ABSTRACT

ASSESSING LEARNING OUTCOMES AND SOCIAL CAPITAL FORMATION RESULTING FROM THE USE AND SHARING OF INTERNET KNOWLEDGE RESOURCES

by
Regina S. Collins

Today's "digital natives" use the Internet to address most, if not all, their learning-related knowledge needs. This research evaluates the outcomes of formal learning activities requiring students to use, manage, share, and consolidate Internet knowledge resources (such as websites, videos, and blogs) to achieve both individual and group learning. This research takes an integrative approach to learning, capturing learner cognitive, interpersonal, and intrapersonal characteristics as well as the impact of the digital environment by evaluating the technological affordances of two different systems supporting such learning activities. This research also examines pedagogical modifications that would best integrate course assignments utilizing Internet resources for learning.

This research begins with semi-structured interviews investigating students' current practices in using, organizing, and sharing digital resources. Based on the results of these interviews, this research implements a pilot study and subsequent quasi-experimental field studies to test digital resource management and sharing in the completion of varied pedagogical activities. Using two different systems, this research evaluates the affordances provided by each, exposing design considerations that can inform the modification of existing systems or the development of new systems to better support digital resource management and sharing in the educational domain.

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APPROVAL PAGE

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LIST OF DEFINITIONS

Actor	A node in a network. Actors can represent individuals, knowledge, resources, or even opinions.
Betweenness centrality	A network measure indicating how often a given node falls along the shortest path between two other nodes. Nodes with high betweenness join clusters that would otherwise be disconnected.
Bipartite network	A special type of two-mode network in which the two types of nodes can only connect to each other and not to other nodes of the same type.
Bonacich power centrality	A network measure indicating the extent to which a node is connected to well-connected others.
Clique count	A network measure indicating the number of distinct cliques to which a node belongs. A clique is defined as a subgroup containing three or more nodes that have direct connections to each other and to which no other nodes can be added without violating that condition.
Closeness centrality	A network measure based on the sum of geodesic distances from a node to all others. Closeness centrality indicates how central a node is in a network, even if it is not well-connected.
Density	The portion of the potential connections in a network that actually exist.
Exclusivity	A network measure indicating a node that has no, or few other, relationships in common with other nodes.
Relationships	The connections between nodes or actors in a network. Relationships can represent friendship, animosity, or even access to knowledge.
Total degree centrality	A network measure indicating the number of ties of a given type that a node has.

CHAPTER 1

INTRODUCTION

1.1 Objective

The objective of this dissertation is to explore how students learn by using and managing Internet knowledge resources individually and sharing those resources with other students in a digital environment. Moving away from the traditional requirement of using and citing "scholarly" resources such as those published in academic or research journals, this research seeks to evaluate how well students learn when they are encouraged to use reliable (not necessarily scholarly) resources they find on the Internet to conduct research.

Beginning with an exploration of the individual skills and characteristics best suited to learning through the use, management, and sharing of Internet knowledge resources, this research focuses on three domains of learner competencies: 1) *intrapersonal* through variables such as learner self-efficacy, learning goal orientation, and perceived value of the learning task; 2) *interpersonal* through the amount and method of collaboration and sharing of Internet knowledge resources; and 3) *cognitive* through learning outcomes and actual learning at the individual and group level. At the same time, the effects of the *digital environment* in such activities cannot be ignored and is explored through the use of two comparable but different information and communication technologies (ICTs). Finally, an evaluation of *pedagogical activities* requiring the above competencies to accomplish learning in this digital environment is conducted.

1.2 Background Information

Students of the millennial generation are entering institutions of higher education, bringing with them a high level of comfort with information foraging and using information from the Internet. Every day, and often several times a day, these individuals access the Internet for reasons ranging from education to entertainment. In fact, research has shown that Millennials turn to the Internet as their first source for information, citing Google as their first choice for finding both educational and personal information (Connaway, Radford, Dickey, De Angelis Williams, & Confer, 2008). Additionally, millennial students often work in groups and share information from both their personal and academic lives with others (Lippincott, 2012).

This culture of sharing is evident in educational institutions in the move towards open resources in education, which began in 2001 with MIT's OpenCourseWare (OCW) project (Caswell, Henson, Jensen, & Wiley, 2008; Johnstone, 2005; Smith & Casserly, 2006). The view that "… the world's knowledge is a public good and that technology in general and the World Wide Web in particular provide an extraordinary opportunity for everyone to share, use, and reuse that knowledge" (Smith & Casserly, 2006, p. 10) espouses the principles of the Open Educational Resources (OER) initiative, an effort to make educational resources freely available to everyone. The OER seeks to build a knowledge base of all education-related materials, including not just course materials and textbooks but also tests and assessments – anything that can be used to ensure that knowledge is made available to all, not just a select few.

At the same time, the amount of informal, peer-generated knowledge content available on the Internet has grown exponentially. While the quality of this peer-generated content varies, many reliable sources have emerged that are regularly used by learners, including websites such as Khan Academy (Thompson, 2011) and Codecademy and YouTube channels such as Gaskination. The varying formats of such peer-generated content cater to the differing learning styles of students, enabling learners to customize and individualize the materials they use to support and facilitate learning. In fact, researchers have identified four dimensions in the Index of Learning Styles that are unique to students: Sensing/Intuiting, Visual/Verbal, Active/Reflective, and Sequential/Global (Felder & Henriques, 1995; Felder & Silverman, 1988). They argue that students learn best when teaching methods are compatible with students' learning styles. While instructors cannot tailor their teaching methods to each individual learner's preferences, students can take control of their own learning by utilizing learning resources available on the Internet that best accommodate their preferred style of learning.

The availability of so many formal and informal Internet knowledge resources is critical to the continued, lifelong learning required in today's knowledge economy (Sharples, 2000; Zimmerman, 2002). In a world of rapidly changing knowledge and advancing technology, Millennials graduating into the workforce must develop the competencies that will enable them to be independent, self-regulated lifelong learners working in a collaborative environment of knowledge sharing and innovation. This research explores the 21st century competencies deemed necessary for life and work (National Research Council, 2012) through a formal learning activity embedded in a digital environment, testing a theoretical model of learning through the use and sharing of Internet knowledge resources.

1.3 Overview of this Research

This research explores the application of Internet resources to individual learning and the implications of sharing Internet resources for collaborative learning and knowledge building. To provide a foundation in which to explore the educational value of such activities, theories of learning, knowledge building, and sensemaking are discussed in detail in Chapter 2. Chapter 3 explores technologies used for learning, including learning management systems and Web 2.0 technologies.

The semi-structured interviews that established the context and metaphor guiding this research are discussed in Chapter 4. These interviews explored students' experiences with using and sharing Internet resources for learning. The results of these interviews informed more detailed research questions and a proposed theoretical model, described in Chapter 5. The methodology used to capture and analyze the data is discussed in Chapter 6, and the results of a pilot study testing the experimental design and instruments are described in Chapter 7.

