor presence” was correlated to student engagement scores. Dixson examined the impact of instructors’ visible activities in an online environment (such as forum posts, email, and participation in group activities) and found that student engagement scores were higher when instructors had more of a presence in the online environment. Stamm (2013) found weak correlations between instructor activity and student grades, while McGill and Klobas (2009) concluded that faculty members have a significant influence on a student’s choice of tools within an LMS. Shen, Laffey, Lin, and Huang (2006) reported that faculty member’s beliefs about the LMS had an impact on students’ perceived usefulness of the LMS. Because multiple studies (Costen, 2009; Landry et al., 2006; Sutton & Nora, 2009) have demonstrated a link between perceived usefulness of LMS tools and student LMS use of these tools, this finding could be interpreted to support a finding that faculty members play a role in encouraging student use through their presence within the LMS. Other researchers (Gašević et al., 2015; Jayaprakash, Moody, Lauria, Regan, & Baron, 2014; Macfadyen & Dawson, 2012) have attributed inconsistent results in studies of student LMS use to the diversity of ways in which faculty members make use of the LMS.

In summary, this study’s third research question sought to determine if there was a relationship between how faculty members set up their courses and interact with students within
the LMS and how students use an LMS. Initial results showed that the Evaluation group had a higher number of course content page visits than the other groups and that the Interaction group had participated in discussions more often than those in the Evaluation & Interaction group. However, a closer look at the data revealed that these two findings are a result not of true differences between groups but, possibly, of anomalies in the data. A difference between the groups was found in students’ estimates of their discussion forum activity. Students in the Administrative group estimated that they read, replied to, or posted to forums at a lower frequency than had students in all other groups. The research literature has shown that faculty LMS use impacts students’ grades, students’ engagement scores, students’ choice of LMS tools, and students’ perceived usefulness of the LMS; however, no research comparing faculty LMS use and student LMS use was found.

**Summary of research question findings.** This study’s first research question used bivariate correlations and one-way ANOVAs to explore the relationship between students’ SEQ scores and students’ LMS use data, and this study found no significant relationship between the variables. A relationship was found between SEQ data and students’ estimates of their LMS activity—specifically, their estimates related to discussion forums. This study did not find a correlation between student engagement scores and LMS activity, which was similar to the findings of Vaughn (2014) but unlike those of Hamane (2014) and Dixson (2010). Just as other studies have suggested, this study found a small relationship between student engagement and student participation in discussion forums (Macfayden & Dawson; 2010; Picciano; 2002; Priem, 2008).

For the purposes of answering research questions two and three, this study collected data about faculty members’ use of their LMS course sites. For each of the 48 classes used in the study, the number of announcements posted, courses content pages shared, drop box
opportunities offered, discussion forum threads created, and quizzes made available were manually counted. The grades awarded for LMS participation were also examined. After combining this quantitative data with qualitative data from faculty interviews, four categories of faculty LMS use were created. Using a one way analysis of variance, the SEQ scores of all 214 study participants were compared across the four groups, and no difference in overall student engagement score was found between any of the four groups. A second ANOVA comparing student LMS use across the four groups also found no differences. The last analysis, comparing student estimates of their LMS activity, found that students in the Administration group had lower estimates of discussion activity than all of the other groups. The results in this study suggest that faculty LMS use does not influence students’ engagement and has a small influence on students’ LMS discussion forum use. This conclusion differs from the findings of Dixson (2010), who stated that instructor presence influences student LMS use, but the conclusion supports McGill and Klobas’s (2009) suggestion that faculty members can influence a student’s choice of LMS tools.

What prompted me to embark on this line of research was the observation that institutions had a large amount of LMS data and that the new field of learning analytics has begun to explore ways to use this data for research and for practical applications. In the literature review, for example, I described the Course Signals program developed at Purdue University, which uses data mined from years of LMS use to create an algorithm that can be displayed as course progress on a student’s dashboard and can alert academic advisors to students at academic risk (Arnold & Pistilli, 2012). Macfadyen, Dawson, Pardo, and Gašević (2014) argue that LMS data should be used for quality assurance in education because such data can allow assessment of individual student learning and can be studied in the aggregate to represent overall institutional delivery on student learning outcomes. I remain skeptical of the algorithms used to determine
academic risk, as it is unclear what is being used to determine the academic standard. It is also unclear to me exactly how LMS data represents learning.

