Using Learning Management System Data Logs to Examine Student Interaction with Available LMS Tools and Course Login Frequency

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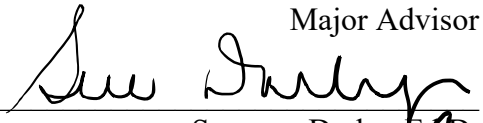

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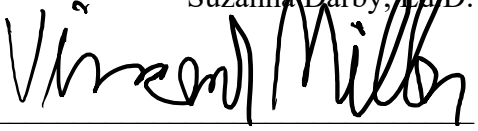

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Abstract

The abundance of data available in Learning Management Systems (LMS) provides an opportunity for objective observation of actions taking place in online courses. However, there is minimal research examining LMS data logs for student behavior in online courses. This quantitative research study used archived data from adult, accelerated online programs at a small, private university in the Midwest to examine student interactions with LMS tools, examine for a difference in graduate and undergraduate student interactions, and review for an association between the number of LMS tools available to students in an online course and the average login frequency. Data were examined from one-year of courses in 11 programs offered in an accelerated, online format geared to adult students**.** Descriptive statistics were used to examine tool interaction; independent samples *t* tests examined for a difference in tool interactions based on degree level; a simple linear regression examined for an association between the number of LMS tools available and average login frequency. The results of the study revealed two of the nineteen tools had no interaction; a statistically significant difference in eight of the seventeen tools with the interaction between graduate and undergraduate students; and a statistically significant association between the number of available LMS tools and students' average login frequency.

Dedication

To my husband, Blake, for supporting and encouraging me on this pursuit. Thank you for dreaming with me.

To my mom, for teaching me bravery and hard-work. Thank you for always believing in me.

To my daughter, Makenna, for your sweet words and hugs. Thank you for the dance parties and teaching me to think differently.

To my son, Harrison, for your patience and snuggles. Thank you for your cooperation as you accompanied me to class for nearly a year and the laughter you bring.

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Chapter One

Introduction

Learning Management Systems (LMSs) held $14 billion of the global market share in 2016, with an expected increase of 22% by 2022 ("Learning Management System," 2017). LMSs created innovation in many areas of education and training: corporate training, K-12 education, and higher education. At higher education institutions specifically, it is common to observe LMS tools (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) in most classroom settings of any format (online, hybrid, or face-to-face) (Dahlstrom, Brooks, & Bichsel, 2014).

Higher education institutions began adopting LMSs in the 1990s, and they quickly took over (Dahlstrom et al. 2014). When 99% of colleges and universities report using LMSs (Dahlstrom et al. 2014), it is clear they have become a part of the expectation of all higher education stakeholders (e.g., students, faculty, accrediting bodies, etc.). What is unclear is the best way to use the data provided by the LMS to improve the learning environment; and the opportunity to use the data to make informed decisions regarding academic policies at higher education institutions (Jo, Park, Yoon, & Sung, 2016; Park & Jo, 2017; Wagner & Ice, 2012).

The rapid increase of this new modality of learning requires new approaches to course design, instruction, and institutional policies (Bach, 2010; Bowen, 2012; Cyrus, 2017; Dahlstrom et al., 2014; Park & Jo, 2017). Without a physical classroom and face-to-face interaction, online instructors should design content and learning activities that

adapt to the new environment; for example, an online instructor may use recorded presentations, synchronous meetings, and lecture capture to deliver content and administer learning activities through discussion forums, collaborative wikis, and assignments. The instructor has to employ new strategies for gauging student comprehension throughout a lesson that reaches beyond the physical classroom's pause for "does anyone have questions thus far?" The increasing number of online programs means higher education administrators now have to consider policies regarding LMSs to ensure quality instruction through and the innovative use of the LMS and appropriate times for interventions to improve students' learning experiences (Bach, 2010; Jo et al., 2016; Park & Jo, 2017). Some policies could include, communication between instructors and students, instructional support through an instructional designer, and common design requirements (e.g., all courses use discussion forums each week, undergraduate courses must include at least four activities each week, etc.).

For the purpose of this study, LMS data logs were reviewed to examine what information can be extracted by instructors, instructional designers, and administrators to evaluate student activity in online courses. The study will look specifically at how often students are interacting with the available LMS tools (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki), if there is a difference in the average student interactions with LMS tools based on degree level (undergraduate versus graduate), and if the number of available tools has any association to how often students log in to online courses. While online course design and the use of LMS tools may differ between course formats (traditional semesters or accelerated terms)

(Salter, 2016), this study focuses on the accelerated format. A traditional semester-long course is often 16 weeks in length, whereas an accelerated course can range from 5 to 12 weeks (Salter, 2016; "What are the Pros and Cons," 2019).

Background

By fall 2016, Babson Survey Research Group reported that over 6.3 million students were taking online courses, a 5.6% increase from fall 2015 (Friedman, 2018). Of the students enrolled in degree-granting postsecondary institutions receiving Title IV federal funding and participating in distance education, 12% of undergraduate students were exclusively online, while 26% of graduate students were enrolled in fully online programs (Fast Facts, 2016). Online enrollment in graduate programs increased by 40% between 2012 and 2017 (Gardiner, 2018). Due to the increase in adult (non-traditional) students in accelerated programs (Miller, 2017), growth of online graduate programs, and emergent need for people with master's degrees in the job market across the United States (Brooks, 2017), it is necessary to better understand LMS tools that work for adult students. Namely, how can the selection of LMS tools increase student interaction and login frequency with online course content (LMS tools), which is known to improve the amount of learning that occurs in a course (Barab, Barnett, Yamagata-Lynch, Squire, & Keating, 2002; Bowen, 2012; Chiang, Yang, & Hwang, 2014; Fink, 2013; Gedera, 2014; Jo, Kim, & Yoon, 2015; Jo et al., 2016; M. Moore, 1997).

At the institution where this research study takes place, there are 11 programs offered in an accelerated, online format geared to adult students. Eight of the programs are at the graduate level, and the remaining three are at the undergraduate level. Classes range from six (undergraduate courses) to seven (graduate courses) weeks. While most

of the programs are asynchronous, two of the graduate programs require a synchronous component. The current online student enrollment in these programs is approximately 670 adult students. The majority of the adult students enrolled in the online programs are located in the Midwest, with under 10% living in other regions of the United States, and two students living internationally.

Activity theory, developed by Vygotsky, established by Leontiev, and advanced further by Engeström (DeVane & Squire, 2012; Nardi, 1996), provides a descriptive lens for what occurs in courses offered via LMSs. The theory presents the idea that all actions of a person (subject) are motivated to resolve an outcome, while also under the influence of external entities (e.g., tools, rules, communities, labor divisions, and objects) (Benson, Lawler, & Whitworth, 2008; Engeström & Miettinen, 1999; Leontiev, 1977; Nardi, 1996). The upper portion of the activity system, including subject-object-tool, is referred to as the action portion of the system and can be viewed and measured externally (Florian, Glahn, Drachsler, Specht, & Gesa, 2011). This portion of the activity system is where this research study focuses because it can be analyzed quantitatively with the data provided by the logs in the LMS (see Figure 3 for the entire activity system and Figure 1 for the portion of the activity system applied to this research study). In the case of this study, students (subject) log in to courses (objects) and interact with LMS tools (tools) to complete course requirements for academic achievement (outcome). Through the lens of activity theory, students' interaction with LMS tools and the average interaction with

LMS tools based on degree level are examined to describe common student behavior and infer future decisions regarding research and policies at the researched institution.

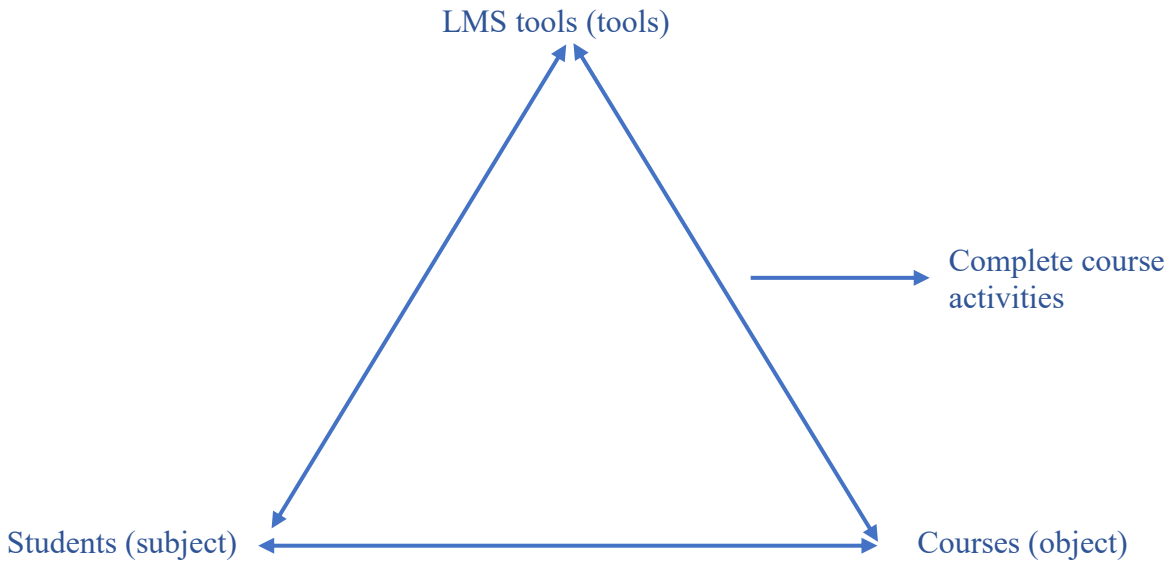

Figure 1. Activity system of LMS interactions. The portion of the activity system as it applies to this research study.

Statement of the Problem

With the LMS becoming a required platform in many higher education classrooms, frustrations with the poor use and limitations of the LMS are growing among online students and instructors (Carvalho, Areal, & Silva, 2011; Ferriman, 2015; Kipp, 2018; Palmer & Holt, 2009). The frustration creates a need for understanding what is happening in online courses (Gedera, 2014; Jo et al., 2015; Jo et al., 2016), which is why the abundance of data obtainable in LMSs provides an opportunity to objectively observe student behavior (Bainbridge et al., 2015; Jo et al., 2016) in these courses through the use of learning analytics and without disrupting the behavior or intruding their privacy (Petropoulou et al., 2010). Most research in higher education involving learning

analytics focuses on retention and increasing enrollments (Biemiller, 2017; Norris, Baer, Leonard, Pugliese, & Lefrere, 2008). The few that investigate how learning analytics can improve instruction or use of the LMS usually focus on at-risk and underserved students rather than all students (Norris et al., 2008; Predictive Analytics, 2013; Wagner & Ice, 2012). Little research examines all students' interaction with LMS tools (Bach, 2010; Park & Jo, 2017). Without face-to-face contact, online instructors often do not know how often students are interacting with course content (LMS tools) (Petropoulou et al., 2010) and accessing courses (logging in) (Jo et al., 2015; Jo et al., 2016). Currently, there are few quantitative research studies reviewing students' interactions with LMS tools and login frequency (Jo et al., 2016; Park & Jo, 2017).

Research conducted in Korea by Park and Jo (2017) and Jo et al. (2016) found that the large amounts of data in the LMS can be used to examine student behavior in online courses and predict future outcomes in the learning environment. Evident through Park and Jo's (2017) research, LMS data logs can be reviewed to find students' interactions with LMS tools and course login frequency, including a comparison of students' degree levels (graduate and undergraduate). However, these studies were conducted at Korean universities with graduate and undergraduate semester-long courses. There is a gap in the research for online, accelerated programs for adult students on how to examine data logs to understand how often students interact with LMS tools, what the average student interaction with LMS tools is based on degree level, and how average login frequency to online courses associated with availability of LMS tools at colleges and universities in the United States.