Results of the larger, quasi-experimental field study are discussed in Chapter 8 (univariate analysis results) and Chapter 9 (multivariate results and model testing). Chapter 10 reports the results of the repeated measures study conducted as part of this dissertation, and Chapter 11 discusses the findings from exploratory social network analysis of networks connecting students and their cited resources. Chapter 12 summarizes all of the findings and provides a more detailed discussion of the meanings of these findings, as well as limitations and suggestions for future research.

CHAPTER 2

THEORIES OF LEARNING AND KNOWLEDGE BUILDING

In the wake of Web 2.0 (O'Reilly, 2006), a culture of participation, sharing, and collaboration is pervading technology and society. This cultural shift is evident in higher education as well, where educators and researchers are exploring learning based on a socio-cognitive model of students as active participants in a globally connected world (Bandura, 2006). This view of students as agents in their own learning creates tension with the more traditional view of students as passive recipients of knowledge, a tension that is evident in the numerous learning theories upon which educational efforts are based.

Such metaphors – perceiving students as active participants or passive recipients of knowledge, for example – are key elements in the conceptualization of research (Gentner & Grudin, 1985; Lakoff & Johnson, 1980). Metaphors are powerful research tools that not only guide scientific theory and practice but also enable dissemination of complex ideas (Coppola & Elliot, 2013; Ruiz de Mendoz Ibanez & Perez Hernandez, 2011)). This research follows the metaphor of students as active participants (Bandura, 2006) and explores the 21st century competencies (cognitive, interpersonal, and intrapersonal) said to be critical in education for life and work (National Research Council, 2012). At the same time, this research acknowledges the impact of the digital environment on these 21st century skills, exploring two comparable yet different systems scaffolding activities in support of learning. Finally, the pedagogical activity driving the formal learning activity is explored as a critical component in this complex system.

In an attempt to classify learning theories based upon common attributes, Sfard (1998) proposes two metaphors of learning that reflect the disparate views of students as active agents or passive recipients of learning. The *acquisition* metaphor is a classification of learning theories that represent knowledge as an entity to be accumulated and refined by an individual. In this class of learning theories, students are individual receptacles waiting for knowledge to be transferred to them by educators. Learning theories that support this metaphor include Behaviorism (Pavlov & Fol'bort, 1941; Skinner, 1953) and Cognitivism (Chomsky, 1965).

The *participation* metaphor, on the other hand, focuses not on knowledge but on the activity of "knowing" (Sfard, 1998, p. 6). In the participation metaphor, learning activities are ongoing and are influenced by the context in which they occur. Rather than isolated receptacles of knowledge, learners are viewed as members of a community in which they advance from novices to integral team members through their participation in learning activities. The participation metaphor encompasses learning theories including Constructivism (Piaget, 1970) and Social Constructivism (Vygotsky, 1978).

This research takes a hybrid approach, combining the knowledge acquisition metaphor and a modified version of the knowledge participation metaphor, called the *knowledge creation* metaphor, and the activities inherent in each to explore learning through the use and sharing of Internet knowledge resources for individual and group learning. To understand the theoretical foundations of this research, learning theories and related activities supporting both metaphors are discussed. Because learning must also be assessed, this chapter includes a discussion of the use of constructed response tasks as learning artifacts and describes the different evaluation methods typically used for assessment of these artifacts.

2.1 Knowledge Acquisition

The *knowledge acquisition* metaphor is reflected in the more traditional learning theories that view learners as empty vessels waiting to be filled with knowledge, and the instructor as the “sage on the stage” (Coppola, 1997) who is dispensing knowledge into the awaiting receptacles. For example, the Cognitivist learning theory focuses on the delivery of knowledge to a learner who must then move that knowledge from short-term to long-term memory through an internal process that involves memory, motivation, thinking, and reflection (Chomsky, 1965). In Cognitivism, a series of sequential steps (recognition, recollection, analysis, reflection, application, creation, understanding, and evaluation) must be scaffolded to support the cognitive activities of learners. Gagne and Briggs (1974) built upon these steps, proposing guidelines for the design of instruction that would facilitate these cognitive activities.

These researchers also explored the planning of instruction, finding that identifying the relevant learning outcomes was critical to the success of instructional design (Gagne & Briggs, 1974). Learning outcomes were first proposed by a committee of educators headed by Bloom (1956). This committee developed what is commonly referred to as Bloom’s taxonomy of cognitive learning outcomes. Their goal was to ensure that educational assessments such as examinations were closely aligned with the learning goals of the curriculum. The committee perceived learning as occurring in three domains: cognitive, affective, and psychomotor. The cognitive domain focused on mental skills or knowledge. The affective domain explored feelings and emotions such as attitude towards learning or feelings of self-efficacy. The psychomotor domain explored the development of manual or physical skills such as learning to play an instrument.

The cognitive learning outcomes developed by Bloom and the committee (1956) outlined a hierarchy of increasingly complex learning goals which built upon each other; that is, each level of learning outcome required mastery of the preceding levels. Figure 2.1 illustrates Bloom's hierarchy of cognitive learning outcomes.

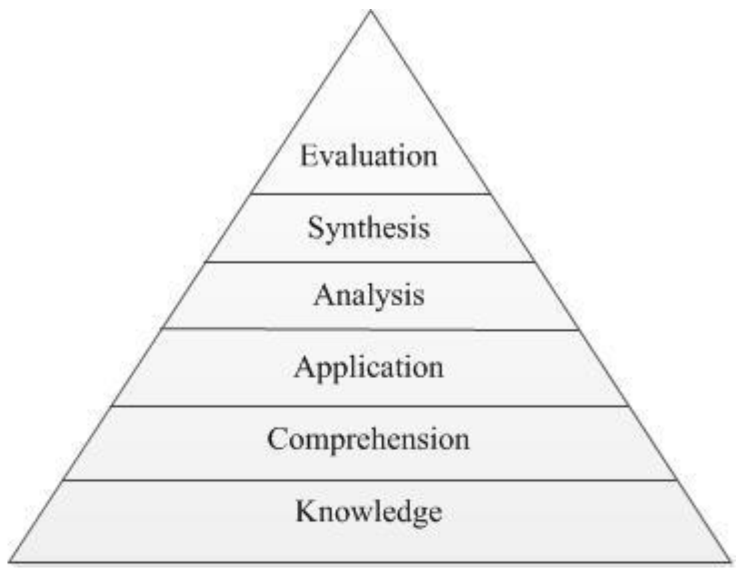


Figure 2.1 Bloom's taxonomy of learning outcomes consists of six hierarchical levels of cognitive learning outcomes with each level requiring mastery of the preceding.

A description of each educational outcome, along with examples of relevant action verbs, is provided in Table 2.1.