One of the pioneering studies in learning analytics was Dawson and McWilliam’s (2008) study of a large number of courses across two institutions in Australia and Canada. The focus of their study was discussion forums, and they explored both the networks formed through the discussions and the content of those discussions. Most studies that explore LMS in higher education cite this study; over time, however, the discussion forum student engagement Dawson and McWilliam referred to in their study has come to be equated with any and all LMS data.

Unlike Dawson and McWilliam’s study, this study collected data primarily on LMS activity that represented a student accessing a link. Activity in discussion forums was also studied, but (as mentioned) only 58 of the 214 student study participants had any discussion activity recorded by the Desire2Learn LMS software. Of these 58 students, the average student only participated 38% of the time. I had more data in my study regarding student logins, course content page visits, and quiz attempts than regarding discussion activity. No correlations were found between the SEQ scores and LMS activity. Discussion forums do seem to play a role in student engagement: even within this study’s small sample, I found correlations between SEQ scores and students’ estimates of their discussion forum activity.

The main reason this study found no correlations between student engagement (as measured by the SEQ) and LMS use could be that the LMS use under examination did not involve true student engagement—that is, did not involve time and effort invested and involvement with the academic material. The fact that a student logged into the LMS provided no guarantee that the login represented engaged reading of course material or other engagement with academic material. Indeed, a student could have been logged into the LMS in one tab of their Internet browser while actively engaging with a web page in a different tab. This study also
looked at course content page visits. Again, though a student accessed a link, it was unclear what happened after the link had been accessed. The student could have moved on in a few seconds or could have downloaded the content of the page and studied it for several hours. The drop box tool in the LMS turned out to be an administrative tool: submitting assignments via drop box provided a binary measure of whether assignments were turned in or not but did not provide a measure of the effort students invested in assignments or the quality of those assignments. The quiz tool has the potential to be representative of student effort or engagement with academic material—but, perhaps because the vast majority of quizzes used in this study were incorporated into course grades, students had a near perfect completion rate. In this regard, student engagement was less likely measured than student compliance with course requirements.

The discussion forums however could potentially provide a more interesting measure of student engagement. Those courses that the best rates of student forum participation were those in which faculty members rewarded discussion forum involvement with a grade. More than other LMS tools, discussion forums tend to blur the line between academic and social because students are engaging in a dialogue. A discussion thread may be created to address an academic question, but students often add personal perspectives. Discussion forums allow a pair or a group of students to respond back and forth in a single thread, and sometimes the initial thread topic evolves into another conversation. In this way, student motivation may begin with the grade attached to the forum but may shift into a more intrinsic motivation brought on by being engaged in the online conversation. Discussion forums support the NSSE benchmark of active and collaborative learning in that they provide opportunities for students to discuss ideas from class outside of class, to ask questions of their peers, and to work with other students to understand course material of complete an assignment.
LMS have added a new dimension to the concept of student engagement on today’s college and university campuses. Campus-based students have new options for engagement with peers, faculty members, and intuitions themselves through LMS course sites that have multiple tools enabled and are maintained by actively engaged faculty members. Trowler’s (2010) definition of student engagement is broad enough to encompass new ways for students to engage in this way. However, current measures of student engagement, such as the NSSE and the SEQ, do not ask students questions about this type of engagement. Theories of student engagement could be enhanced with further study of LMS log data and how it may (or may not) represent student engagement.

This section of the discussion and conclusion chapter has reviewed the research questions the context of the results and recent research literature. Before I discuss the implications and limitations of this study and propose future research, I will consider some interesting results which arose from the demographic information collected in the study. Far from conclusive, my examination of the roles of age, gender, and native language on LMS use is the start of an exploration into outside factors that may influence LMS use.

**Student engagement and student demographics.** The differences in online engagement between age, gender, and primary language groups was not an initial area of inquiry for this study. However, when the data were analyzed by comparing student respondents’ SEQ scores with LMS use by demographic group, some interesting results emerged. Female students were more engaged in general than male students; older students were more active in discussions and accessed more course content than younger students; and non-native English speakers logged in more often, had higher Online Social Interaction scores, and estimated their discussion activity at higher rates than native English speakers. This section will discuss these findings and related research literature in more detail.
Male students in this study had significantly lower mean Online Active Learning, mean Online Contact with Staff, and overall SEQ scores than female students in the study. Male students also demonstrated a lower number of course content page visits and quiz attempts than the female students. Male students estimated significantly lower frequencies creating new forum posts, checking grades, and attempting quizzes than female students. One study of gender differences in the use of technology concluded that female students typically had more anxiety and less experience with technology, while male students generally had higher interest in computers than female students (Parker & Bianchi, 2008). However, other studies of female students who were born in a time of near-universal home Internet access and home computer and smartphone ownership have found that these differences are decreasing (Junco & Cole-avent, 2008). The 2014 ECAR study did not find major differences in technology use between genders (Dahlstrom & Bichsel, 2014). Additional studies have found that women are now surpassing men in education-related technology use, finding that men have fewer overall selections to links in LMS than women (Beer, 2010; Heffner & Cohen, 2005).