Park and Jo's (2017) study found that graduate students log in to online courses more often than undergraduate students. As online enrollment continues to grow for graduate and adult populations (Gardiner, 2018) in an accelerated format in the United States (Miller, 2017), it is important to examine if there is a difference in students' average interactions with LMS tools based on degree level (graduate or undergraduate) with United States samples as well.

Although the same research found that graduate courses did not utilize as many of the available LMS tools as undergraduate courses, they did not examine an association between students' average login frequency and the number of LMS tools available to students to further examine the phenomenon (Park & Jo, 2017). It is worthwhile to expand Park and Jo's (2017) research to examine an association between the number of LMS tools available to students and students' average login frequency at a university in the Midwest of the United States offering adult, accelerated programs.

Purpose of the Study

The main purpose of this study is to access the LMS data logs to examine the amount of student interaction with LMS tools available in online courses, which is based on the number of times students select an LMS tool. Another purpose of this study is to examine the data logs for a difference of online undergraduate and online graduate students' average interactions with LMS tools. The final purpose of this study is to examine the data logs for an association between the number of LMS tools available to students in online courses and the students' average login frequency.

Significance of the Study

For far too long, higher education leaders have relied on their instincts to make policy decisions (Long & Siemens, 2011). The growing number of adult online students and programs (Gardiner, 2018), specifically in an accelerated format (Miller, 2017), means higher education leaders are facing decisions regarding policies for teaching adults in an online, accelerated environment (Colson, 2017). It is difficult to develop informed, purposeful policies with little research and understanding of the data to support the decision (Long & Siemens, 2011). The focus of this research study on information available through LMS data logs on student interactions can provide higher education leaders at the institution in this study and similar ones with insight into online student interactions to assist with how to address policies (e.g., attendance policies) involving the use of LMS tools in online, accelerated courses for an adult population.

An important part of teaching is "capitalizing on instruction received" (Skerry, Lambert, Powell, & McAuliffe, 2013, p. 563), which means understanding and responding to what students are doing in their online courses in real time (Petropoulou et al., 2010). Through the use of instantaneous LMS data logs, this research study seeks to increase knowledge on how instructors and instructional designers can use LMS data to examine student activity, especially for adult students, by looking at interactions with LMS tools, comparing the average interactions between degree levels, and average login frequency of adult students in accelerated programs.

Based on the findings of numerous research studies, if instructors can design courses that facilitate more interaction (e.g., student to student, student to content, student to instructor), more learning will occur from the course (Barab et al., 2002; Bowen, 2012;

Chiang et al., 2014; Fink, 2013; Gedera, 2014; M. Moore, 1997). Taking the time to examine adult student interactions with LMS tools, comparing the average interaction by degree level, and the average frequency of adult student logins in association to the available LMS tools in online courses provides the feasible opportunity to understand how to improve the use of LMS tools and online course designs for accelerated degree programs geared to adults. The findings from this study may provide immediate information to online accelerated program instructors and instructional designers at the researched institution, and institutions of similar size offering adult accelerated programs, on how to use LMS data logs to consider students' interaction patterns in online courses.

Delimitations

Lunenburg and Irby (2008) defined delimitations as "self-imposed boundaries set by the researcher on the purpose and scope of the study" (p.134). The following delimitations were identified for this study.

- Only data from accelerated online degree programs with adult students from a Midwestern, private university were used.
- Data were analyzed from February 2018 to March 2019 because the host server deletes data logs after one year.
- Available LMS tools were determined by the LMS chosen by the university.
- Available data were determined by the capability of the university's LMS host server.
- The examination of course grades was not included because Bainbridge et al. (2015) and Arum and Roksa's (2011) research found that grades are insufficient in determining how much a student learns from a course.

Assumptions

Lunenburg and Irby (2008) defined assumptions as the "postulates, premises, and propositions that are accepted as operational for the purpose of the research" (p. 135). The following assumptions were included in this study.

- When students interact with LMS tools, they are doing so intentionally and to complete course requirements as instructed.
- When students log in to an online course, they are accessing course content for learning or completing course activities as intended by the instructor.
- Instructors are utilizing multiple LMS tools in each course.
- Data provided by the Learning Management System are accurate.

Research Questions

RQ1. How often are online adult students interacting with the course tools in the Learning Management System (LMS) (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki)?

RQ2. Is there a difference in the average interaction with the course tools in the LMS (e.g assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) between online undergraduate and online graduate adult students?

RQ3. Is there an association between the number of LMS tools available to online adult students and their average login frequency?

Definition of Terms

Accelerated Format. Courses offered in rolling terms year-round, ranging in length from five to eight weeks.

Adult Student. Sometimes referred to as non-traditional, adult students are often 25 years or older; typically have families to support; are usually employed full-time; undergraduate adult students may have delayed entering college after high school or have taken time off for other responsibilities; and are viewed as having more experience and independence than traditional college students ("Adult Learners," 2019).

Assignment (LMS tool). "The assignment activity module enables a teacher to communicate tasks, collect work and provide grades and feedback" (University Moodle site).

Book (LMS tool). "The book module enables a teacher to create a multi-page resource in a book-like format, with chapters and subchapters. Books can contain media files, as well as text and, are useful for displaying lengthy passages of information which can be broken down into sections" (University Moodle site).

Chat (LMS tool). "The chat activity module enables participants to have text-based, real-time synchronous discussions" (University Moodle site).

Choice (LMS tool). "The choice activity module enables a teacher to ask a single question and offer a selection of possible responses" (University Moodle site).

Course Content. The learning activities, tools, and material that compose the course.

Data Logs. Records kept in learning management systems (LMS) of every occurrence in the LMS. Occurrences include users logging in or out of the LMS,

selecting items within the LMS, submitting or editing assignments, grading assignments or forums, providing feedback, viewing and posting to forums, and adding or removing content.

Interact or Interaction. Each time a user selects a tool (e.g., forum, assignment, file, URL, wiki, etc.) in the learning management system.

Database (LMS tool). "The database activity module enables participants to create, maintain and search a collection of entries (i.e. records). The structure of the entries is defined by the teacher as a number of fields. Field types include checkbox, radio buttons, dropdown menu, text area, URL, picture and uploaded file" (University Moodle site).

External tool (LMS tool). "The external tool activity module enables students to interact with learning resources and activities on other web sites. For example, an external tool could provide access to a new activity type or learning materials from a publisher" (University Moodle site).

Feedback (LMS tool). "The feedback activity module enables a teacher to create a custom survey for collecting feedback from participants using a variety of question types including multiple choice, yes/no or text input" (University Moodle site).

File (LMS tool). "The file module enables a teacher to provide a file as a course resource. Where possible, the file will be displayed within the course interface; otherwise students will be prompted to download it. The file may include supporting files, for example an HTML page may have embedded images or Flash objects" (University Moodle site).

Folder (LMS tool). "The folder module enables a teacher to display a number of related files inside a single folder, reducing scrolling on the course page" (University Moodle site).

Forum (LMS tool). "The forum activity module enables participants to have asynchronous discussions i.e. discussions that take place over an extended period of time" (University Moodle site).

Glossary (LMS tool). "The glossary activity module enables participants to create and maintain a list of definitions, like a dictionary, or to collect and organize resources or information" (University Moodle site).

Learning Analytics. "The measurement, collection, analysis and reporting of data about students and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (*1st International Conference*, 2011, para. 6).

Learning Management System (LMS). A software program that organizes and disseminates information to promote learning, while tracking student activity, instructor feedback, and grades.

LMS tools. A variety of learning tools available in the Learning Management System. For this study using the Learning Management System Moodle, the tools available are assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider (Pearson plug-in), page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki.

Log in. Each time a user accesses a course in the learning management system.

LTI – Pearson plug-in (LMS tool). "Pearson offers integration between Moodle and its MyLab & Mastering products. This integration provides the ability for the instructor and students to log in to Moodle and click a link from a Moodle course to access their MyLab & Mastering experience" (University Moodle site).

Moodle. The learning management system utilized by the university in this study.

Page (LMS tool). "The page module enables a teacher to create a web page resource using the text editor. A page can display text, images, sound, video, web links and embedded code, such as Google maps" (University Moodle site).

Questionnaire (LMS tool). "The questionnaire module allows you to construct surveys using a variety of question types, for the purpose of gathering data from users" (University Moodle site).

Quiz (LMS tool). "The quiz activity enables a teacher to create quizzes comprising questions of various types, including multiple choice, matching, short-answer and numerical" (University Moodle site).

Survey (LMS tool). "The survey activity module provides a number of verified survey instruments that have been found useful in assessing and stimulating learning in online environments. A teacher can use these to gather data from their students that will help them learn about their class and reflect on their own teaching" (University Moodle site).

Turnitin (LMS tool). "Creates a Turnitin Moodle Direct assignment which links an activity in Moodle to an assignment/assignments on Turnitin. Once linked, the activity allows instructors to assess and provide feedback for student's written work using the assessment tools available within Turnitin's Document Viewer" (University Moodle site).

URL (LMS tool). "The URL module enables a teacher to provide a web link as a course resource. Anything that is freely available online, such as documents or images, can be linked to; the URL doesn't have to be the home page of a website" (University Moodle site).

Wiki (LMS tool). "The wiki activity module enables participants to add and edit a collection of web pages. A wiki can be collaborative, with everyone being able to edit it, or individual, where everyone has their own wiki which only they can edit" (University Moodle site).

Organization of the Study

This dissertation is organized into five chapters. The first chapter introduces the background of the study, statement of the problem, the purpose of the study, the significance of the study, delimitations, assumptions, research questions, and definition of terms to provide clarity to terms used throughout the dissertation. "The review of the literature can illuminate every aspect of a research problem" (Lunenburg & Irby, 2008, p. 137), which is presented in the second chapter. The third chapter explains the methodology of the research, participant selection, instrumentation, data collection, and data analysis process. The results of the study, along with the testing of the three research questions, is provided in the fourth chapter. In the fifth chapter, a summary of the study, discussion of the study's findings, and implications of the findings are provided. The final chapter also reports on recommendations for action and future research.

Chapter Two

Review of the Literature

The literature review begins with the history and current state of teaching and learning. Focusing on higher education, the literature revealed some conflicts with technology in the classroom and a mounting need for research on the growing population of adult, or non-traditional, students. As online and distance learning increase in popularity, learning management systems have become universal, while administrators and instructors begin to recognize the effect quality course development and design has on student learning outcomes. To improve the learning environment based on objective data, learning analytics became a key innovation. However, a gap became clear, which this research study seeks to examine: how often adult students interact with available LMS course tools; how students' average interaction with LMS course tools changes based on degree level; and, students' average login frequency based on LMS tools available in online courses. Activity theory provides a lens to review the results of the research study to discover any tensions in the activity system and areas for improvement or future research.