Table 2.1 Bloom's Cognitive Learning Outcomes

Learning Outcome	Activity	Sample Action Verbs
Knowledge	The learner must recall previously acquired knowledge	Repeat, Define, Label, Memorize
Comprehension	The learner must restate, in his own words, previously acquired knowledge.	Explain, Describe, Identify, Paraphrase
Application	The learner must employ the knowledge in new ways to solve problems.	Compute, Illustrate, Modify, Solve
Analysis	The learner must decompose the knowledge by classifying common elements, relationships and organizational principles.	Categorize, Contrast, Diagram, Outline
Synthesis	The learner must recompose the knowledge into a new pattern or propose alternative solutions.	Assemble, Combine, Summarize, Explain
Evaluation	The learner must assess the knowledge by making judgments or forming opinions.	Appraise, Defend, Evaluate, Justify

A revision to Bloom’s taxonomy was proposed by Krathwohl (2002). In this revision, the learning outcomes changed to a verb form (Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). In addition, Evaluating was no longer the highest form of learning outcome; instead, Creating was considered the most complex learning outcome because it required the creation of new knowledge (or knowledge that is new to the learner). However, in educational domains, Bloom’s taxonomy remains the de facto standard and is therefore utilized in this research.

More recently, the National Research Council (NRC) re-evaluated the domains suggested by Bloom (cognitive, affective, and psychomotor) and suggested three new domains of competence considered to define 21st century skills: cognitive, intrapersonal, and interpersonal. The cognitive domain remains similar to Bloom's definition of cognition as involving thinking, reasoning, and problem solving. The intrapersonal domain is similar to Bloom's affective domain, exploring the learner's emotions and self-regulation. The NRC's interpersonal domain extends beyond Bloom's original domains to explore skills and competencies that support communication of ideas and information to others, the interpretation of information provided by others, and the ability to interact and respond appropriately (Bedwell, Fiore, & Salas, 2011; National Research Council, 2012).

This research follows Bloom's taxonomy of cognitive learning outcomes to explore hierarchical learning outcomes evidenced in student assignments completed through the use and sharing of Internet knowledge resources. At the same time, this research integrates the intrapersonal and interpersonal domains identified by the NRC. The intrapersonal domain is captured through self-reported student characteristics such as learning goal orientation (Nicholls, 1984; Yi & Hwang, 2003) and self-efficacy (Pintrich & De Groot, 1990). The interpersonal domain is evaluated using self-reported perceptions of student interactions (Benbunan-Fich & Arbaugh, 2005) and observed interactions classified according to the the Socialization Externalization Combination Internalization (SECI) model (Nonaka & Takeuchi, 1995) discussed in Section 2.3.

In previous studies, researchers have applied Bloom's taxonomy to the task of searching for relevant Internet-based resources, suggesting that search activities fall into three general categories: Lookup, Learn, and Investigate (Marchionini, 2006). *Lookup* tasks are suited to clearly defined knowledge needs, for example, a programmer looking up the proper format of a statement in Visual Basic. Lookup activities reflect the lower levels (Knowledge and Comprehension) of Bloom's taxonomy. *Learn* searches are more complex and typically require the integration of data from several sources to fully address the knowledge need. Learn activities incorporate the Analysis and Synthesis levels of Bloom's taxonomy. *Investigate* searches are the most complex because they require that information seekers assess and evaluate the search results before accommodating or assimilating them into their knowledge base. The Investigate search is believed to integrate the highest-level learning objectives in Bloom's taxonomy, including Evaluation.

Other research exploring information foraging and the use of Internet resources in relation to learning has focused on the domain of software programming (Brandt, Guo, Lewenstein, Dontcheva, & Klemmer, 2009), finding that programmers used online resources for several types of knowledge needs. At the most basic level, programmers used Internet resources to remind themselves of details not worth remembering, such as the order of parameters for a particular function. The time required to resolve simple knowledge needs was minimal because the programmers could easily find a resource that provided the required information.

At a more complex level, programmers used Internet resources to clarify or extend their existing knowledge. This type of knowledge need required more effort as resources had to be explored and evaluated for suitability and completeness, but in general the researchers considered the learning resulting from this type of foraging as surface learning.

The most complex type of knowledge need involved just-in-time learning, in which programmers were locating Internet resources that provided tutorials for new and unfamiliar activities. This type of learning activity required the most time to complete and evidenced deep learning. Information foraging for appropriate resources for this type of learning also required more effort on the part of the programmer to evaluate the knowledge provided by the various resources.

Learning through Internet research has also been explored at the high school level (Ellis, Goodyear, Bliuc, & Ellis, 2011). Researchers found that, while some students viewed the Internet as an easy way to find answers, other students used Internet resources to improve their knowledge of a topic or to gain a deeper understanding by exploring multiple viewpoints. These results suggest that learning activities requiring the use of Internet resources must be structured, constructed response tasks that guide students to knowledge integration and deeper learning. In fact, the researchers found that students using a deep learning approach received significantly higher grades than students using a surface learning approach when conducting research using Internet resources.

Although information foraging is frequently a solitary activity, there is often a social component before, during, and after searching for Internet resources. For example, before foraging for information on the Internet, individuals frequently discuss their information needs with others to obtain suggestions on where to search, how to design the query, or even to see if anyone has the information being sought. During search, individuals discuss their current findings with others who could help them in assessing the completeness or accuracy of the information. After search, the researchers found that

58.7 percent of respondents shared their knowledge products with others (Evans & Chi, 2008).

2.2 Knowledge Participation

The knowledge *participation* metaphor incorporates learning theories such as Constructivism and Social Constructivism that acknowledge the learner's active participation in the learning process. Constructivist theory proposes that individuals build knowledge not in a vacuum but based on the context of their own realities and experiences. Social Constructivism extends this focus to a group; in Social Constructivism, knowledge is based on the shared meanings of the group and is typically represented through socially constructed artifacts.

The theory of Cognitive Development, for example, explores how children create schema or mental models to explain what they are experiencing (Piaget, 1970). The cognitive processes used to create and refine these schema are:

- *Assimilation*. When new information fits the learner's understanding or mental model, the learner assimilates the new information into her existing knowledge, thus reinforcing her current understanding.
- *Accommodation*. When new information does not fit the learner's existing understanding or mental model, the learner must accommodate the new information by revising her existing understanding to explain the incongruities between the new information and her existing knowledge.

The concept of schemas and the processes of assimilation and accommodation are critical in research exploring internal knowledge organization. Schemas provide a framework for organizing knowledge in memory; this organization aids in the subsequent interpretation of complex information into patterns that make sense to the individual (National Research Council, 2012). The use of schemas is evident in theories of sensemaking described later in this chapter.

2.3 Knowledge Creation

Some researchers argue that Sfard's participation metaphor is restricted by its focus on learning activities and communal participation, overlooking critical factors such as outcomes of learning (Paavola & Hakkarainen, 2005; Paavola, Lipponen, & Hakkarainen, 2002). These researchers instead propose a *knowledge creation* metaphor that emphasizes advancing knowledge through social structures and collaborative processes. The knowledge creation metaphor acknowledges the individual learner's efforts as contributions to a knowledge community while also recognizing the effect of the community on the individual's cognitive growth, adding as an outcome a learning product (report, presentation, wiki, etc.) of the collaborative knowledge building effort.