It should be noted that some of the courses considered in this study were over-representatively male. For example, all seven participants in one course (which was part of a male-dominated college program) were male. Their faculty member made little use of the LMS, meaning these students had less of an opportunity to engage in the online environment. Therefore, a finding that male students were less engaged than female students could be due to male students being enrolled in courses whose faculty members made less use of the LMS, providing fewer opportunities for online engagement.

Although no differences were found in online student engagement scores between students of different ages, different age groups had different rates of recorded LMS use and different estimations of LMS use. Older students (46 to 55 years) had significantly higher levels of
participation in online discussions than younger students (17 to 35 years). One group of older students (25 to 35) had significantly more course content page visits than the youngest group (17 to 19). Students in the 36 to 45 age range had significantly higher estimations of the frequency with which they read forum posts than students aged 17 to 35. Results from this study agree with those of Beer (2010), who also found that older students accessed more course content via LMS than did younger students. In his study, those over 40 years of age showed the highest number of selections on LMS links (i.e., clicks), followed in order by those aged 30 to 39, those 20 to 29, and those under 20. Xu and Jaggars (2013) reported that older students adapted more readily than younger students to online learning. Additionally, the 2014 ECAR study reported that older students rated themselves higher on a scale of inclination towards technology than younger students (Dahlstrom & Bichsel, 2014).

Caution must be used in drawing any conclusions about the differences in discussion participation and selections on LMS links to course content pages between age groups. The small number of student respondents in the 46 to 55 ($n = 6$) and 36 to 45 ($n = 8$) age groups could mean that these students may not have been representative of the overall population of older students. Older students are a diverse group, returning to school for a multitude of reasons, which may affect their approach to studying and to LMS use.

Lastly, the responses of native English speakers who participated in the study were compared to those of non-native English speakers in the study. Non-native English speakers had significantly higher scores for the Online Social Interaction and Online Academic Relevance scales as well as a higher mean number of logins. Non-native English speakers also had higher estimated frequencies of posting and replying in discussion forums than did native English speakers. This result followed the overall results for all student respondents in the study, which was that students who had higher estimates of reading, replying, and posting in discussion
forums also had higher mean Online Social Interaction scores. Hannon and D’Netto (2007) conducted research into how students from different linguistic backgrounds engaged in online learning environments. The researchers did not find differences in survey responses about engagement and satisfaction between non-native and native English speakers. I would conclude from these results and previous literature that those who speak English as an additional language are not disadvantaged by use of an LMS. On the contrary, this study showed that non-native English speakers made more use of the LMS than native English speakers. Sharpe, Beetham, and De Freitas (2010) suggest that online environments such as an LMS allow non-native English speakers time to reflect on course content and to draft and correct their contributions to the class via, for instance, forum posts rather than in-class discussion. It is possible that non-native English speakers log in more often and make increased use of discussion forums as a way of supporting their learning by accessing and interacting with course material in different modalities.

Although not an initial focus of this research, analysis of the differences in engagement scores, LMS activity, and estimates of LMS behaviour between groups of student respondents based on their gender, age, and language spoken at home produced some interesting findings. Female students had higher SEQ scores and visited course content pages in the LMS more often than male students. Similarly, older students were found to be more active in the LMS by visiting more course content pages and participating more often in discussion than younger students. Non-native English speakers showed more engagement on two of the seven SEQ scales and logged into the LMS more often than native English speakers. Higher education in North America has been moving towards universal access in recent decades. These findings seem to suggest that LMS could potentially serve as tools to assist non-traditional students by providing multiple modes of interacting with academic material in addition to traditional lectures.
Summary. This study found that students accessed their college’s LMS daily but that the tools within the LMS were not being used to their potential. Students viewed less than two-thirds of the course content available to them, but they did use LMS tools that were directly associated with a grade. LMS discussion forums, which previous research has demonstrated have an impact on student engagement, were not activated by many faculty members’ in this study; even when forums were available, students very little. This study also found that students made use of the LMS in different ways depending on their gender, age, and native language. Male students were less engaged than female students, and while there was no difference in engagement scores by age, older students were more active in discussions and accessed more course content than younger students. Non-native English speakers logged into the LMS more often and estimated their discussion activity at higher rates than native English speakers.