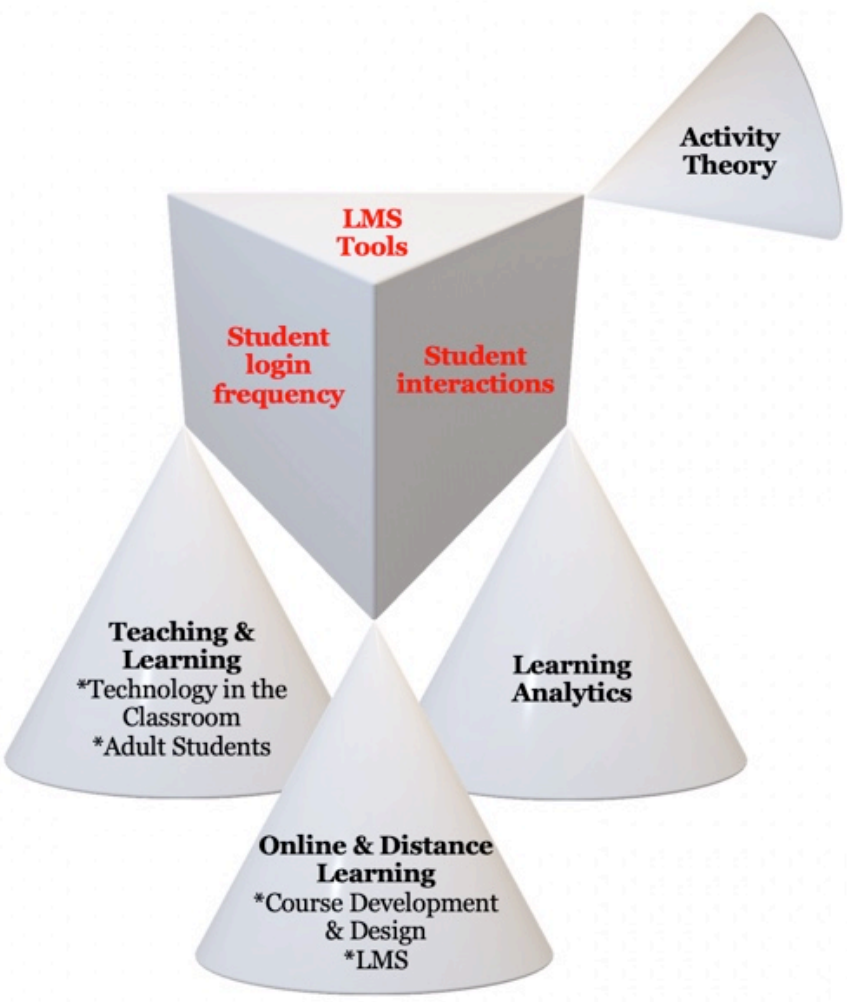

Figure 2. Literature review model. An organization model of the literature review showing the literature that supports the research study.

Introduction

Before the invention of writing, people learned through observation and oral conversation with one another. The development of written language greatly expanded the way learning occurred. As learning modalities increased, the role of educators was introduced. Hippocrates wrote his oath to respect the knowledge that was passed down from generations previous in 400 BC (McPherson, 2015) and, not long after, Socrates

taught others with his probing method of questions and answers (Socrates, 2018). Audiovisual learning tools at the start of the 20th century commenced the modern educational movement. These audiovisual tools led to the start of distance learning (Reiser, 2012). The 21st century is revealing a new transformation in learning with 1:1 device initiatives and learning management systems documenting a student's every move.

Technology has changed educational environments by providing new learning opportunities, expanding collaboration possibilities, and increasing excitement for exploration (Barab et al., 2002). Fink (2013) highlighted that the Industrial Age provided set, structured learning that often meant a sabbatical from work or family; while, the current Information Age pushes lifelong learning with just-in-time content and focuses on students as individuals.

Teaching and Learning

The central act of instruction is when the knowledgeable person actively transmits his or her knowledge to the student; however, what is understood from developmental psychology and the social cognitive theorem is the equally important activity of the student (Forouzesh & Darvish, 2012; Ma, Han, Yang, & Cheng, 2014; Ruiz-Molina, Marin-Garcia, & Llopis-Amorós, 2018; Skerry et al., 2013; Zimmerman, 2000). This new paradigm in education shows the importance of students relating to content rather than only memorizing (Fink, 2013) and that learning is now more social, conversational, and constructive (Jonassen & Land, 2012).

"College has been focused on individual work and social interaction, but the world is becoming a place of collaborative work and social isolation" (Bowen, 2012, p.

228-229). The college classroom must find ways to embrace this change. Increased human interaction in the classroom (e.g., student to student and student to instructor) is shown to increase content knowledge and connections (Bowen, 2012; DeVane & Squire, 2012; Fink, 2013; Gedera, 2014; M. Moore, 1997), as well as learning environments that embrace learning *by doing* along with observing (DeVane & Squire, 2012; Lemke, 1997). Researchers have revealed that regular attendance and increased login frequency in online courses promote student success and learning (Jo et al., 2015; Jo et al., 2016; R. Moore, 2003; Zhang, 2015). "These [participatory learning] environments are intended to support the emergence of activity systems that allow students to extend their understandings" (Barab et al., 2002, p. 77). Chiang et al. (2014) and Lemke (1997) found that a highly interactive environment in any form (e.g., human, content, activities, etc.) increased knowledge as compared to traditional learning strategies. When students connect to the content and understand its application, they are relating at a deeper level (Fink, 2013).

Fink (2013) notes that the two main activities of teaching are designing the course and exchanges with students. Instructors are often well-versed in their exchanges with students but often have little to no training on how to design an effective course for learning (Fink, 2013). An institution's administration team should create an educational environment that stimulates innovation in the classroom. Using technology allows instructors to design an environment that uses growing amounts of resources (Bowen, 2012). Yet, Bowen (2012) argued that innovation does not mean technology; in some ways, it may mean daring to instruct without technology and finding new, unique ways of interaction with the content, fellow students, and the instructor.

Technology and the Classroom. Administrators at colleges and universities are now including a digital learning initiative in their strategic plans, many making it a core initiative (Schaffhauser, 2017). Innovations in technology are often decided at the highest levels of an organization, and then trickled down to the unit (e.g., classroom), ignoring input from the users (e.g., instructor), so these innovations are often unsuccessful in transforming practices. Schaffhauser (2017) found that most administrators believe that "faculty are crucial to the success of digital learning initiatives — serving as both a bolster and a barrier to implementation success," but that "the resources for supporting faculty to implement digital learning are insufficient" (para 6). To increase the success of technology transforming teaching practices, effective professional development and training are necessary. Specifically, training that is relevant to the day-to-day classroom, rather than the idealistic one (Herold, 2015).

Administrators and policymakers view technology as a solution, whereas practitioners find it to be another problem to overcome, only worsened by the lack of input the practitioners had in the decision to require technology in the classroom (Karasavvidis, 2008; Reiser, 2012). The pressure to cover all the curriculum required, especially with the emphasis on assessments and showing learning outcomes, derails instructors' focus on whether students are learning anything about the curriculum. The implementation of technology only exacerbates the problem (Herold, 2015; Karasavvidis, 2008).

Technology has not been fully-embraced by educators in the way it was intentioned (Herold, 2015; Karasavvidis, 2008; Newman, 2017). Professor Emeritus Larry Cuban from Stanford University stated the original hope was that introducing

computers into classrooms would solve issues with traditional instruction and transform education (Herold, 2015). Yet, this still is not happening decades later because of the misutilization of technologies. Educators use technologies as support of familiar practices instead of transforming the classroom and instruction (Herold, 2015; Karasavvidis, 2008; Newman, 2017). Instructors continue to do what they are comfortable with rather than what is best for students. They use technology to enhance their teaching, not reconstruct it to something new (Karasavvidis, 2008). "The student-centered, hands-on, personalized instruction envisioned by ed-tech proponents remains the exception to the rule" (Herold, 2015, p. 8). However, the increase in educational technologies is beginning to show a shift in the look of today's classrooms (Newman, 2017). To expand learning beyond the classroom and increase learning opportunities, educators are mimicking the working environment by creating informal and collaborative workspaces for students (Newman, 2017).

Adult Students. In the past decade, there has been a significant increase in adult students beginning academic programs offered in the accelerated format (Colson, 2017; Long, 2004; Miller, 2017). The reason for the increase is likely due to the adult students' desire to continue to work while going to school, along with other factors, such as family responsibilities (Colson, 2017; Miller, 2017). Adult students are students who hold full-time jobs or other commitments that keep them from enrolling in conventional higher education degree programs (Miller, 2017). Motivations and challenges for adult students are unique to this population of non-traditional students (Jo et al., 2015; Long, 2004). Adult students' motivations are both intrinsic and extrinsic, often influenced by age. Younger adults (29 years old and under) report more extrinsic motivators (e.g., job

requirements, licensure/certification attainment, etc.), whereas older adult students (45 years old and up) report more intrinsic purposes (e.g., service to the community, personal goals, etc.) (Long, 2004). An increase in degree level (undergraduate, masters, and doctorate) shows the same progression from extrinsic to intrinsic motivators. Doctorate students report very high levels of intrinsic motivation to succeed in their coursework (Hinkle, Iarussi, Schermer, Yensel, 2014; Kew, Petsangsri, Ratanaolarn, Tasir, 2018).

Across all ages of adult learners, time management is their leading challenge (Jo et al., 2015), which is why the flexibility of online learning and the accelerated format are attractive (Colson, 2017). Time management is known to predict learning outcomes and student success (Jo et al., 2016). Thus, examining students' login frequency for possible patterns may help to provide information to administrators and instructors about attendance policies that promote learning outcomes.

One trait that helps adult students in the online environment is the reported increased level of self-direction as compared to traditional students (Long, 2004). However, even with the preference of self-directed learning, adult students need instructors who are invested in best practices for teaching adults and, as Long (2004) emphasizes, consider the significant variability of adult students' personal experience and circumstances. This consideration and investment are important because research confirms that instructors play a key role in persistence, retention, and graduation rates for adults (Miller, 2017).

Online and Distance Learning

The option of distance learning eliminates barriers of time and location, allowing students to study in times of convenience. Students selecting the online learning

environment report flexibility, convenience, and accessibility as the root causes of their decision (Clayton, Blumberg, & Anthony, 2018; Kew et al., 2018). In an era where knowledge and skills are necessary for job advancement, distance learning opens up numerous possibilities. Babson Survey Research Group found 5.8 million students have taken at least one online course; and, more than a quarter of enrolled students have taken at least one online course (Cyrus, 2017).

In the increasing number of online courses, the approach to instruction becomes a new challenge and growing concern (Ma et al., 2014). Designing first-rate online courses means creating an experience with multiple and varying interactions that are fluid in a traditional face-to-face setting (e.g., student to student, student to content, student to instructor) (Cyrus, 2017) and well-integrated resources with purposeful instructional guidance (Ma et al., 2014). When the course content and design are more interesting, student motivation levels are increased, which allows for an enhanced learning experience (Kew et al., 2018). Multiple research studies (Bainbridge et al., 2015; Jo et al., 2015; Jo et al., 2016; P. Vu, Cao, L. Vu, & Cepero, 2014; Zhang, 2015) reported that students with less participation in online discussion forums, interaction with course content, or infrequent course logins are more at-risk for failing a course.

The largest issues faculty are raising about online education are quality, support, incentives (Ascione, 2017), time, and curriculum (Karasavvidis, 2008). "Nearly five years ago, 58 percent of professors in a Babson College survey described themselves as having “more fear than excitement” about the growth of online learning; more than 80 percent of academic technology administrators, on the other hand, said they felt more excitement than fear" (Ascione, 2017, para 4). However, quality is not lost in the

growing online classrooms. Over 70% of academic leaders "believe that learning outcomes achieved by online education are equivalent (if not superior) to those found in the face-to-face classroom" (Cyrus, 2017, para 3). With course content and instructional quality being determining factors in online student success, institutions need to provide support for training online instructors, time and assistance in online course development, and examine ways to increase student interaction (Bainbridge et al., 2015).

Course development and design. Higher education institutions have a prime opportunity for individualized learning experiences. Institutions that can offer unique and transformative learning experiences will thrive in the ever-competitive global market of education (Bowen, 2012). To understand the complexity of a student's academic experience and performance, course development and design should be considered. The course design process is growing rapidly in importance due to the rising competition in online education. The purposeful design creates a quality experience for students that is "consistent, engaging, and accessible" (Cyrus, 2017, para 6). A student's engagement level in course content is dependent on beneficial course goals, appropriate course design, and the facilitation of a motivated instructor (Carvalho et al., 2011; Choi & Kang, 2007; Ma et al., 2014). Park and Jo's (2017) research recommended that well-developed policies about the course design and use of the LMS will increase the quality of the pedagogy and overall learning environment.