In proposing the knowledge creation metaphor, Paavola et al. (2002) examined three models that reflected learning as a process of knowledge creation; this research focuses on two of these three models: Nonaka and Takeuchi (1995) and Bereiter (1985).

Nonaka and Takeuchi (1995) proposed an iterative model of organizational learning based upon the interactions of tacit and explicit knowledge. (Explicit knowledge is knowledge that can be easily codified, while tacit knowledge reflects individual expertise and understanding that can be difficult to codify (Davenport & Prusak, 2000).) In their model, Nonaka and Takeuchi define four modes of knowledge conversion:

- *Socialization* is the process of sharing tacit knowledge between individuals.

- *Externalization* is the process of codifying tacit knowledge for the purposes of sharing it with a larger community.
- *Combination* is the process of integrating multiple explicit knowledge sources to provide coherent meaning.
- *Internalization* is the process of integrating explicit knowledge into previous knowledge and experience to make it one's own tacit knowledge.

These four modes of knowledge conversion occur iteratively in the Socialization Externalization Combination Internalization (SECI) model, effecting individual learning through the exchange and conversion of various forms of knowledge within an organization.

Bereiter (2002) criticized the focus of the Nonaka and Takeuchi SECI model as being too dependent on knowledge residing in an individual. Instead, Bereiter's learning process emphasizes knowledge as something that can be created, shared, and understood in the process of collaborative knowledge building. Scardamalia and Bereiter (1999) argue that learning communities should function as research communities by sharing, discussing, and debating ideas. However, while research communities focus on creating new knowledge, learning communities focus on identifying knowledge that is new to the members of the community. Collaborative knowledge building focuses on the advancement of knowledge through the sharing of multiple ideas and perspectives (Chatti, Jarke, & Frosch-Wilke, 2007; Chatti, Klamma, Jarke, & Naeve, 2007; Hong & Sullivan, 2009; Kozma, 2003; Paavola & Hakkarainen, 2009) and is explored in this research through a group component to each assignment. The group submission enables students to build on their individual knowledge by sharing their resources and responses with their group members to achieve a more complete understanding of the topic.

2.4 Sensemaking

Sensemaking is an activity built on the theories of Constructivism and Social Constructivism that describes the process of understanding the relationships between knowledge elements, identifying patterns, and building on previous knowledge to create new understanding (Weick, 1995; Zhang, Soergel, Klavans, & Oard, 2008). Sensemaking supports several critical learning functions, including 1) enhancing comprehension, 2) testing and improving explanations, and 3) deliberating multiple viewpoints (Klein, Moon, & Hoffman, 2006a). In effect, the activities involved in sensemaking exhibit Bloom's learning outcomes of Analysis (to decompose information into common elements and relationships) and Synthesis (to recompose these elements into new knowledge) (Bloom, 1956; Zhang et al., 2008). These activities can be performed individually (Constructivism) or by a group working to establish a shared understanding (Social Constructivism).

In the process of sensemaking (Pirolli & Card, 2005; Qu & Furnas, 2005; Russell, Stefik, Pirolli, & Card, 1993; Ryder & Anderson, 2009; Shah, 2010; Zhang et al., 2008), the individual or group first attempts to develop representations that effectively describe current understanding. Once these representations are established, they are tested by instantiating them and applying existing data to determine their effectiveness. Data supporting the representation provides evidence of the representation's validity and reinforces that representation (assimilation). Data that does not support the representation is considered "residue". When sufficient residue accumulates, the representation must be revised, causing a representational shift (accommodation) (Klein, Moon, & Hoffman, 2006b; Piaget, 1970; Russell et al., 1993).

2.5 Integrated Learning Theories

More recently, researchers have begun to argue against the separation of collaborative knowledge building and individual learning, arguing for a "co-evolution model of cognitive and social systems" (Cress & Kimmerle, 2008; Kimmerle, Cress, Held, & Moskaliuk, 2010). The co-evolution model combines individual learning and collaborative knowledge building (Cress & Kimmerle, 2007, 2008; Kimmerle, Moskaliuk, & Cress, 2009; Moskaliuk, Kimmerle, & Cress, 2012), defining collaborative knowledge building as a combination of the cognitive systems of the individual learners and a social system that is represented by the shared knowledge artifact (Cress & Kimmerle, 2008). In the co-evolution model, internalization processes in a learner's cognitive system coincide with the process of externalization in the social system as the individual learner assimilates or accommodates (Kimmerle et al., 2010) his knowledge into the shared knowledge artifact. Although the co-evolution model begins to explore the interactions between collaborative and individual learning processes, this research moves beyond the knowledge artifact as outcome, instead focusing on perceived and actual learning at the individual and group level.

2.6 Constructed Response Tasks

Assessment of learning is a controversial topic, with researchers arguing that indirect assessments such as multiple choice tests create a gap between the indicator (the assessment result) and the learning goal (the application of knowledge). To address this concern, researchers have proposed alternative forms of assessment – in particular, complex, performance-based assessments called “authentic” assessments (Linn, Baker & Dunbar, 1991). Authentic assessments are thought to provide more direct evidence of knowledge and skills mastery because they involve the *performance of* tasks rather than *responses about* tasks.

Constructed response tasks provide meaningful artifacts for authentic assessment because they enable instructors to have students create learning artifacts that measure complex skills (Bennett, 1993). For example, requiring a student to construct a mathematical proof provides a much more accurate representation of the student’s mastery of that particular skill than a test question asking the student to select the correct proof from several provided (Educational Testing Service, 2009). Constructed response tasks allow educators to measure the higher levels of Bloom’s learning outcomes (Application, Analysis, Synthesis, and Evaluation) by creating activity prompts using Bloom’s *action verbs* to elicit evidence of the different levels of learning.

Constructed response tasks are evaluated against a scoring rubric that provides guidelines about how the response should be assessed. Rubrics can support either analytic scoring or holistic scoring or a combination of both. Analytic scoring identifies key features that should be present in the response and provides a numeric value to be awarded for each correct feature. For example, in the case of the mathematical proof, the rubric may specify that the restatement of the givens is worth one point, each step in the proof is worth two points, and identification of the proper theorem is worth two points.

Holistic scoring involves a judgment regarding the overall quality of the constructed response (White, 1985). Because holistic scoring is based on the scorer’s judgment, training is required to ensure consistency and scoring norms between the scorers. This training is done using exemplars (actual responses selected to show varying quality of responses) (Educational Testing Service, 2009).

In some constructed response assessments, analytic and holistic scoring are combined. Key features of the response are identified, but the quality of each feature is evaluated holistically. For example, in a first year composition course, skills such as Rhetorical Knowledge and Composing in Electronic Environments are considered key features (competencies) that the students must exhibit in their constructed responses. Each of these competencies is scored by trained readers on a scale from one (at a failing level) to six (at an exceptional level). Additionally, each constructed response receives an overall holistic score (again on a scale from one to six); the individual competencies were shown to be accurate predictors of the holistic score in this particular environment (Collins, Elliot, Klobucar, & Deek, 2013).