Student LMS activity was measured in this study by counting the number of times student respondents logged into the LMS in a 30-day period and the percentage of course content accessed, discussion forum threads participated in, drop box assignments submitted, and quizzes attempted. No correlation was found between students’ LMS activity and students’ engagement scores. Student respondents were grouped according to their frequency of logins, the presence or absence of a discussion forum in their course LMS sites, and the primary use of the LMS by their faculty members. In each case, no differences in student engagement scores were found between any of these groups. The lack of any significant correlation or significant difference in mean LMS activity between groups led me to conclude that LMS activity as recorded by system software was not related to student engagement as measured by the Online Student Engagement Questionnaire (SEQ).

A second measure of students’ LMS activity was answers from a survey that asked students to estimate their LMS use. Once again, no correlations were found between students’
engagement scores and their estimates of how often they logged in, visited course content pages, checked their grades, or attempted quizzes. When the student respondents were grouped by faculty members’ primary LMS use, no differences in these same students’ estimates were found. However, students’ estimates of how often they read, replied to, or posted to discussion forums did have a positive correlation with overall student engagement scores. It was also found that student respondents in courses for which faculty members did not use LMS discussions (the Administrative and Evaluation groups) had lower estimates of their reads, replies, and posts. The finding that students’ estimates of their behaviours in LMS discussion forums were positively correlated to students’ engagement scores indicates that there may be some relationship between LMS forums and student engagement. It is likely that students’ estimates of discussion behaviour provided a more robust activity measure because recorded LMS discussion activity was restricted to the courses included in the study—that is, because student respondents may have participated in forums for courses not captured in the study’s count.

One scale of the SEQ student engagement measure in particular was shown to have a relationship with students’ estimates of their LMS discussion forum activity. In the analysis for the first research question, a positive correlation was found between students’ estimates of the frequency with which they read, replied to, or posted to discussion forums and their Online Social Interaction score. Groups of respondents who had no access to discussion forums had, on average, a lower Online Social Interaction score than those who did have discussions available. Similarly, the analysis of variance between groups of student respondents based on faculty LMS use showed that those without access to discussion forums (the Administrative group and the Evaluation group) had lower Online Social Interaction scores than groups of students who did have access to discussions. These results show that there may be a relationship between discussion forums and the online social interactions of students. Because faculty and student
participation in discussions was so very low, however, it is likely that this study’s recorded data did not fully represent the overall LMS forum activity of student respondents.

I must reject the hypothesis for the first research question—that there will be a positive correlation between the average score of each scale of the Online SEQ and the overall SEQ score and the frequency counts of student LMS data. No correlations were found between the SEQ data and the student LMS activity data. The hypothesis formulated for the second research question was that there will be a positive correlation between the average score of each scale of the Online SEQ items and the frequency counts of faculty LMS data. Because the faculty LMS use data was categorical, correlational analysis was not conducted. It can be concluded from the analysis that there was no relationship found between student engagement and faculty activity recorded within the LMS. The hypothesis for the third research question stated that there will be a positive correlation between the frequency counts of student LMS data and the frequency counts of faculty LMS data. Similar to the second hypothesis, no correlational analysis was done. However, it was found that students had higher estimates of their discussion form activity when they were enrolled in courses whose faculty members made use of the LMS discussion forum tool.

Implications

As can be seen from my rejection of the first hypothesis, I found no correlations between student engagement scores as measured by the SEQ and student LMS activity as recorded by Desire2Learn software or students’ estimates of their activity. Further exploration of the data, performed by comparing SEQ scores and LMS activity data between various groups of student participants, revealed very little relationship between student engagement and faculty LMs use or between faculty and student LMS use. There are several important implications for theory and practice arising from these results. Practical implications include a call to resolve data
governance issues with proprietary LMS software companies and a suggestion that current student engagement measures need to be re-examined in light of new developments in the technologies students use to learn. Policy implications include the need to explore the ethics and issues involved in using student LMS data for measures of institutional and system-wide quality. This study also has implications for how faculty make an LMS available to all students as well as to certain traditionally under-represented groups.