Faculty and instructors are spending less time lecturing and more time curating resources and creating self-directed learning activities (Bowen, 2012). This transition increases the importance of course design, communication, and facilitation. To motivate students to develop an interest and joy for the course content, instructors must construct

clear goals and plans that elicit interest in the topic (Fink, 2013). The need to have clear goals is especially true for accelerated courses (Salter, 2016). Kew et al. (2018) found that differing instructional techniques and lessons that increase student interest will improve students' focus on the content, which overall, improve student motivation levels. The most effectively designed courses "motivate change…with a combination of high standards and an environment that supports risk and failure" (Bowen, 2012, p. 103).

Cyrus (2017) discusses three steps for quality online courses, including upfront analysis, framework mapping, and student experience. Instructors have to understand how students interact and behave in the online environment (Choi & Kang, 2007) to design a quality course. Benson et al. (2008) emphasized the value in the development of a model or checklist to guide the researcher or practitioner in what to pay attention to when deciding which tool to use. The model or checklist can create a "kind of contextual design space" (p. 458). These new approaches to designing a course mean instructors have to move past traditional teaching strategies.

Bowen (2012) suggests thinking of technology as a means to deliver content rather than relying on traditional lectures and specified class times. Designing a flipped classroom with well-integrated technology (e.g., videos, podcasts, emails with current events connected to course content, etc.) allows for increased interaction and integration during class. This approach to using technology to deliver content in new and unique ways improves face-to-face, hybrid, and online courses. The long lecture has to be disaggregated and redeveloped into digestible bites to avoid cognitive overload resulting in a disengaged student (Cyrus, 2017). A lecture may increase knowledge, but practice and integration are what stimulate learning and change behavior (Bowen, 2012). Lave

(1997) was an early adopter of this approach to learning, noting that a student's ownership of the problem resulted in increased integration levels compared to problems that were owned or fragmented by the instructor or class materials. The course design has to ensure student-driven learning to promote increased knowledge (Bowen, 2012; Choi & Kang, 2007; Jonassen & Rohrer-Murphy, 1999). The best course designs remain simple and provide a variety of activities (Choi & Kang, 2007; Cyrus, 2017; Salter, 2016) that "enable community members to both develop individually and collaboratively construct knowledge" (Choi & Kang, 2007, p. 28).

Learning Management Systems. Another part of the quality course is dependent on the institution's selection and use of a Learning Management System (LMS). The "LMS is an infrastructure that presents and manages the educational content and also determines and evaluates the educational object or individual and organizational study purposes" (Forouzesh & Darvish, 2012, p. 496). Currently, 99% of colleges and universities have adopted LMSs for the classroom (Dahlstrom et al., 2014), along with 86% of business and industry for training (2017 Training Industry Report). An LMS makes this personalized learning approach possible by allowing a student to evaluate his or her learning, receive feedback in real time, store documents for future use, and self-pace the content and assessments (Forouzesh & Darvish, 2012). Overall, students feel that LMSs have a positive impact on their learning (Carvalho et al., 2011; Gedera, 2014; Munoz & Van Duzer, 2005).

Instructional support and training are key to a successful implementation of an LMS, along with student engagement and overall student and instructor satisfaction with the LMS (Carvalho et al., 2011). "If LMSs are to be used to higher levels of engagement

in universities, positively contributing to enhancing student learning, faculty must be supported and encouraged to make better use of the technological tools available" (Carvalho et al., 2011, p. 840). The LMS is a key tool in hybrid and online learning environments. "Humans' social and cultural practices influence the way they use tools and in return their practices are shaped by tools" (Gedera, 2014, p. 44). At this time, there is not significant research analyzing how the use of LMSs are influencing student engagement (Gedera, 2014) or the overall behavior of students in the online environment (Park & Jo, 2017).

Forouzesh and Darvish (2012) state that continuous improvement will show significant changes to LMSs. They predict the structure of the content will remain, while allowing students to create flexible goals; increase participation in the learning by expanding the classroom beyond the students to include people from outside of the classroom; “better personalized evaluation,” (p. 499); improved support for participants, namely instructors; and, increasing and improving the use of the resources currently present in the LMS, like data logs and learning analytics (Forouzesh & Darvish, 2012).

Learning Analytics

Business and industry lead in the application of analytics to predict consumer behavior and improve practices (Wagner & Ice, 2012). Conversely, "public demand in the United States is escalating for colleges and universities to measure, demonstrate, and improve performance and to provide access to this data" (Norris et al., 2008, p. 44). To meet students' needs in today's world, educational institutions must make advances in their technology and learning (Ruiz-Molina et al., 2018) and learning analytics are proving to be the way.

Analytics by itself can be used to produce standardized reports, explain data, forecast, create research ideas, predict behavior, and increase organizational operation (Bainbridge et al., 2015), while learning analytics are used to delineate patterns in students' behavior in online environments so that student learning can be better evaluated and understood (Bainbridge et al., 2015; Jo et al., 2016). Major advances in the data available in LMSs allow for a better observation of students' behavior and interactions. However, data in LMSs remain largely unused to assess student behavioral patterns and performance (Bainbridge et al., 2015); this lack of use is due to the significant difficulties manually mining the vast amounts of data available in LMSs, not to mention that it is time-consuming (Biemiller, 2017; Park & Jo, 2017; Petropoulou et al., 2010; Zhang, 2015). In 2008, Norris et al. reported how overwhelmed institutions are by the amount of data they possess, namely past performance of the institution (e.g., popular courses, etc.), and the underutilization of the knowledge the data could provide; Biemiller (2017) found the challenge is still true nearly a decade later. Nevertheless, "they are starved for actional analyses, especially relating to current and near-future needs" (p. 55). Most institutions focus and do well in the area of technology, but not in the area of analytics. However, for-profit universities have led the way in performance analytics to increase their efficiencies with accelerated programs for adults (Norris et al., 2008).

With the excessive amounts of data now available in LMSs, somehow, institutions have to ascertain how to find meaningful student interaction patterns, navigational performance (Petropoulou et al., 2010), and measure performance through data mining, and then be able to consider ways to take action for improvement (Norris et al., 2008). The use of learning analytics has the opportunity to create a learning

environment that is interactive and dynamic. Applying predictive techniques can anticipate activity and performance in the classroom (Wagner & Ice, 2012). These analytics help to identify at-risk students to initiate intervention tactics that improve student learning in real-time; the earlier the intervention, the better (Lu, Huang, J. C. H., Huang, A. Y. Q., & Yang, 2017) and help instructors understand the behavior and flow of activity of all enrolled students (Petropoulou et al., 2010). While most institutions use learning analytics for recruitment and retention (Norris et al., 2008), it could "provide useful information to instructors by combining and analyzing students' historical data during the course" (Lu et al., 2017, p. 221) and deliver evidential causes for real-time course improvement. Through the use of learning analytics, Casquero, Ovelar, Romo, Benito, and Alberdi (2016) discovered the positive effect it can have on students' academic performance. Lu et al. (2017) found:

> The proposed collaborative programming environment collected students' learning data by recording students' clickstreams [sequence of clicks] during learning activities. With the learning analytics captured by mining clickstream data, the instructors can intervene in students' learning processes. After instructor intervention, students learn to improve their learning by adjusting their behaviors. (p. 223)

An institution has to "stimulate a culture of measurement and improvement" (Norris et al., 2008, p. 45). An analytics-healthy institution can smoothly turn data into analysis, and then into action; using the analytics to drive institutional research and effectiveness. According to Norris et al. (2008), the institution has to incorporate analytics into all aspects of the institution. Decisions regarding technology selections

should be driven by analytics (Wagner & Ice, 2012), otherwise, the value of the new technology will never measure up to the investment made (Norris et al., 2008).

Analytics produce a considerable amount of possible uses. Going beyond recruiting and retention, analytics can be used to improve course organization and development. They have the potential to improve student learning, once they are better understood and data mining becomes manageable for more institutions.

Activity Theory

Activity theory began in the early twentieth century (DeVane & Squire, 2012) and was founded by Russian psychologist, Vygotsky, further developed by A. N. Leontiev, and its roots lie in the works of Karl Marx (Engeström & Miettinen, 1999). The third generation of activity theory, established by Engeström, deepened the theory's focus on specific cultural and historical influences, and expanded the name to Cultural Historical Activity Theory (CHAT) (DeVane & Squire, 2012). Activity theory research is well-established in the former Soviet Union, but the end of the twentieth century showed an increase in the interest of western researchers (Barab et al., 2002; Benson et al., 2008; Engeström & Miettinen, 1999). The theory originated with the mission to improve the effectiveness and efficiency processes in the work setting (Florian et al.., 2011), but by post World War II, activity theory was "applied in research on language acquisition and experimental development of instruction" (Engeström & Miettinen, 1999, p. 2).

Actions, not the results, are the focus of activity theory; and it is descriptive, not predictive (Benson et al., 2008; DeVane & Squire, 2012; Nardi, 1996) of subjects' behavior. Nardi (1996) aptly regarded consciousness as the everyday actions of people, "you are what you do" (p. 7). While Engeström (1999) further characterized this

definition of consciousness by stating that “human activity is endlessly multifaceted, mobile, and rich in variations of content and form” (p. 20), and activity theory is trying to capture the complex relationships occurring within activities by analyzing the interaction between the six components of the model results in an activity, or outcome, (see Figure 3). "Activity theorists are not simply concerned with 'doing' as a disembodied action but are referring to 'doing in order to transform something'" (Barab et al., 2002, p. 78). In essence, how are people’s actions determining the outcome? In reference to the educational setting, DeVane & Squire (2012) clarify that activity theory is "not a learning theory (per se), not an instructional theory, and certainly not an instructional-design theory… [it is used] as a tool for understanding learning, refining instruction, and suggesting directions for instructional design" (DeVane & Squire, 2012, p. 250). The theory provides a guide to looking at a person’s behavior to discover the tensions that arise with the external entities influencing the actions that result in an outcome. Understanding these tensions provides information to influence improvements in the activity system (Engeström & Miettinen, 1999; Florian, Glahn, Drachsler, Specht, & Gesa, 2011).

Leontiev’s (1977) research states there is motivation (e.g., drive, need, etc.) to complete an activity, which is done through a myriad of actions. By completing the actions, an activity is finished, and the motivation is satisfied. “An activity and all the component actions are always realized in specific contexts” (Karasavvidis, 2008, p. 438), determining the ability to successfully complete the activity (e.g., instruments available, rules, etc.). As such, Leontiev (1977) determined that “human activity exists as action or a chain of actions” (p. 8) and “different activities are distinguished by their motives” (p.

6). Activities cannot occur without motivation and are differentiated by the actions that create them. Vygotsky argued that learning is constructed during these motivated activities (Barab et al., 2002). Put another way, the purpose is related to an action, just as motive is to an activity (Leontiev, 1977).

The perspective of activity theorists is that to fully examine and understand an outcome (e.g., learning) all components of the outcome must be considered; specifically reviewing how the components "mediate this transformation" (Barab et al., 2002, p. 79). The theory examines activity within its context; without context, an activity cannot be understood (Jonassen & Rohrer-Murphy, 1999). Studying the tensions that grow among and between the components of an activity develop an understanding of the motivating factors behind the activity system (Barab et al., 2002; DeVane & Squire, 2012; Karasavvidis, 2008). Barab et al. (2002) believe instructors and instructional designers should "exploit systemic tensions, discussing these with students to facilitate their meta-contextual understanding of the learning context" (p. 104-105).

The activity theory is grounded in the argument that learning and doing are intertwined, rather than the idea that learning occurs before doing as many traditional theories emphasize (Barab et al., 2002; Jonassen & Rohrer-Murphy, 1999). Choi and Kang (2007) and Park and Jo's (2017) research proves that students' activity is not static, but constantly changing and reacting to the environment, resulting in contradictions and tensions. In truth, these contradictions are how instructors and instructional designers know where to make improvements in the course design. Choi and Kang (2007) aptly point out how activity theory reveals the evolvement of the learning environment

throughout a course. Yet, they admit it is only the first step in understanding student behaviors.