This research utilizes the combined analytic and holistic scoring methods. For each research assignment, a constructed response task is developed based on the instructor's input. Based on the given topic, five questions are developed; each question is designed to reflect one of the upper levels of Bloom's taxonomy of learning outcomes (Comprehension, Application, Analysis, Synthesis, and Evaluation). After the questions have been approved by the instructor, a scoring rubric is developed, again with input from the instructor; the scoring rubric lists the key features that should be evident in the constructed response and provides a description of each feature and its components. Scorers can then assess the quality of each feature evident in the constructed response on a scale from one to six; they are also asked to provide a holistic score for the response.

CHAPTER 3

ICT AND LEARNING

The divergence of the knowledge creation and knowledge acquisition metaphors discussed in Chapter 2 are reflected in the divergent research paths of existing learning technologies. Systems implementing the knowledge acquisition metaphor include intelligent tutoring systems that chunk information and rely on repetition and formative assessment to achieve learning (Gagne & Briggs, 1974). Systems implementing the knowledge creation metaphor include Information and Communication Technologies (ICTs) that facilitate the use, management and sharing of knowledge resources such as Personal Learning Environments (PLEs) and Collaborative Knowledge Building systems (CKBs). While the overarching goals of both types of systems are to support learning, PLEs focus on supporting tasks involved in individual knowledge acquisition, while CKBs support communal learning through knowledge sharing and building. These technologies and others are discussed in greater detail in this chapter.

3.1 Intelligent Tutoring Systems

Following the Cognitivist theory of learning (Chomsky, 1965; Gagne & Briggs, 1974) and incorporating the knowledge acquisition metaphor (Sfard, 1998), agentic intelligent tutoring systems such as SolveIt (Deek, 1997) and ALEKS have been developed to scaffold the cognitive processes involved in a learner's acquisition of domain-specific knowledge through the exposure to and practice of manageable knowledge chunks. Research in intelligent tutoring systems has focused not only on system usage and learning outcomes but has also begun to explore the use of affective agents to detect indicators of learner frustration (D’Mello et al., 2005; D’Mello, Dowell, & Graesser, 2009) and provide interventions to encourage learner perseverance (Burleson & Pickard, 2004).

These expert systems incorporate elements of Gagne’s nine steps of instruction to facilitate information chunking, skills practice, and the eventual movement of knowledge to long-term memory. Because these systems deliver prepared knowledge chunks while constantly assessing whether the knowledge or skill has been acquired by the learner, they are not suited to the participatory knowledge creation activities included in this research.

3.2 Personal Learning Environments

In general, a Personal Learning Environment (PLE) is a system that supports individual learning through the creation of an environment in which learners can integrate their learning tools and learning objects. Although numerous, often conflicting views of a PLE exist (Johnson et al., 2006), all of the views have in common the concept of supporting individual learning through exploration of resources, thus reflecting the knowledge participation metaphor. PLEs have sometimes been defined as e-portfolios in which students document their learning through accumulation of knowledge artifacts (Hiebert, 2006; Nicol & Macfarlane-Dick, 2004). Other researchers view PLEs as tools to enhance informal, not institutional learning (Attwell, 2007; Bull et al., 2008). Still others argue that PLEs are redundant given the availability of Web 2.0 tools and learning management systems (Blackall, 2005). In response to these differing definitions, and to address the shortcomings inherent in each, Johnson et al. (2006) propose a PLE model that supports activities such as relationship maintenance, communication, and codification. Regardless of the robustness of this model, however, all of the aforementioned PLE definitions focus on individual knowledge acquisition and do not address the communal knowledge building activities considered critical by many learning theorists.

A hybridized description of a PLE was proposed by Kolas and Staupe (2007). In their proposed personalized e-learning interface, learners would customize their learning environments by selecting those learning objects which were most appropriate for their style of intelligence (Gardner, 1985), level of proficiency (Dreyfus, 2002), and cultural dimension (Hofstede, 2001). Through effective use of ranking and tagging of learning objects, students could either search for and retrieve relevant learning objects or request recommendations from the system based on their previous preferences. Although this hybrid learning system would enable students to extract learning objects from a larger collection of resources based upon individual understanding and preference, the researchers omitted any discussion regarding how these shared learning objects were acquired, rated, and tagged for consumption by the learning community.

In general, most researchers agree that the critical issues to be addressed by any Personal Learning Environment are: 1) ensuring a learner's sense of ownership of the technology and the information stored therein; 2) enabling an integration of both institutional and informal learning; and 3) providing the ability to work with peers (Attwell, 2007; van Harmelen, 2006; Johnson & Liber, 2008; Johnson et al., 2006).

3.3 Virtual Classroom/Learning Management Systems (LMS)

The first version of a learning management system (LMS) was the Virtual Classroom developed at New Jersey Institute of Technology during the 1980s and later refined for the new Web technology in the 1990s (Hiltz, 1994). These systems centered around threaded asynchronous discussions but also provided features that enabled the kind of variety of activities that could occur in the traditional classroom, such as breaking into smaller discussion groups, adding synchronous chats, and supporting exams and an online "gradebook" showing students their grades and comments for all assignments. Subsequently, a number of commercial LMS systems supporting similar activities have been developed including WebBoard and Blackboard. More recently, open source versions of this class of software have emerged, including Moodle which is one of the systems to be used in this study and whose affordances are described later in this chapter.

3.4 Collaborative Knowledge Building Systems

Research in the area of Collaborative Knowledge Building systems (CKBs) has not suffered from the discord of conflicting definitions of Personal Learning Environments. In general, CKBs are systems that scaffold group interactions such as sharing resources, contributing notes or comments, and working towards a single understanding of the shared knowledge. Systems such as WebGuide (Stahl, 1999) and Knowledge Forum (Scardamalia & Bereiter, 1999) have been tested in classroom settings to assist with communal knowledge building activities. WebGuide, for example, supports project-based learning; the system drives learner interactions towards a final goal of a single, coherent response in the form of some final submission or project deliverable. Regardless of their specific implementations, CKBs differ from PLEs in their focus on knowledge as emerging from communal knowledge building efforts rather than individual knowledge acquisition.

This research takes a more integrated approach, exploring learning at both the individual and group level. Learners are given the opportunity to learn individually before sharing their new knowledge and supporting resources with others. The integration of individual and group learning in a single digital environment requires different affordances than those provided by either a personal learning environment or a collaborative knowledge building system alone. One of the key activities when knowledge and resources are shared among learners is sensemaking, discussed in the following section.

3.5 Sensemaking Systems

Sensemaking systems support the assimilation and accommodation activities required to integrate new knowledge into existing understanding or modify the existing understanding to make sense of the new and conflicting information. Sensemaking can occur at both the individual and group level. The following sections discuss individual and group sensemaking systems in more detail.