The method used for data collection from the LMS in this study was chosen in part due to data governance issues with a proprietary LMS software company. Currently, institutions must depend on privately owned LMS companies that decide how data will be recorded, displayed, and extracted. For example, I was hoping to capture an entire semester’s worth of logins, but the software only keeps 30 days’ worth of login data in the system. Additionally, the particular software I used for the study did not provide downloads of the data as a whole, instead displaying pre-packaged data sets to students so they could see their progress in their courses; working with system administrators, and having permission from each professor, I was granted access to the course sites so I could manually extract usage data from these student progress displays. Institutions and researchers need to work with LMS companies for better access to reports and raw data produced from student selections on LMS links. As institutions change LMS providers or expand their relationships with current providers, they should be including in their contracts a data reporting and data sharing agreement.

The lack of a relationship between a self-report measure of student engagement, such as the SEQ, and recorded LMS activity is an important finding at this time, as institutions begin to explore the potential of learning analytics. Higher education institutions are collecting a huge amount of data on student LMS activity, but there does not seem to be a framework for analyzing this data. The field of learning analytics is less than a decade old, and the leading scholars in the
field argue that learning analytics needs to be better grounded in the research on learning and teaching (Gašević, Dawson and Siemens, 2015). These scholars suggest that growth in learning analytics can only occur if the data being collected is framed in theoretical models. In this study, I attempted to use the theory of student engagement for such a framework, but the results indicate that established instruments for measuring student engagement do not correlate with LMS use data. The NSSE is a well-respected instrument in Canada and the SEQ makes up part of the AUSSE, a student engagement instrument used in Australia, but both instruments are expensive to administer for institutions. As governments increasingly demand accountability from higher education institutions, it could be tempting for institutions to turn to their vast store of LMS data for measures of student learning and student engagement. However, the findings in this study suggest that caution is warranted when using LMS activity data to assess student engagement. Student affairs practitioners, institutional researchers, and those in administration should avoid making decisions based on LMS data alone; they should instead look into how LMS data can enhance current student engagement measures.

This study has been an exploration of the concept of student engagement. Throughout, I have used Trowler’s definition of student engagement: “the investment of time, effort and other relevant resources by both students and their institutions intended to optimise the student experience and enhance the learning outcomes and development of students, and the performance and reputation of the institution” (Trowler, 2010, p. 3). This definition was chosen because it is broad enough to encompass many forms of engagement, both in terms of who is engaged (students, faculty, or institutions) and where they are engaged (physical or virtual environments). Self-report measures of student engagement provide students’ views of their engagement—that is, the NSSE and the SEQ ask students about their experiences. The survey measures provide an indirect measure of institutional engagement by way of students’ reports on
how they engage with their schools. LMS data, on the other hand, has the potential to provide a 360-degree perspective on student engagement because the LMS can capture not only student behaviour but also faculty and institutional behaviour. This study did not find a relationship between student engagement and faculty LMS use, but further research should explore how LMS data can help illustrate institutional investment in student learning outcomes.

This study used the SEQ, a NSSE-based instrument that was designed specifically to explore the student engagement of campus-based students whose courses were enhanced with LMS. It is possible that I could have had different results if I used a different measure of student engagement. When the Online Student Engagement Survey (OSES) was used by Dixson (2010 and Hamane (2014), a relationship was found between student engagement and frequency of logins and discussion forum posts. When the Classroom Survey of Student Engagement (CLASSE) was used to look for relationships between LMS use and student engagement, only a weak correlation was found on one of the five scales of engagement. Considering all four studies together, it would seem that the instrument used has an influence on the level of correlation that can be established between student engagement and LMS activity. The construct of student engagement has been defined in the last two decades almost exclusively through the NSSE. The abundance of LMS data and new methods of learning analytics means there is potential in coming years to re-examine the construct of student engagement.