The students are participants in the learning activities, not merely objects. Activity theory focuses on people as executors of tasks, completing outcomes driven by motivations often influenced by external forces, rather than "creative beings" (Lektorsky, 1999, p. 65), which, as Lektorsky (1999) points out, is frustrating to some people. However, the theory acknowledges that people's behavior is self-determined by creating the stimuli (motivation) that then influences the person's actions (obtaining the goal). The subject (e.g., instructor or student) acts upon the object (e.g., course content, assignments, etc.) to obtain the goal or outcome (e.g., completing the assignment successfully, learning the content, etc.). The tools (e.g., LMS, textbook, etc.) are used to mediate the activity between the subject and object.

Activity theory provides a valuable framework to design student-lead and constructivist learning environments (Jonassen & Rohrer-Murphy, 1999; Park & Jo, 2017). It is flexible enough for an instructional designer to apply the theory pre-implementation for the course design; an instructor to apply during implementation for dynamic course improvements; and a researcher to apply post-implementation for studying what occurred in the learning environment (Benson et al., 2008). The theory has proven to be a powerful tool in distinguishing the conflicts and experiences students and instructors have in technology-supported learning environments (Barab et al., 2002; Choi & Kang, 2007; Gedera, 2014; Jonassen & Rohrer-Murphy, 1999; Karasavvidis, 2008; Park & Jo, 2017).

For learning to occur, activity must be present. Activity theory supports that knowledge is acquired through cultural, social, historical, and environmental influences, rather than the traditional transfer of knowledge between people (Nardi, 1996); and it can help to identify what or who is directing the learning (student, instructor, object, etc.). In the case of Barab et al. (2002), they found their believed teacher-directed learning was actually object-directed. The tensions found between the components of outcomes drive changes to course instruction and curriculum, along with what objects and instruments should be used and improvements to rules and divisions of labor. Gedera's (2014) research focused on how instruments, specifically LMSs, mediate the relationship between the subject and object, which affects the overall outcome of the activity system. The students' interaction with course activities was influenced by the LMS, viewed through the participant-tool-object relationship of the activity theory framework.

With many studies using qualitative or mixed methods to research the use of LMSs across higher education (Barab et al., 2002; Benson et al., 2008; Choi & Kang, 2007; Karasavvidis, 2008), the collected data were limited to response rates and attitudes. By mining the large dataset directly from the LMS, Park and Jo (2017) could analyze the specific actions of students in the course environment. They found that many of the available tools in the LMS were underused, and the design of most courses had little diversity in the usage of tools. Most instructors used the LMS for communication and sharing resources. However, the required courses did contain more tools than elective courses. In addition, the researchers found that students logged in more often when they were enrolled in prerequisite courses as opposed to major courses.

Vygotsky observed the mediating tools as something that broadened the subject's activity beyond the scope of a direct line to the object. The additional influences acted as stimuli to mediate the subject's actions, and thus, observing the interaction between tools and subjects allow for a better understanding of future activities (DeVane & Squire, 2012). New outcomes are produced when introducing new tools, modifying rules and expectations, or modifying divisions of labor (Barab et al., 2002; Engeström, 1999). Engeström (1999) refers to these changes as the mediation of external tools and other stimuli (e.g., community, rules, etc.) that are not otherwise internally driven. Change, or new outcomes, do not have to be internally driven; they can occur from external forces. The external influences act as stimuli to mediate a subject's actions, and consequently, observing the interaction between tools and subjects allows better understanding of future activities (DeVane & Squire, 2012). When considering the LMS and the design of a course (e.g., tools used) these are external stimuli mediating the learning process for the student. Leontiev (1977) discovered that external influences are determined by the interpretations of the subject's actions. "Attention is concentrated on the fact that external causes act through the medium of internal conditions" (p. 2). Thus, the actions of students in the LMS environment are affected by the 'internal conditions' of the student and how the student interprets the LMS tools. The process of acknowledging the external environment (e.g., LMS) and reacting accordingly creates the student's activities.

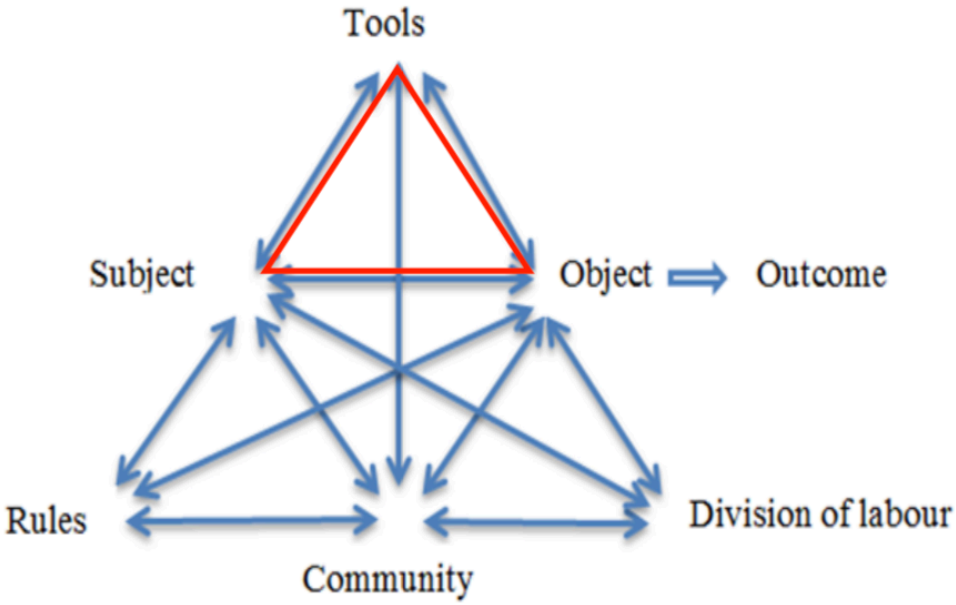

Figure 3. Engeström's model of the activity system. Developed by Engeström, this basic structure of an activity system shows the six interacting components involved in an activity with the original activity system introduced by Leontiev highlighted (Gedera, 2014).

Summary

Data logs are proving to be a key source of information to what is occurring in courses using LMSs. However, understanding what the data logs are saying creates its own unique challenge. When examining the actions of the students in an LMS through data logs and without access to internal motivations, activity theory becomes an appropriate framework. The use of learning analytics is necessary to inform the decisions made regarding the LMS and online learning environment.

Chapter Three

Methods

The purposes of this study were to access LMS data logs to examine student interactions with available LMS tools; examine the logs for a difference in the average interactions with LMS tools based on degree level (undergraduate and graduate); and examine the logs for an association between the number of available LMS tools and students' average login frequency in online courses. This chapter includes a summary of the research design, population and sampling procedures, research measurement, data collection procedures, data analysis, hypothesis testing, and limitations.

Research Design

A quantitative research design was used in this study. Particularly, a cross-sectional descriptive research method was used to measure the difference between the quantitative variables available from archived course data in the Moodle LMS. According to Lunenburg and Irby (2008), a descriptive study looks to "describe phenomena in our world" (p. 30), and these studies, "provide the impetus for many other research studies" (p. 31).

The five variables assessed in the study were the frequency of all online students' interaction with (selection of) LMS tools, the mean of online graduate students interaction frequency with LMS tools, the mean of online undergraduate students interaction frequency with LMS tools, the number of available LMS tools in an online course (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki), and students' average login frequency.

Selection of Participants

The population for this study were all adult students enrolled in the 11 online, accelerated programs at a small, private Midwestern university. The convenience sampling (i.e., availability sampling) technique was employed based on the constraints of the data storage provided by the host of the LMS server, which stores one year of data in total. Participants were selected based on their enrollment from February 2018 to March 2019 in the courses offered in the institution's eight graduate online, accelerated degree programs in education, business, and liberal arts and three undergraduate online, accelerated degree programs in business. The sample includes approximately 455 graduate adult students and 215 undergraduate adult students living mainly in the Midwest, with under 10% living in other regions of the United States, and two international students. Only accelerated, online courses were selected to ensure all courses analyzed were as similar in nature as possible.

Measurement

Online adult students interacting with the course tools was measured by the frequency of adult student LMS tool interactions. More specifically, this frequency is measured by accumulating the number of times a student selects (clicks) on a tool in Moodle. For example, if students selected a weekly discussion forum 225 times in the course, a measurement of 225 was recorded for the forum tool in Moodle for the course.

The mean of online graduate and online undergraduate adult student interaction with LMS tools was measured by calculating the mean of the number of student interactions with each available LMS tool. Each tool (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider,

page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) was calculated individually. For example, if an undergraduate course had 10 students enrolled and 954 interactions with forums, a mean of 95.4 was recorded for the forum tool interaction.

The number of tools available to students in each course was measured by how many tools are available per course. Each tool was calculated individually. For example, if a course had two forums, one assignment, and three articles in portable document format (PDF) each week of the seven-week course, and three quizzes throughout the course, a record of 45 tool instances were documented for the course.

Students average login frequency was measured by calculating the mean of login frequency of each student enrolled in a specific course. For example, if a course with three enrolled students had one student access a course page 587 times over the duration of a course, another student access a course page 702 times, and a third student access a course page 439 times, the average student login of 576 was recorded for the student login frequency in the course.

Data Collection Procedures

An Institutional Review Board (IRB) form was prepared and submitted on March 7, 2019 for Baker University's approval prior to data collection. This study was designated exempt based on the archival data and minimal threat to subjects, and then approved on March 8, 2019. After IRB permission was obtained, the researcher developed and implemented a plan with the LMS administrator at a small, private Midwestern university and the company that hosts the institution's LMS server to collect the archival course log data from February 2018 to March 2019 for the adult, accelerated programs. Data were collected for RQ3 on March 11, 2019 for 512 courses; for RQ1 and

RQ2, data were collected on March 21, 2019 for 669 courses. The difference in the number of courses available for the research questions is based on the course terms available at the time of the pulled data. Student names were replaced with a unique, unidentifiable number. Data were stored electronically on a two-step authenticated password-protected cloud server only accessible by the researcher. Data will be deleted five years after the research completes.

Data Analysis and Hypothesis Testing

RQ1. How often are online adult students interacting with the course tools in the Learning Management System (LMS) (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki)?

A descriptive analysis was conducted to test RQ1. The total frequency of online adult students' interactions with LMS tools (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) was calculated.

RQ2. Is there a difference in the average interaction with the course tools in the LMS (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) between online undergraduate and online graduate adult students?

***H2*.** Graduate adult students will interact with LMS tools differently than undergraduate students.

An independent samples *t* test was conducted to test RQ2 for each of the 19 LMS tools. The mean of online graduate student interactions with each LMS tool was

compared to the mean of online undergraduate student interactions with each LMS tool. The level of significance was set at .05.

RQ3. Is there an association between the number of LMS tools available to online adult students and their average login frequency?

H3. The average frequency of adult student logins changes based on the LMS tools available in the course.

A simple linear regression was conducted to examine the relationship between the number of LMS tools available and students' average login frequency. A one sample *t* test was conducted to test for the statistical significance of the slope. The level of significance was set at .05.

Limitations

This study investigated data collected from one small, private Midwestern university from online courses offered from February 2018 to March 2019, and the data were extracted from the LMS, Moodle, which may skew the generalizability and scope of the study. The data were collected through structured query language (SQL) developed by the company hosting the LMS server for the institution, and then validated by the researcher and institution's LMS administrator. This study did not control for policy changes in the use of the LMS or course and programs evaluations that may have resulted in changes to the availability of LMS tools.

Summary

This exploratory research study examined students' interaction with LMS tools and average student login frequency in association with available LMS tools. The research design, selection of the population, methods of data measurement, procedures of

data collection, data analysis, hypothesis testing, and limitations were provided in detail. In the following chapter, the study's results are presented.