3.5.1 Individual Sensemaking Systems

Individual sensemaking systems (Qu & Furnas, 2005; Ryder & Anderson, 2009; Sharma, 2011) support activities that enable individual learners to make sense of various knowledge sources. These activities include assessing the relevance of information and indicating (either textually or visually) connections between information sources (Zhang et al., 2008).

3.5.2 Group Sensemaking

Group sensemaking systems support many of the same activities as individual sensemaking systems but at the group level. However, they additionally require awareness features to understand the efforts and current status of others participating in the sensemaking process. Group sensemaking systems must also support representation construction through searching, organizing, storing, and adding value to information through tags, notes, and other annotations (Paul & Morris, 2009; Ryder & Anderson, 2009; Shah, 2010). For example, the activities involved in social tagging (e.g. delicio.us) have been explored as group sensemaking activities (Boeije, Kolschoten, de Vries, & Veen, 2009; Golder & Huberman, 2006).

3.6 Web 2.0 Technologies

With the advent of Web 2.0 (O'Reilly, 2006), researchers began to explore the use of Web 2.0 tools such as wikis and blogs (Chatti et al., 2007b; Cress & Kimmerle, 2007, 2008; Ivanova & Ivanova, 2009; Top, 2009) and social tagging (Pata, 2009; Trant, 2009; Yew, Gibson, & Teasley, 2006) to support learning through sensemaking and collaborative knowledge building. Other researchers have focused on the use of Twitter to encourage collaboration among learners (Junco, Elavsky, & Heiberger, 2012).

Chatti et al. (2007b) proposed a blended learning process based on a combination of the SECI model, knowledge management concepts and Web 2.0 technologies. The resulting framework posited that knowledge sharing and learning could be driven by: 1) communal knowledge creation, 2) networking and collaboration, and 3) intelligent searching integrated into the four knowledge creation processes of Nonaka and Takeuchi's Socialization Externalization Combination Internalization (SECI) model

(1995). These three drivers can be classified, respectively, according to the 21st century competencies as *cognitive* (communal knowledge creation), *interpersonal* (networking and collaboration), and *intrapersonal* (intelligent searching) (National Research Council, 2012). Applying these domains to the SECI model and Web 2.0 technologies, *Socialization* could be achieved through e-mails or video chatting between learners and experts or through the sharing of instructional videos on sites such as YouTube. *Externalization* could be supported by blogs and wikis through which individuals could codify their tacit knowledge to share with the community at large. *Combination* could be achieved using blogs, wikis, and RSS to share codified knowledge and to remix it to create new or more meaningful knowledge. *Internalization* could be supported through technologies such as games and simulations where learners could acquire specific skills; it could also be supported through reflection and sensemaking in communal knowledge building.

McLoughlin and Lee (2007) explored the integration of Web 2.0 technologies into higher education but with a focus on the technological affordances required to link process skills with socio-cognitive outcomes of learners. The affordances they identified were similar to those implemented in the collaborative knowledge building systems (CKBs) discussed previously: connectivity/communication, collaborative discovery and sharing of resources, content creation, and aggregation/modification of knowledge. These affordances could be combined to create what the researchers called Pedagogy 2.0, in which content and curriculum is learner-driven, communication utilizes various forms of multimedia, and processes and learning tasks are authentic, experiential and inquiry-based. This research explores the concept of Pedagogy 2.0 through learner-driven research based on an instructor-provided topic, communication through the sharing of various forms of Internet resources, and authentic learning tasks through the use of constructed responses.

3.7 Social Capital, Intellectual Capital, and Social Media

Everyone is, at least to some extent, a member of some social network. Social networks are defined as "links from people to other people, groups, or information objects" (White, 2011). Social networks can exist in school, at work, and among social connections. Social networks can also exist in communities of practice such as among open source developers or emergency management professionals. Families are social networks by default, meaning that we have no choice in selecting our familial connections. Neighborhoods are social networks based on proximity and shared experiences such as local government, taxes, and school systems.

Social capital is defined as the sum of an individual's connections and the value that individual can obtain from those connections, whether realized or potential (Bourdieu & Wacquant, 1992; Nahapiet & Ghoshal, 1998). More specifically, social capital has been categorized into bonding social capital, which typically provides close, emotional support, and bridging social capital, which is less intimate but provides useful information or alternative viewpoints (Granovetter, 1982; Putnam, 2000). In exploring the impact of social capital on organizations, researchers have proposed an interaction between social capital (the connections and shared understandings between the individuals in the organization) and intellectual capital (the knowledge, skills, and capabilities of the individuals in the organization) (Nahapiet & Ghoshal, 1998). These researchers cite combination and exchange of knowledge as the two key activities that create intellectual capital. These activities reflect the Combination and Socialization/Externalization knowledge creation processes of the SECI model (Nonaka & Takeuchi, 1995) which is explored in this research.

Some researchers refer to the technologies supporting social networks as *social media* (White, Plotnick, Kushma, Hiltz, & Turoff, 2009). Social media 1) enables the maintenance of social capital through communication between individuals who are already connected and 2) facilitates the growth of social capital by connecting previously unconnected individuals. Additionally, social media supports the dissemination of new knowledge and information sources (White, 2011). According to this definition, social media are distinct from social network sites that are defined as web-based services focusing on maintaining connections rather than initiating new connections (boyd & Ellison, 2007; Ellison, Steinfield, & Lampe, 2007).

Recent research has explored the use of social media in education, in particular focusing on the effects of social capital on learning. However, this research has most often focused on motivation for sharing, rather than the effects of sharing. Results suggest that online learning facilitates the formation of social capital, but mostly in terms of the development of a sense of community, trust, and cooperation (Chang & Chuang, 2011; Daniel, Schwier, & McCalla, 2003). Other research suggests that social capital can develop in virtual learning communities through learner interactions such as the exchange of information and experiences (Daniel, McCalla, & Schwier, 2002). An exploration of the effect of communication technologies on the creation of social capital suggests that the complexity and quality of the ICT must be well aligned with the required forms of interaction in order to facilitate the emergence and growth of social capital in an online learning environment (Biggs & Tang, 2011; Lu, Yang, & Yu, 2013). This is explored in this research through the evaluation of two comparable but different systems as the digital environment in which learning occurs.

3.8 Pedagogical Considerations

Other researchers call for a redefinition of pedagogical practices to transfer more control and responsibility to the learners (Educause Center for Applied Research, 2008; Fiedler & Valjataga, 2011), exploring theoretical foundations such as multiple intelligences, proficiency stages, and cultural dimensions to argue that PLEs can enable learners to select information based on their individual learning preferences (Felder & Silverman, 1988; Kozma, 2003).

To encourage collaborative knowledge building and the evolution of the classroom into a community of learners, researchers have argued for a shift in epistemology, moving away from the instructivist “sage on the stage” model of teaching to the constructivist, “guide on the side” model (Arbaugh & Benbunan-Fich, 2005; Coppola, 1997; Leidner & Jarvenpaa, 1995). Additionally, for collaborative knowledge building to be successful, students must feel responsible for the knowledge being discovered and must be encouraged to build on that knowledge without fear of repercussions (Bielaczyc & Blake, 2006; Scardamalia, 2002).