This research partially supports previous studies which demonstrated a relationship between LMS discussion forums and the social interaction and engagement of students (Black et al., 2008; Dixson, 2010; Macfadyen & Dawson, 2010). Student respondents who estimated a higher use of discussion forums did have higher SEQ scores. The Online Social Interaction scale was higher for student respondents whose sites had discussion forums, but no difference was found in the overall SEQ score. The results show a relationship between forums and social
interaction but are less clear about forums affecting student engagement. This study also found that both faculty members and students made very little use of LMS discussion forums. The limits of the LMS software also meant that discussions that took place on Facebook, in subject-specific online forums, or elsewhere were not captured in this study. If we know that LMS discussions can foster a sense of belonging and engagement for campus-based students outside of their classroom experiences, the task for faculty members and the staff who support teaching and learning is to focus on how LMS discussion tools can best be used. The college where this study took place mandated that all faculty members use the LMS in all of their courses. However, the instruction to use the LMS was binary: there was not a minimum standard of use in place at the college. A variety of supports were in place for the faculty to learn how to use the LMS, but there were no templates for use and no best practices were established and shared. The results of this study suggest that discussion forums can possibly play a role in student engagement; therefore, institutions should encourage their use. This encouragement could take the form of specialized sessions for learning to create and moderate forums and for incorporating them into the curriculum. Institutions could model best practice by enrolling their faculty members in an LMS course site, utilizing the discussion forums and other LMS tools to educate and inform faculty members not only about the LMS but also about student services and other aspects of the institution.

The analysis of demographic information collected in this study suggested that some groups of student participants use the LMS at greater rates and are more engaged than others. On average, female student respondents had higher SEQ scores, demonstrated more page visits, and estimated that they checked their grades more often than did male student respondents. While there was no difference between age groups for the SEQ scores, older students visited more course content pages in the LMS and participated in discussion more often than did younger
students. Native English speakers in this study logged in less often and had lower online social interaction scores than did non-native English speakers. The implication of these findings for higher education is that faculty members and student affairs staff need to ensure that younger or male students are provided with interventions and services that will enable them to fully engage in the LMS sites which support their courses. On the other hand, the finding that older students and non-native English speaking students are using the LMS at higher rates than others could be seen as an opportunity for higher education institutions to reach out to a new demographic of non-traditional students. The multiple modalities of course delivery allow for a diversity of learners to find and use the learning supports that work best for them. Chickering and Gamson (1989) called for educators to respect diverse talents and ways of learning. When used in conjunction with a campus-based in-person course, an LMS provides a secondary environment for learning. Posting course content (e.g., lecture slides) online gives students an opportunity to review course material repeatedly and at their own pace. The posting of content together with the announcement function also allows students who may need to miss classes (due to family or work commitments) to keep up with the rest of the class. LMS discussion forums provide an opportunity for non-native English speakers or those with auditory or language processing challenges to review course material in the forms of questions and answers. The asynchronous nature of the forum allows students to reflect, revise, and revisit their own questions and those of others in the course.

Limitations

There are three main limitations of this study. The first has to do with research design choices regarding sampling. Non-probability convenience sampling was used, which means that the results cannot be generalized to all faculty members and students at the college or at other colleges. Study participants were limited to students in courses whose faculty members had
already given me permission to access their LMS sites. I was not able to sample students across all of the courses available at the college. It is possible that my sample was biased towards courses where faculty are supportive of LMS technology. Relatedly, the study took place online, and students were contacted through the LMS email system. Students who do not access the LMS or check their emails may have been excluded from the study. To reduce these limitations, all faculty members at the college were contacted several times with requests for their participation, and even those who made little use of the LMS were encouraged to take part in the study. Student recruitment was done via in-class presentations and through emails in order to reach those students who may be online less often. While these limitations reduce the generalizability of results, I did find a general pattern of faculty member and student LMS use across the 28 classes and 214 students involved in the study.

A second limitation of this study was the restricted reporting functionality of the LMS software. I worked with college professionals in the Information Technology department as well as with individual faculty members so that I had a high level of access to each course LMS site used in the sample. Excepting the ability to view students’ grades or to edit the site, I had the same level of access to course sites as did faculty members. The software does provide a number of metrics of students’ activity; however, not every action in the system is recorded or accessible to faculty members. For example, logins are only available for the most recent thirty days. If I had anticipated this, I could have downloaded login data earlier in the semester in addition to downloading this data at the end of the semester. Some changes faculty make to course sites, such as deleting content pages or placing expiry dates on announcements, are also not captured in a retroactive analysis of student LMS activity. A thorough examination of each course site and the students’ and faculty members’ activity within it was conducted for this study, but much of this examination had to be done manually. It is possible that I made mistakes in recording the
activity data, and it is also possible that the data I recorded was not a fully accurate representation of students’ and faculty members’ activity. Students’ online activity was only recorded within the LMS environment. The software does not track students’ use of other online technologies (e.g., textbook websites, Facebook and other social media, and faculty member-generated online content).