Chapter Four

Results

The main purpose of this study was to access the LMS data logs to examine the amount of student interaction with LMS tools available in online courses, which is based on the number of times students select an LMS tool. Another purpose of this study was to examine the data logs for a difference of online undergraduate and online graduate students' average interactions with LMS tools. The final purpose of this study was to examine the data logs for an association between the number of LMS tools available to students in online courses and the students' average login frequency. Chapter four presents the results of the hypothesis testing that addressed the three research questions in this study.

Descriptive Statistics

The number of courses examined for student interaction with tools was 669 courses, of which 394 were at the graduate level and the remaining 275 were undergraduate. The data for reviewing average login frequency in association with the number of course tools included 512 courses. Due to the real-time data used in this research study, the available courses for the research questions were determined by the date pulled from the LMS. The available tools that were examined were assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider (Pearson plug-in), page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki.

Hypothesis Testing

The research questions are presented separately followed by the associated hypothesis, type of analysis performed, and the results of the hypothesis testing.

RQ1. How often are online adult students interacting with the course tools in the Learning Management System (LMS) (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki)?

A descriptive analysis was conducted to test RQ1. The total frequency of online adult students' interactions with LMS tools (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) was calculated. Three of the nineteen tools (assignment, file, and forum) had more than 100,000 interactions in a year, while two revealed no interactions (external tool and Turnitin).

Table 1

Total Student Interactions with LMS Tools

LMS Tool name	Total views of tool (669 courses)
Assignment	425,018
Book	1,621
Chat	1,506
Choice	4,215
Database	73
External Tool	0
Feedback	1,449

File	137,664
Folder	19,527
Forum	1,624,475
Glossary	9,640
LTI (Pearson plug-in)	29,485
Page	41,145
Questionnaire	1,065
Quiz	37,245
Survey	41
Turnitin	0
URL	69,289
Wiki	7,463

Note. Data on total student interaction with available LMS tools for 669 courses was collected on March 21, 2019 from a Moodle report at the researched institution. All online graduate and undergraduate accelerated, adult program courses from February 2018 to March 2019 were included.

RQ2. Is there a difference in the average interaction with the course tools in the LMS (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki) between online undergraduate and online graduate adult students?

***H2*.** Graduate adult students will interact with LMS tools differently than undergraduate students.

An independent samples *t* test was conducted to test RQ2 for each of the 19 LMS tools. The mean of online graduate student interactions with each LMS tool was compared to the mean of online undergraduate student interactions with each LMS tool. The level of significance was set at .05.

Based on the analysis of RQ1, no results were available for the external tool and Turnitin interactions. No further analysis was conducted on the external tool or Turnitin for RQ2 because no data were found.

For the assignment tool, outliers were detected, and eight outliers were found. The outliers were excluded from the following analysis. The results of the independent samples *t* test indicated no difference between the two means of assignment interaction in graduate and undergraduate courses, $t(659) = -.982$, $p = .327$. The mean of the assignment interaction for graduate courses ($M = 533.11$, $SD = 404.12$, $n = 387$) was not different from the assignment interaction mean for undergraduate courses ($M = 564.12$, $SD = 394.33$, $n = 274$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the assignment tool.

For the book tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of book interaction in graduate and undergraduate courses, $t(393.36) = 2.889$, $p = .004$, $d = .29$. The mean of the book interaction for graduate courses ($M = .23$, $SD = 1.53$, $n = 394$) was significantly higher than the mean book interaction for undergraduate courses ($M = .004$, $SD = .03$, $n = 275$). The hypothesis was supported. Graduate students

interact with the book tool more often than undergraduate students. The effect size indicated a medium effect.

For the chat tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of chat interaction in graduate and undergraduate courses, $t(405.21) = 2.12$, $p = .03$, $d = .21$. The mean of the chat interaction for graduate courses ($M = .40$, $SD = 3.22$, $n = 394$) was significantly higher than the mean chat interaction for undergraduate courses ($M = .06$, $SD = .34$, $n = 275$). The hypothesis was supported. Graduate students interact with the chat tool more often than undergraduate students. The effect size indicated a small effect.

For the choice tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of choice interaction in graduate and undergraduate courses, $t(426.89) = -2.54$, $p = .011$, $d = .25$. The mean of the choice interaction for graduate courses ($M = .37$, $SD = 1.42$, $n = 394$) was significantly lower than the mean choice interaction for undergraduate courses ($M = .76$, $SD = 2.24$, $n = 275$). The hypothesis was supported. Graduate students interact with the choice tool less often than undergraduate students. The effect size indicated a small effect.

For the database tool, outliers were tested and not found. The Levene's test was significant, $p = .018$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated no difference between the two means of database

interaction in graduate and undergraduate courses, $t(393) = 1.41$, $p = .160$. The mean of the database interaction for graduate courses ($M = .02$, $SD = .26$, $n = 394$) was not different from the database interaction mean for undergraduate courses ($M = .00$, $SD = .00$, $n = 275$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the database tool.

For the feedback tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of feedback interaction in graduate and undergraduate courses, $t(460.05) = 2.67$, $p = .008$, $d = .25$. The mean of the feedback interaction for graduate courses ($M = .26$, $SD = 1.58$, $n = 394$) was significantly higher than the mean feedback interaction for undergraduate courses ($M = .04$, $SD = .39$, $n = 275$). The hypothesis was supported. Graduate students interact with the feedback tool more often than undergraduate students. The effect size indicated a small effect.

For the file tool, outliers were detected, and 44 outliers were found. The outliers were excluded from the following analysis. The Levene's test was significant, $p = .005$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated no difference between the two means of file interaction in graduate and undergraduate courses, $t(603.77) = 1.64$, $p = .102$. The mean of the file interaction for graduate courses ($M = 15.19$, $SD = 14.19$, $n = 359$) was not different from the file interaction mean for undergraduate courses ($M = 13.43$, $SD = 12.54$, $n = 266$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the file tool.

For the folder tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of folder interaction in graduate and undergraduate courses, $t(518.79) = 3.35$, $p = .001$, $d = .29$. The mean of the folder interaction for graduate courses ($M = 2.96$, $SD = 9.44$, $n = 394$) was significantly higher than the mean folder interaction for undergraduate courses ($M = 1.24$, $SD = 3.28$, $n = 275$). The hypothesis was supported. Graduate students interact with the folder tool more often than undergraduate students. The effect size indicated a small effect.

For the forum tool, outliers were detected, and 11 outliers were found. The outliers were excluded from the following analysis. The Levene's test was significant, $p = .003$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated no difference between the two means of forum interaction in graduate and undergraduate courses, $t(621.96) = .230$, $p = .818$. The mean of the forum interaction for graduate courses ($M = 200.36$, $SD = 171.71$, $n = 386$) was not different from the forum interaction mean for undergraduate courses ($M = 197.43$, $SD = 152.56$, $n = 272$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the forum tool.

For the glossary tool, outliers were tested and not found. The results of the independent samples *t* test indicated no difference between the two means of glossary interaction in graduate and undergraduate courses, $t(667) = -.39$, $p = .697$. The mean of the glossary interaction for graduate courses ($M = 1.22$, $SD = 7.22$, $n = 394$) was not different from the glossary interaction mean for undergraduate courses ($M = 1.45$, $SD =$

7.74, n = 275). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the glossary tool.

For the LTI (Pearson plug-in) tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples t test indicated a statistically significant difference between the two means of LTI (Pearson plug-in) interaction in graduate and undergraduate courses, $t(545.20) = -4.29$, $p < .001$, $d = .37$. The mean of the LTI (Pearson plug-in) interaction for graduate courses (M = 2.61, SD = 8.31, n = 394) was significantly lower than the mean LTI (Pearson plug-in) interaction for undergraduate courses (M = 5.61, SD = 9.32, n = 275). The hypothesis was supported. Graduate students interact with the LTI (Pearson plug-in) tool less often than undergraduate students. The effect size indicated a medium effect.

For the page tool, outliers were tested and not found. The results of the independent samples t test indicated no difference between the two means of page interaction in graduate and undergraduate courses, $t(667) = -1.06$, $p = .290$. The mean of the page interaction for graduate courses (M = 5.14, SD = 13.92, n = 394) was not different from the page interaction mean for undergraduate courses (M = 6.20, SD = 10.88, n = 275). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the page tool.

For the questionnaire tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples t test indicated a statistically significant difference between the two means of questionnaire interaction in graduate and undergraduate courses, $t(430.20) =$

3.24, $p = .001$, $d = .31$. The mean of the questionnaire interaction for graduate courses ($M = .20$, $SD = 1.13$, $n = 394$) was significantly higher than the mean questionnaire interaction for undergraduate courses ($M = .013$, $SD = .207$, $n = 275$). The hypothesis was supported. Graduate students interact with the questionnaire tool more often than undergraduate students. The effect size indicated a small effect.

For the quiz tool, outliers were tested and not found. The Levene's test was significant, $p < .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated a statistically significant difference between the two means of quiz interaction in graduate and undergraduate courses, $t(473.86) = -4.03$, $p < .001$, $d = .37$. The mean of the quiz interaction for graduate courses ($M = 3.83$, $SD = 8.25$, $n = 394$) was significantly lower than the mean quiz interaction for undergraduate courses ($M = 7.03$, $SD = 11.19$, $n = 275$). The hypothesis was supported. Graduate students interact with the quiz tool less often than undergraduate students. The effect size indicated a medium effect.

For the survey tool, outliers were tested and not found. The Levene's test was significant, $p = .017$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated no difference between the two means of survey interaction in graduate and undergraduate courses, $t(274) = -1.00$, $p = .318$. The mean of the survey interaction for graduate courses ($M = .00$, $SD = .00$, $n = 394$) was not different from the survey interaction mean for undergraduate courses ($M = .01$, $SD = .21$, $n = 275$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the survey tool.

For the URL tool, outliers were tested and not found. The results of the independent samples *t* test indicated no difference between the two means of URL interaction in graduate and undergraduate courses, $t(667) = -.81$, $p = .420$. The mean of the URL interaction for graduate courses ($M = 9.27$, $SD = 15.85$, $n = 394$) was not different from the URL interaction mean for undergraduate courses ($M = 10.41$, $SD = 20.92$, $n = 275$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the URL tool.

For the wiki tool, outliers were tested and not found. The Levene's test was significant, $p = .001$, so the degree of freedom was adjusted. The results of the independent samples *t* test indicated no difference between the two means of wiki interaction in graduate and undergraduate courses, $t(526.61) = 1.87$, $p = .063$. The mean of the wiki interaction for graduate courses ($M = 1.55$, $SD = 9.94$, $n = 394$) was not different from the wiki interaction mean for undergraduate courses ($M = .53$, $SD = 3.58$, $n = 275$). The hypothesis was not supported. Graduate and undergraduate students interact the same amount with the wiki tool.

Table 2

Descriptive Statistics of Average Tool Interaction in Graduate and Undergraduate Courses

	Graduate		Undergraduate		
LMS Tool	Mean	Standard Deviation	Mean	Standard Deviation	Significance level
Assignment	533.11	404.12	564.12	394.33	.327
Book	.23	1.53	.004	.028	.004
Chat	.40	3.22	.06	.34	.034
Choice	.37	1.42	.76	2.24	.011

Database	.02	.26	.00	.00	.160
Feedback	.26	1.58	.04	.39	.008
File	15.19	14.19	13.43	12.55	.102
Folder	2.96	9.44	1.24	3.28	.001
Forum	200.36	171.71	197.43	152.56	.818
Glossary	1.22	7.22	1.45	7.74	.697
LTI (Pearson)	2.61	8.31	5.61	9.32	< .001
Page	5.14	13.92	6.20	10.88	.290
Questionnaire	.20	1.13	.01	.21	.001
Quiz	3.83	8.25	7.03	11.19	< .001
Survey	.00	.00	.01	.21	.318
URL	9.27	15.85	10.41	20.92	.420
Wiki	1.55	9.94	.53	3.58	.063

Note. SPSS output examining the difference in average LMS tool interaction between graduate and undergraduate online students. Data were collected on March 21, 2019 from the researched institution and includes seventeen available LMS tools.