But how can these epistemological changes translate into effective pedagogical techniques that can encourage collaborative knowledge building and individual learning through the use and sharing of digital resources? In exploring the evolution of instructor roles in online/distance courses, researchers found that virtual professors reported having to modify their approaches to instruction in three areas: 1) intrapersonal roles dealing with how instructors facilitate and influence student relationships and the atmosphere of the class; 2) interpersonal roles affecting the planning and organization of course activities; and 3) cognitive roles dealing with mental processes such as reasoning and information storage (Coppola, Hiltz, & Rotter, 2002). Pedagogy and instructor differences have been found to play a significant role in the effectiveness of collaborative learning (Alavi & Dufner 2005; Hiltz, Benbunan-Fich, Coppola, Rotter, & Turoff, 2000), with some researchers encouraging instructors to implement small group activities and discussions to foster a sense of community and to encourage interactions (Frederickson, Pickett, Shea, Pelz, & Swan, 2000).

Although pedagogical modifications in these areas are particularly critical for instructors in virtual classrooms, they can also be successfully applied in blended learning situations, integrating asynchronous elements such as online discussions into traditional face to face courses. For example, researchers have found that students in blended courses who perceived more motivation and enjoyment from online discussions also reported increased perceptions of learning from those discussions (Wu & Hiltz, 2004). Additionally, when instructors required and graded participation in online discussions, the grades were positively correlated with students' perceptions of learning (Jiang & Ting, 2000).

More recently, research on participation in asynchronous online discussions (AODs) has suggested that empowering students as facilitators of asynchronous online discussions can increase participation. Researchers reported that students were more likely to contribute to a discussion when they were familiar with the student-facilitator or when the student-facilitator had contributed to their own discussion (reciprocity). Other factors contributing to participation in student-facilitated AODs included 1) whether the student–facilitator acknowledged their contributions and encouraged students to participate; 2) whether the student-facilitator summarized contributions or asked for clarification; 3) whether the student-facilitator had established ground rules such as setting expectations regarding prompt responses; and 4) whether the student felt he had something to contribute to the discussion (Hew, Cheung, & Ng, 2010).

Researchers generally agree that, without proper pedagogical support and encouragement, ICT capabilities enabling collaborative knowledge building in educational settings will likely go unused. Instructors must therefore incorporate specific activities into their coursework to encourage students to actively participate in tasks such as using and sharing Internet resources. More importantly, because many students already perform these activities independently when they have a specific need, instructors must encourage the sharing of the results of these activities with the classroom community to develop a collaboratively-built knowledge archive from which all students can benefit. This research formalizes the sharing of resources for collaborative knowledge building and captures actual sharing as occurring in two different systems, Moodle and Pearltrees.

3.9 Issues of Non-Use of ICT Systems for Learning

While participation in real world classroom discussions has been shown to lead to improved learning outcomes, researchers exploring the lack of dialogue in computer-supported collaborative learning environments have posited that, in online collaborative environments, students can 1) learn vicariously by reading the dialogues posted by other students; and 2) learn through reflection when mentally composing a post, even if that post is never submitted (Guzdial & Carroll, 2002). However, researchers have also explored instances in which collaborative activities were not successful, finding three general causes impeding collaborative activities: 1) in highly competitive environments and environments with perceived single right or wrong answers, students were reticent to collaborate because of a perception that their success was in part dependent on the lack of success of others; 2) a feeling of learned helplessness in which students fear admitting their confusion or lack of understanding; and 3) lack of faculty support or integration with course activities (Guzdial, Ludovice, Realff, Morley, & Carroll, 2002).

This research addresses these issues by actively encouraging students to participate in discussions and by creating an environment in which their input is valued and incorrect responses are not penalized. Additionally, the assignments utilized in the research study require complex learning outcomes that eliminate the perception of single right or wrong responses.

3.10 Knowledge Management for Internet Knowledge Resources

This research requires students to utilize Internet knowledge resources for their own learning and subsequently share those resources with their group members for collaborative learning and knowledge building. When Internet resources are used for individual learning and shared with others to enhance collaborative learning, the organization and management of those resources require the capabilities and affordances of knowledge management technologies. Knowledge management (KM) systems must be able to capture, store, and distribute knowledge with the goal of making that knowledge widely available while also enabling the addition of value by individuals through personal context, experience, and interpretation (Davenport & Prusak, 2000).

Researchers exploring knowledge management have proposed that the conversion of information to knowledge involves several considerations which should be supported by KM systems (Davenport & Prusak, 2000). Because Internet resources contain information that learners must convert to knowledge, these activities, listed in Table 3.1, must be scaffolded by systems facilitating learning through managing and sharing these resources.

Table 3.1 Conversion of Information to Knowledge

Consideration	Meaning
Comparison	The learner must assess the information provided by the resource, evaluating it against what is already known or against other trusted resources.
Consequences	The learner must evaluate the information provided by the resource to determine if it is sufficient to complete his knowledge requirements.
Connections	The learner must determine how this new information resource relates to other resources.
Conversation	The learner must explore what other learners think of the resource and the information it provides.

This research explores the use of two systems serving as KM technologies that support these activities. One system (Moodle) is an open source learning management system (LMS) in use at New Jersey Institute of Technology. The other, Pearltrees, is a Web 2.0 technology aligned with the activities of digital curation and resource sharing. While neither of these systems was specifically designed for the purposes of knowledge management, each supports many of the processes described in Table 3.1, making them suitable to KM activities for learning.

3.10.1 Moodle

Moodle is a widely used, open source learning management system (LMS). Designed as a platform for distance and online learning, Moodle provides capabilities such as discussion forums and wikis in which students can post links to Internet resources and annotate them. Depending on the attributes of the forum or wiki, resources posted by students may be shared with only the instructor, with the student's group members, or with the entire class. Moodle's discussion forums are threaded, hierarchical discussions showing the evolution of the conversation both chronologically (oldest to newest) and relationally (who replied to whose posting), thereby providing opportunities for Comparison of resources and Conversation with other learners through both formal and informal annotations and discussions. Forums also provide advanced capabilities such as peer ratings of postings; these advanced capabilities provide support for the evaluation of resources to reflect the Consequences activity. Both forums and wikis further meet the demands of KM systems to capture, store, and distribute knowledge while also supporting the addition of individual context, experience and interpretation. However, Moodle lacks the ability for learners to organize their resources into meaningful hierarchies which is the focus of the Connections activity.

3.10.2 Pearltrees

With the advent of Web 2.0, new social media services have aligned themselves with the activities of resource management and sharing. After exploring systems including Pinterest, Storify, and Scoop.It, the system chosen for this research is Pearltrees.com because it most closely aligns itself with the requirements and capabilities of KM technologies. Pearltrees also addresses some of the shortcomings of learning management systems cited by researchers because it is owned by the student rather than the university, meaning that the knowledge accumulated will persist beyond the course or the student's time at the university.