Finally, this study is limited by the number of variables chosen for the analysis. The study explored students’ LMS activity but did not factor in external pressures that students may face in making choices about using the technology. Multiple factors which could have affected students’ online engagement within the LMS are not accounted for in the research design. Students’ characteristics, such as previous experience with technology and access to the Internet, may have impacted online student engagement (Bhati, Mercer, Rankin, & Thomas, 2009; Hargittai, 2010). The students’ levels of participation may have been affected by factors other than students’ engagement, such as time constraints, external commitments, communication apprehension, or technological difficulties (Normore & Blaylock, 2011). Each of these limitations is addressed in the next section, which proposes future research.

**Future research**

LMS use in campus-based courses is in its infancy, making the opportunities for future research vast. Future work should include exploring research methods in cooperation with proprietary LMS companies. Several different methodologies could be used to further explore the relationship between student engagement and LMS use. The field of learning analytics would benefit from qualitative and mixed-method studies that explore students’ estimates about their behaviour and recorded LMS data. The student engagement measures in use today would benefit from future studies that seek to incorporate the online aspects of the student experience of on-
campus students. Lastly, future studies should explore aggregated institutional data to examine trends in learning patterns and, possibly, in engagement.

This study found different results depending on whether LMS activity was measured using recorded LMS activity or students’ estimates of their LMS activity, which could indicate that the recorded data did not accurately capture students’ true LMS activity. One method of future research that would address the current study’s limitations would be working closely with LMS software companies to develop transparent and efficient ways of extracting data about the links and locations that students select in the LMS course site. If student data could be downloaded as a full report, one showing the history of all actions, the errors potentially produced from manual data collection could be reduced. An accurate history of activity would also be made possible, eliminating errors of omission from changes faculty members make to the site after the course starts.

Future research should continue to explore the relationship between LMS activity and student engagement as measured using student self-report surveys. Several different methodologies which compare student survey results with LMS data are possible. This study examined LMS log data and survey results across several different programs and courses. Being able to access all LMS course sites at one institution would enable a methodology opposite to the one used in this study. Once a student has agreed to participate in the study, faculty members could then give permission to have their LMS site viewed and counted. Capturing all LMS activity across multiple courses for one student would enable the creation of a more robust picture of how a student behaves in the online environments that support their face-to-face courses.

Future studies could collect LMS data from all students in one course so that the faculty member and LMS site remain constant. Another methodology that would help explore the
influence of faculty member LMS use on student engagement would be the collection of LMS data from several sections of a course that is taught by different faculty members; this would allow the comparison of student engagement results and LMS activity across course sections. A third methodology that would examine faculty member influence on student LMS use and student engagement would be the collection of LMS data and survey data from students enrolled in classes whose faculty members are known high users of LMS—that is, faculty members who activate multiple tools and are active participants in discussion forums. This data can then be compared with LMS and survey data collected from students enrolled in classes whose faculty are known minimal users of LMS—that is, faculty members who activate nothing more than the announcement and course content tools. Issues of academic freedom for faculty members using LMS sites will need to be carefully considered in such studies.

I found in this study that faculty members from different academic areas at the college (for example, nursing versus aviation maintenance) made different use of the LMS. An area for future research, similar to what is mentioned above, would be to gather the LMS data from all courses and all students in one program and to compare this LMS activity data with LMS data from all courses and all students in a different program. Studying the LMS activity in the aggregate at a program level would allow for comparisons not only of student use but also of faculty member use. Patterns of LMS use in different academic areas could then be compared. A larger study using LMS data from one academic area or program across multiple institutions would yield valuable data about how that specific academic area makes use of LMS. In each of these cases, LMS data could be paired with student engagement data in order to compare student engagement levels across academic areas.

To date, few studies have attempted to find a relationship between LMS use and student engagement. A major issue in these studies is that each has used a different measure of student
engagement. Future research could administer the NSSE, SEQ, and OSES and collect LMS data in a single study, allowing comparison of the surveys’ different engagement scores with each other and with LMS data. Experimentation with the different measures of student engagement could yield interesting results that may help researchers better understand how LMS activity could potentially be used as a measure of student engagement.