RQ3. Is there an association between the number of LMS tools available to online adult students and their average login frequency?

H3. The average frequency of adult student logins changes based on the LMS tools available in the course.

A simple linear regression was conducted to examine the relationship between the number of LMS tools available and students' average login frequency. A one sample *t*

test was conducted to test for the statistical significance of the slope. The level of significance was set at .05.

A simple linear regression was conducted to examine the association between the number of available course tools and average course login frequency. Outliers were detected and 49 outliers were found. The outliers were excluded from the following analysis. The results of the simple linear regression revealed that a statistically significant regression equation was found, $F(1, 461) = 37.51$, $p < .001$, $R^2 = .075$. Therefore, there was a significant association between the number of available course tools and average course login frequency, $B = 1.92$, $t(461) = 6.124$, $p < .001$. The number of available course tools explained a significant proportion of the variance (7.5%) in the average course logins, as for each additional tool available in a course, the average logins increased 1.92 additional logins.

Summary

The fourth chapter included the data analysis, hypothesis testing, and results for the three research questions. RQ1 results found three of the nineteen available tools (assignment, file, and forum) resulted in more than 100,000 interactions, while two of the available tools (external tool and Turnitin) produced zero results; RQ2 results showed eight of the seventeen available tools (book, chat, choice, feedback, folder, LTI plug-in, questionnaire, and quiz) had a significant difference in average interaction between graduate and undergraduate courses; and RQ3 results suggested a significant association between the number of available course tools and average student login frequency. In the next chapter, a summary of the study, including an overview of the problem, a review of the methodology, and major findings are discussed. Additionally, chapter five contains

related literature to the findings, implications for action, future research recommendations, and conclusions.

Chapter Five

Interpretation and Recommendations

Business and industry, along with healthcare, have led the way in how big data can inform decision-making across an organization (Wagner & Ice, 2012). Education is beginning to adapt to this trend of reviewing large amounts of quantitative data for information (Bainbridge et al., 2015). The research Jo et al. (2016) and Park and Jo (2017) conducted at a Korean institution examining student interaction with available LMS tools and average student login frequency discovered useful information regarding graduate and undergraduate interaction with tools and login frequency. Their research conveyed a need for similar research to be conducted at an institution in the United States.

Study Summary

A summary of the current study is provided in this section. A problem overview is included about the lack of research examining the LMS data logs for student interaction with LMS tools and course login frequency. The purposes of the study, research questions, and methodology are reviewed. Lastly, the major findings of the data analysis are described.

Overview of the problem. A growing interest in online education (Friedman, 2018) increases the need for current research on the topic. With most higher education institutions relying on LMSs to deliver online courses (Dahlstrom et al., 2014; "Learning Management System," 2017), it is useful to employ research with the data provided intuitively by the LMS. The majority of the current research surrounding online education is focused on retention, recruitment, and at-risk students (Biemiller, 2017;

Norris et al., 2008; Predictive Analytics, 2013; Wagner & Ice, 2012), while very little research evaluates the behavior of all students enrolled in online courses to better understand how students are interacting and logging in to the online environment (Bach, 2010; Park & Jo, 2017). Because the type of research conducted in the present study had only been conducted at a Korean institution with traditional semester-long courses (Jo et al., 2016; Park & Jo, 2017), a clear gap surfaced in how the research would apply to a private university in the Midwest with accelerated courses for adult students.

Purpose statement and research questions. Three purposes were the focus of the current study. The first purpose of this study was to access the LMS data logs to examine how often students were interactive with the LMS tools available in online courses. The second purpose of this study was to examine the same data logs for a difference in online graduate and online undergraduate students' average interactions with LMS tools. The third and final purpose of this study was to examine the LMS data logs for how the number of LMS tools available to students in online courses may have associated with students' average login frequency. Three research questions were developed to address each of the three purposes influencing the current study.

Review of the methodology. A quantitative cross-sectional descriptive research method was used to examine the archival data from the LMS in this study. A descriptive analysis was used for RQ1. An independent samples *t* test was used to examine RQ2's independent variable, graduate and undergraduate courses, and the dependent variable, average interaction, with each LMS tool. Though 19 tools were included in RQ2, the results of the RQ1 analysis included no data for two of the LMS tools; thus, only 17 tools were tested for RQ2. A simple linear regression was used to examine RQ3, with the

number of available course tools as the independent variable and average login frequency for the dependent variable.

Major findings. The results of the data analysis for RQ1 included evidence that forum has the highest level of interaction far above every other LMS tool, with assignment next in line with over a million fewer interactions. The next two highest tools after assignment are file and URL. It was also revealed that the external tool and Turnitin had no interactions in this data set.

Eight of the seventeen tools included in the RQ2 data analysis revealed a statistically significant difference in average interactions between graduate and undergraduate courses: book, chat, choice, feedback, folder, LTI provider (Pearson plug-in), questionnaire, and quiz. Graduate course average interaction with book, chat, feedback, folder, and questionnaire was higher than undergraduate courses, while undergraduate courses had a higher interaction with choice, LTI provider, and quiz. The hypothesis for RQ2 was supported by these eight tools. The remaining nine tools did not reveal a statistically significant difference in the interaction with the tools between graduate and undergraduate courses (assignment, database, file, forum, glossary, page, survey, URL, and wiki).

The simple linear regression conducted for RQ3 revealed a statistically significant result in the number of available LMS tools and average student login. The average number of LMS tools available in a course was 76.7 tools (calculated by totaling each tool instance in a course). The variance of 7.5% in average login frequency was explained by the number of available tools in an online course. For each tool added to a

course, there was an average of 1.92 additional student logins. Therefore, the hypothesis for RQ3 was supported.

Findings Related to the Literature

Students are no longer passive participants in today's learning environment (Forouzesh & Darvish, 2012; Ma, Han, Yang, & Cheng, 2014; Ruiz-Molina, Marin-Garcia, & Llopis-Amorós, 2018; Skerry et al., 2013; Zimmerman, 2000). Learning and doing are interwoven (Barab et al., 2002; Jonassen & Rohrer-Murphy, 1999), especially in the online classroom. At a basic level, online students have to engage in course activities to verify attendance. As the shift to collaborative work environments continues, the education environment must simulate the change by creating collaborative and interactive courses (Barab et al., 2002; Bowen, 2012; DeVane & Squire, 2012; Fink, 2013; Gedera, 2014; M. Moore, 1997). One way to verify online course interaction and engagement levels is to examine LMS data logs for student interactions and login frequency.

Fink (2013) noted that today's learning is just-in-time for students' needs, while Bainbridge et al. (2015) and Jo et al. (2016) reveal how learning analytics provide just-in-time data analysis opportunities in the classroom for instructors, instructional designers, and administrators. Researchers also argue that the data provided by LMSs are still largely unexploited or misunderstood (Bainbridge et al., 2015). Though, the argument also includes the acknowledgment that the amount of data available is overwhelming and time-consuming to ingest and prepare for research (Biemiller, 2017; Norris et al., 2008; Park & Jo, 2017; Petropoulou et al., 2010; Zhang, 2015); the same challenges were true for the current study. However, the current study's researcher and university's LMS

manager were able to establish a plan and method for collecting manageable data reports to store for future research on this topic.

Researchers using learning analytics have discovered the importance of increased interaction in any form (student-to-student, student-to-instructor, and student-to-content) to improve students meeting course outcomes (Chiang et al., 2014; Lemke, 1997). Park and Jo (2017) decided to examine how students were interacting with courses and LMS tools at a Korean university. The researchers discovered that most courses did not offer a diverse set of LMS tools and that the LMS was used more as a repository of information than an interactive course system. The lack of diversity in the LMS tools used in the courses may be explained by instructors using the tools they are comfortable with rather than venturing to new and more applicable tools (Herold, 2015; Karasavvidis, 2008). This instructional practice could also partially explain why the current study only found three of nineteen tools with more than 100,000 interactions over the course of a year.

Additionally, Park and Jo (2017) discovered that undergraduate students were more active in their interaction with tools as compared to graduate students. However, the current study results reflect that the majority of the statistically significant results comparing graduate and undergraduate tool interaction possessed higher interaction from graduate students.

The finding of the current study regarding higher interaction from graduate students for five of the eight statistically significant results may be partially explained by the motivation levels reported for the highest degree levels (masters and doctorate) versus the lower degree levels (associates and bachelors) (Hinkle et al., 2014; Kew et al., 2018). The older the student and higher the degree level report more intrinsic motivation to learn

rather than the extrinsic motivators influencing the younger students and lower degree levels (Hinkle et al., 2014; Kew et al., 2018), likely resulting in increased tool interaction for these students. Nevertheless, little research examines specific tool interactions for different degree levels, which suggests a need for future research on this topic.

Other research using learning analytics in an education environment showed that increased login frequency in online courses enriched student learning (Jo et al., 2015; Jo et al., 2016; R. Moore, 2003; Zhang, 2015). Examining the data logs from LMS courses at a university in Korea, Park and Jo (2017) discovered that graduate students log into courses more often than undergraduate students. What was missing from these research studies was an examination of ways to increase login frequency for online students. The current study explored this area and provided some evidence to show that the number of available LMS tools might have an impact on login frequency. Courses in the current study had an average of 76.7 LMS tool instances for the six- and seven-week courses, which is calculated by totaling each tool placed in a course (e.g., assignment, book, chat, choice, database, external tool, feedback, file, folder, forum, glossary, LTI provider, page, questionnaire, quiz, survey, Turnitin assignment, URL, and wiki). For each additional tool in an online course, student login frequency increased nearly two additional logins. Though there is limited research on student login frequency in association with the number of LMS tools available, it is a topic to consider for future research.

Conclusions

Activity theory was the descriptive lens used to assess the findings in the current study that examined what occurs in online courses at a small, private Midwestern

university. With the external measurement of data provided by the LMS, the activity portion of the activity theory, subject-object-tool (see figure 1), was applied to the results of the current study. For the context of this study, the students, as *subjects*, interacted with LMS *tools* in a course, the *object*, and completed course activities to achieve the desired *outcome* (course completion). Using data analytics applied to one year of LMS log data, the researcher attempted to identify how students are interacting with LMS tools and how LMS tools affect students' login frequency. As Engeström and Miettinen (1999) suggest, activity theory reveals the tensions that may occur between parts of the activity system. Numerous tensions and conclusions were captured in this study.

First, the absence of interaction with two LMS tools, external tool and Turnitin, revealed a lack of availability or possible misuse (on the part of the instructor) of these tools. Based on the data, the absence of use is likely due to the lack of availability of the external tool. As for Turnitin, the tool is available in some of the courses, but the lack of interaction from students would reveal a need for better understanding by instructors on how to use the tool to engage students.

The tool with the highest student interaction was the forum. This distinction suggests a few conclusions. Foremost, it would imply that the forum is the tool used most often by instructors, no matter the course content. The large interaction with the tool also provides evidence that instructors are employing the forum tool in a myriad of ways (e.g., topic discussions, group work, announcements, questions for the instructor and classmates, etc.). Lastly, the forum is often used to stimulate discussion that would otherwise naturally occur in a face-to-face course. With over 1.6 million student

interactions (not including posts and replies) it appears that the forum is being used for its intended purpose.

The two tools with the highest interaction level, assignment and forum, most often have grades associated with them. The high interaction level would suggest that students are motivated to interact with the tools based on the grades associated to achieve the desired outcome of completing course activities. Expanding further, four of the highest tool interactions (assignment, file, forum, and URL) did not expose a significant difference between graduate and undergraduate students. A lack of tension in the activity system between the students and these tools provides reasoning for the value of these tools no matter the degree level. It may also indicate evidence for the necessity of these tools in the online course environment.

Five of the eight tools with statistically significant results had more interaction at the graduate level than the undergraduate level (book, chat, feedback, folder, and questionnaire). Overall, this result could suggest that graduate students interact with LMS tools more often than undergraduate students. However, it could also suggest a difference in the variety of tools made available by instructors at the graduate level versus undergraduate and the purpose of these tools. The three tools with significantly higher undergraduate interaction (choice, quiz, and LTI plug-in) are most commonly used to check for understanding or knowledge of a topic. The increased interaction for undergraduates with these tools would suggest an instructional strategy to test for students' knowledge and understanding on a given topic.

The tension between tools and students (subjects) was made obvious through RQ3's data analysis. Students' average login frequency increased by nearly two logins

per additional tool. This finding should inform instructors and instructional designers on the importance of how the number of tools in a course affects course login, which is considered important for student engagement (Jo, et al., 2015; Jo et, al, 2016; R. Moore, 2003; Zhang, 2015). However, this should not be confused for miscellaneous work added only for the intention of increasing logins, otherwise considered 'busy work.' Meaningful assignments are still necessary for meaningful interaction (Gilman, 2010; Boye, 2017).

Implications for action. The current research study examining student interactions with LMS tools and student login frequency in association with available LMS tools provides implications for the researched institution. In support of Park and Jo's (2017) recommendations, the current study suggests that the institution should use the LMS data showing student interaction levels, student login frequency, and use of LMS tools in online courses to inform policy decisions referring to online courses and practices surrounding training in online course instruction.

The data analysis provides information about the lack of use of the majority of LMS tools. The institution should use this information to engage in conversations with instructors and instructional designers investigating reasons for the lack of use. The information may also be useful in guiding discussions regarding the available LMS features with the LMS host and Moodle community users. Specifically, it might be worthwhile to explore why one of the most commonly reported types of online course assignments is wikis (Fuster, 2017), yet the researched institutions had less than 8,000 student interactions with wikis in 669 courses over a year.

Paying attention to student interaction levels provides an opportunity for the researched institution to re-examine its current attendance policy for a more meaningful approach. Rather than focusing solely on submitted work during a class week, the institution can be empowered to use the data logs to view students' interaction levels and login frequency. Low interaction levels and infrequent course logins often result in a student failing the course or can identify at-risk students sooner (Bainbridge et al., 2015; Jo et al., 2015; Jo et al., 2016; P. Vu, Cao, L. Vu, & Cepero, 2014; Zhang, 2015). At a time where nearly every institution strives to increase retention (Doucette, 2018; Nutt, 2003), the ability for someone at the institution to evaluate student interaction and login frequencies becomes an invaluable option to consider the needs of the student. For example, if a student is logging into an online course infrequently it may be a time management or motivation issue; yet, a student logging in frequently but still struggling with completing tasks may suggest an issue with comprehension and the need for tutoring or instructor guidance. The researched institution might consider this practice.

In addition to improving retention, the objective review of interaction levels and login frequency could assist instructors in improving online courses, which Casquero et al. (2016) discovered as a significant difference in students' engagement and academic performance. It may be worth the time of administrators at the researched institution to consider a policy that requires mid-course reports with data on students' login frequency and interactions with tools sent to the instructors to examine student activity to help determine any changes that could be made to increase student engagement. These reports may also be useful to academic advisors to increase their assistance to students' success.

Recommendations for future research. The hope is for the LMS to be able to integrate more comprehensible learning analytics as time progresses (Forouzesh & Darvish, 2012). However, more research is needed to determine which analytics have the most impact across the online learning environment. The current study provided data to add to the sparse research conducted in the area of student interaction with LMS tools and login frequency in online courses. The implications for action for the researched institution were provided, yet there are still many areas of this topic to be explored. The following list is the beginning of what is likely to be a long list of recommended research on this subject.

1. The current research explored data from one year based on the restrictions of data storage from the LMS host server. Now that a year's worth of data is collected and stored, a follow-up study comparing the findings from one year to the next is worthwhile to explore the longevity of the current findings.
2. This study examined one institution, specifically a small, private university in the Midwest. To expand the applicability of the study's findings, the research study should be replicated in multiple types of institutions offering fully online programs.
3. The current data were collected from accelerated adult programs. It is worthwhile to determine if there is evidence of significant differences in online undergraduate programs with traditional-aged students, along with semester-length online programs offered to adult students.
4. The current study was applied to data from Moodle. It would be beneficial to apply this research to other learning management system environments.

5. Future research might explore which individual LMS tools have more influence on student logins. These findings may provide more detail on which tools would have a greater impact in online course development and design.
6. The researched institution is expanding online program offerings. The research could be applied to the new programs to discover similarities and differences with new versus established online programs.
7. The current research implored a quantitative research design exploring LMS data logs. It could be worthwhile to use a qualitative or mixed methods research design to explore instructor's knowledge of LMS tools, instructor's intentions with selecting LMS tools, student perceptions of LMS tools, and other student factors influencing course logins. Data collection could include surveys and interviews to develop a more complete view of online student behavior and online instructor tool usage.
8. Expanding the current research to examine login frequency for a difference in undergraduate and graduate students may provide a deeper understanding of how the number of LMS tools affects login frequency.
9. Future research investigating instructor behavior in the online course setting, specifically in association with student behavior, could provide institutional leaders and instructional designers with a guide to improving online course development and support for instructors.

Concluding remarks. The use of LMSs at nearly all higher education institutions (Dahlstrom et al., 2014) and increasing online enrollment (Friedman, 2018) provide an increasing need for research examining the online environment. The existing literature

regarding online student behavior does little to inspect LMS data logs for an objective examination of online student behavior (Bainbridge et al., 2015; Jo et al., 2016), such as LMS tool interaction and course login frequency, especially at institutions located in the United States. Literature supports the need for increased interaction (Chiang et al., 2014; Lemke, 1997) and frequent course logins (Jo et al., 2015; Jo et al., 2016; Zhang, 2015) to improve student learning and engagement. The next steps should include an examination of what can be done to positively influence these aforementioned student behaviors in online courses.

Learning analytics provides a pathway for better understanding and increased knowledge of online courses. Somehow, institutions should find a way to tackle the overwhelming amount of data collecting from the multitude of systems (Biemiller, 2017; Norris et al., 2008), namely the LMS, to harness the wealth of knowledge that could inform the direction of the institution's online courses (Biemiller, 2017). At one time, having a computer in every classroom seemed like an insufferable feat, but now it is nearly impossible to find a classroom without a computer or digital device. If institutions' administrators and stakeholders are starved for information as Biemiller (2017) suggests, hopefully the future holds actionable learning analytics in every classroom.

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Appendices

Appendix A: IRB Request

BAKER UNIVERSITY

IRB Request

Date 3/7/19

IRB Protocol Number _____
(IRB use only)

I. Research Investigator(s) (students must list faculty sponsor)

Department(s) Graduate School of Education

	Name	Signature	
1.	Katie Uhlenhake	Katie Uhlenhake Digitally signed by Katie Uhlenhake Date: 2019.03.07 10:49:18 -06'00'	Principal Investigator
2.	Dr. Marc Childress	Marcus Childress Digitally signed by Marcus Childress Date: 2019.03.07 10:56:59 -06'00'	☑ Check if faculty sponsor
3.	Dr. Li Chen-Bouck	Li Chen-Bouck 2019.03.06 13:08:20 -06'00'	☐ Check if faculty sponsor
4.			☐ Check if faculty sponsor

Principal investigator contact information

Phone 785-215-2103

Email kuhlenhake@bakeru.edu

Address 7421 Melrose Ln
Shawnee, KS 66203

Note: When submitting your finalized, signed form to the IRB, please ensure that you cc all investigators and faculty sponsors using their official Baker University (or respective organization's) email addresses.

Faculty sponsor contact information

Phone 913-344-1235

Email mchildress@bakeru.edu

Expected Category of Review: ☑ Exempt ☐ Expedited ☐ Full ☐ Renewal

II. Protocol Title

Using Learning Management System Data Logs to Examine Student Interaction with Available LMS Tools and Course Login Frequency

III. Summary:

The following questions must be answered. Be specific about exactly what participants will experience and about the protections that have been included to safeguard participants from harm.

A. In a sentence or two, please describe the background and purpose of the research.

LMS data logs contain a wealth of information to review and analyze. The main purpose of this study is to access the LMS data logs to examine the amount of student interaction with LMS tools available in online courses; another purpose is to take the aforementioned examination and look for a difference in online undergraduate and online graduate students' average interactions with LMS tools. The final purpose of this study is to inspect the data logs for an association between the number of LMS tools available to students in online courses and the students' average login frequency.

B. Briefly describe each condition, manipulation, or archival data set to be included within the study.

There will not be any conditions or manipulations in the study; only archival data from a learning management system will be accessed.

IV. Protocol Details

A. What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

There are no observations in the study. The measures are the number of times a student selects a tool in the LMS and the amount of tools an instructor uses in their course design.

B. Will the subjects encounter the risk of psychological, social, physical, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

The subjects will not encounter risk in any way.

C. Will any stress to subjects be involved? If so, please describe.

The study will use archival data; subjects will not be actively involved in the research process.

D. Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

The study will use archival data; subjects will not be deceived or misled.

E. Will there be a request for information which subjects might consider to be personal or sensitive? If so, please include a description.

There is no request for subjects' information that may be considered personal or sensitive.

F. Will the subjects be presented with materials which might be considered to be offensive, threatening, or degrading? If so, please describe.

The subjects will not be presented with any materials, offensive or otherwise.

G. Approximately how much time will be demanded of each subject?

The study uses archival data, so subjects will not be asked to spend any additional time on the study.

H. Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

The subjects are students in the undergraduate and graduate SPGS and GSOE programs at Baker University. With archival data in use, there is no need to solicit or contact subjects.

I. What steps will be taken to insure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

No inducements will be offered to subjects.

J. How will you insure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

Archival data will be used for the study so no subject consent is necessary.

K. Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

No data from the study will be made part of any permanent record that could be identified with the subject.

L. Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher, or employer? If so, explain.

No data from the study will be made part of any permanent record that could be identified with the subject.

M. What steps will be taken to insure the confidentiality of the data? Where will it be stored? How long will it be stored? What will be done with the data after the study is completed?

Subject names will be removed and a unique, unidentifiable number will be assigned to act as the identifying name for each subject. The data will be stored electronically on a 2-step authenticated password-protected cloud server only accessible by the researcher. Data will be stored for five years after the completion of the study, and then deleted from the cloud server.

N. If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks involved with this study.

O. Will any data from files or archival data be used? If so, please describe.

Data logs from Baker University's SPGS and GSOE online programs offered in Moodle (Baker University's LMS) will be used for the study. The data will include identifying information about the course and, when necessary, the student. Two data logs will include student interaction with LMS tools (number of times students select a tool), one log will include students login frequency, and the last log will include the number tools available in each course.

Appendix B: IRB Letter of Approval

Baker University Institutional Review Board

March 8th, 2019

Dear Katie Uhlenhake and Marc Childress,

The Baker University IRB has reviewed your project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,

Nathan Poell, MA
Chair, Baker University IRB

Baker University IRB Committee
Scott Crenshaw
Erin Morris, PhD
Jamin Perry, PhD
Susan Rogers, PhD

Appendix C: Permission for Data Access from Institution's LMS Manager

Hi Katie!

Yes, you may access to the logs you need for this project.

Thanks,

[redacted]

From: Katie Uhlenhake
Sent: Thursday, March 7, 2019 4:31:55 PM
To: Toby Ebel
Subject: Request for LMS Data Logs

Good afternoon, [redacted]

Per our previous conversations, I know you are aware of my dissertation research topic examining LMS data logs from [redacted] online [redacted] programs to review student log data for LMS tool interaction and login frequency. May I have access to [redacted] student log data from Moodle to complete my research study?

Thank you for your assistance,

Katie Uhlenhake, M.Ed.
Assistant Director of Academics
Graduate School of Education
Baker University
913-344-6036