Future studies should explore the development of a survey that could capture online student engagement and the multitude of factors that influence both students’ and faculty members’ LMS use. As an alternative, rather than develop a new tool, researchers could modify current tools to better capture the online experiences of campus-based students. Current measures of student engagement (NSSE, KPIs, and CCSSE) do not fully account for the online aspects of today’s campus environments. The NSSE was initially developed using previous research that had established correlations between certain behaviours and positive student outcomes. Future research using LMS data should focus on student outcomes. What are students doing in their LMS that is producing positive outcomes? An established body of LMS outcomes research could provide a foundation for modifying the NSSE.

The field of learning analytics would benefit from future qualitative and mixed-methods research on LMS. Qualitative studies would enable a more nuanced examination of the motivations for and barriers to participation in LMS environments. Interviews and focus groups could give both faculty members and students opportunities to discuss how issues of technological literacy, access, and course design affect LMS use. Involving students in discussions about how their estimates of their LMS activity compare to recorded data could yield some interesting insights. Qualitative studies could also explore the relationships between students’ perceptions of their engagement, their estimates of how much they use an LMS, and actual recorded behaviour captured by LMS software.
Student engagement can be measured and studied at the micro and macro levels. At the micro level, as in this study, classroom level analysis can capture the engagement activities and cognitive and affective behaviours of individuals. Future studies could be at the macro, or institutional, level of analysis, where measures of student engagement are considered in the realm of quality assurance. Aggregated student LMS data could be used to demonstrate institutional or discipline-specific trends, which may then inform practice. This aggregated course-based data may help faculty and administrators alike gain a better understanding of some aspects of student engagement (Lockyer, Heathcote, & Dawson, 2013). Although these attempts to quantify a small fraction of the student learning experience are still in their early stages, they present important opportunities to initiate discussions about student engagement (Baepler & Murdoch, 2010).

This study used bivariate correlations and one-way analysis of variance to examine the Online SEQ and LMS log data. Because I found differences among different demographic groups of student respondents, a future study should further explore these differences. The unified theory of acceptance and use of technology (UTAUT) asserts that gender and age influence how technology is used. Future research should analyse a large sample of student engagement and LMS data using linear regression in order to further validate the UTAUT model.

Conclusions

This study set out to explore the relationship between LMS activity and student engagement. One semester’s worth of a sample of students’ activity within a college’s LMS (Desire2Learn) was collected and subsequently compared with those students’ responses on the Online Student Engagement Questionnaire (SEQ). The study confirmed that the LMS is an integral part of college life, with the average student logging into the system three times per day. However, students did not take full advantage of all tools within the system. The average student
viewed less than sixty percent of course content pages, and students made very little use of
discussion forums. Tools within the LMS that affected a student’s final grade showed very high
use. Despite the fact that students spent time in the LMS daily, the study found no correlation
between students’ recorded LMS activity and their SEQ scores. Students’ estimates of their LMS
activity proved to be a slightly better indicator of students’ engagement: estimates of their
frequency of reading discussion forum posts, writing original posts, and responding to others’
posts show a positive correlation with overall SEQ score. Analysis of the faculty members’
activity within the LMS revealed that students’ recorded LMS use was not significantly affected
by faculty use. However, I did find that students’ estimates of their discussion activity were
higher in groups of student respondents whose course LMS sites contained discussion forums.

An analysis of the demographic data of student respondents revealed very interesting
results. Female students in the study had higher SEQ scores and showed a higher number of page
visits and quiz attempts than male students. Female students also estimated that they checked
their grades and read and wrote discussion forum posts more often than did male students. I also
found that older students visited more pages and estimated that they read more forum posts than
did younger students. Lastly, non-native English speakers in the study showed higher Online
Social Interaction and Online Academic Relevance scores, logged in more often, and estimated a
higher number of forum posts and replies than native did English speakers. The findings
challenge stereotypes about how female, older, and non-native English speaking students engage
with technology. An LMS could potentially serve as an alternative (and additional) learning
environment in which non-traditional students can find support. Integrating an LMS into a face-
to-face class provides a diversity of opportunities for communication with peers and faculty
members and provides improved access to course content. Alternate modes of interaction and
alternate modes of absorbing course material enable different learners to choose learning modalities that best suit their needs and strengths.

What became clear through this study is that students view their LMS experience globally. Although enrolled in individual courses, they access a broader learning experience when they log in to an LMS. While the current study did not find a relationship between student engagement and recorded LMS activity, future studies may determine a way to collect LMS data on all of a student’s courses and, thus, capture her or his true LMS experience. The finding in this study that students’ estimates of LMS activity have some (though weak) relationship to student engagement suggests that LMS may play some role in engagement.
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