Pearltrees enables management of an individual's digital resources through a visual, hierarchical organization (Connections), and sharing of resources through the creation of resource-sharing teams and through appropriation of knowledge resources called pearls (Conversation). Pearltrees provides a browser add-on that enables users to browse the Internet in search of helpful learning resources and, with one click, add and organize them into hierarchical Pearltrees. Pearltrees' graphical, drag and drop interface and integration with social media sites such as Twitter and Facebook enable learners to easily capture, store, and distribute knowledge. Notes, comments, and the ability to explore and appropriate pearls from other users support the KM activities of Comparison, Consequences and Conversation. Additionally, Pearltrees supports the KM concept of value added through individual context, experience, and interpretation in notes and comments.

Early research has begun to explore the use of Pearltrees in the domain of education. Because of its inherent affordances for the development of social capital and knowledge sharing, Pearltrees has been tested as a tool to facilitate peer-to-peer learning in a Massive Open Online Course (MOOC) (Purser, Towndrow, & Aranguiz, 2013). An example of a Pearltrees account is shown in Figure 3.1. The blue circle in the center (having a white silhouette) is the Pearltrees user's home pearl tree. From this tree, Pearltrees allows the creation of additional trees to organize Internet knowledge resources. The inner blue circles with white silhouettes each represent individual trees used to organize the stored Internet resources (represented by the outer circles). In the lower left of the tree structure, the blue circle with white silhouette and blue puzzle piece represents membership in a group in which resources can be shared and discussed.

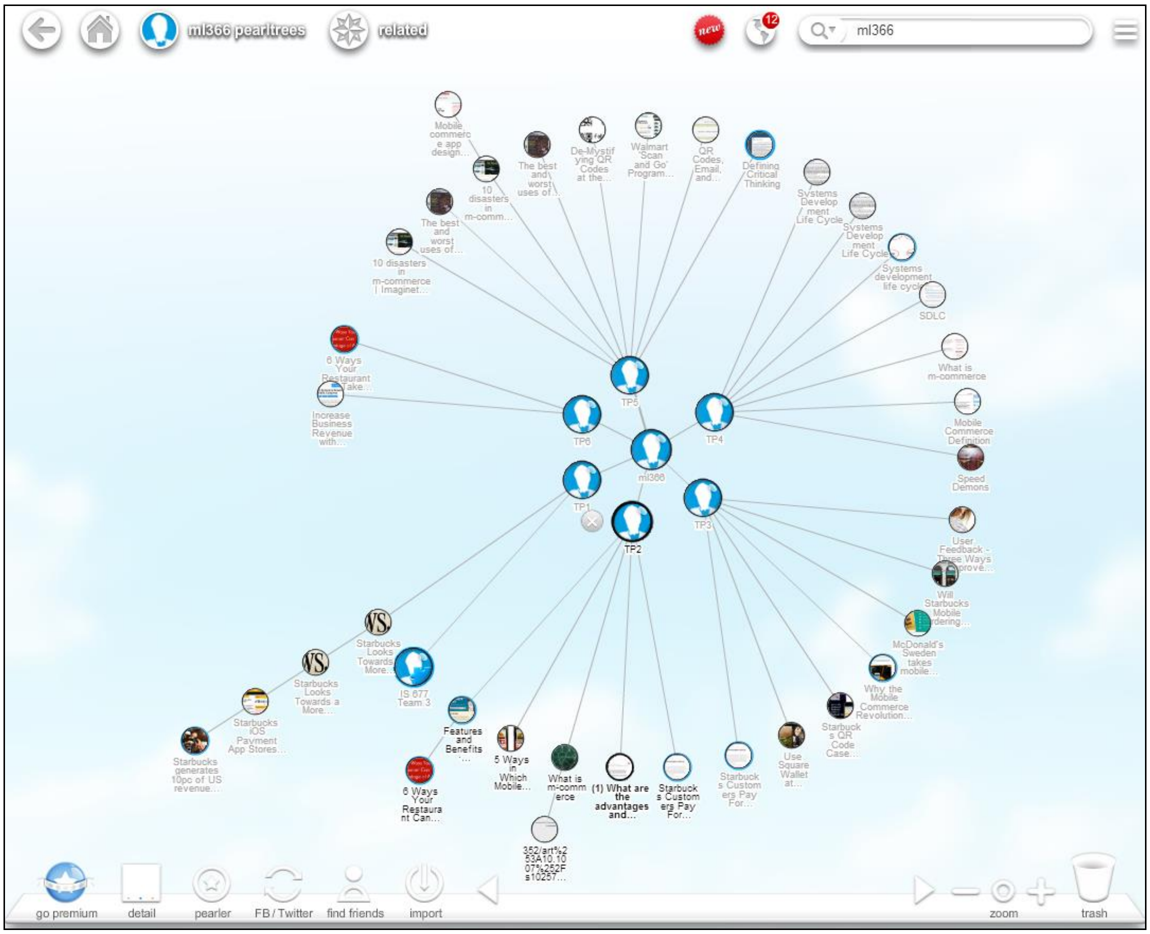


Figure 3.1 This image of a Pearltrees account shows how users can organize related Internet resources into hierarchical trees, as well as how collaboration through teams is supported.

3.11 Summary

This research integrates both individual learning and collaborative knowledge building through specifically designed assignments. The first part of each assignment requires students to conduct individual research on the Internet and to save and cite the resources they used as part of their individual submission. This is followed by a requirement to share and discuss their individual responses and the resources they cited with their group members to arrive at a group response. Because such activities encompass both individual learning and collaborative knowledge building, a system is needed that can support both types of activities. For this research, Moodle (the university's learning management system) and Pearltrees (a Web 2.0 social curation site) are implemented to assess the affordances of each system in supporting the activities of personal learning environments (PLEs), collaborative knowledge building systems (CKBs), and sensemaking systems.

CHAPTER 4

EXPLORATORY INTERVIEWS

There is a wealth of information available on the Internet, and individuals around the globe use this information every day for reasons ranging from entertainment to education. This research is motivated by an interest in students' use of Internet-based resources for learning. It begins with a qualitative study using semi-structured interviews (Wood, 1997) to understand students' current practices using external (Internet-based) knowledge resources in their educational endeavors. Research questions explored in the semi-structured interviews are:

INT RQ1 *What drives students to search for external information resources?*

INT RQ2 *What factors influence the sharing, summarizing, and consolidation of these information resources?*

INT RQ3 *How do these activities support learning?*

INT RQ4 *What technologies do students use to support these activities?*

The variables explored in these research questions are illustrated in Figure 4.1. The interviews reveal that students actively forage for educational resources to address a variety of knowledge needs. Not only do students use Internet-based resources for their own learning, but many also report sharing the knowledge resources, or the information gained from them, with others. The results of these semi-structured interviews and the domain-specific literature discussed in Chapters 2 and 3 informed the research model described in Chapter 5. The results of the interviews are discussed in more detail in this chapter.

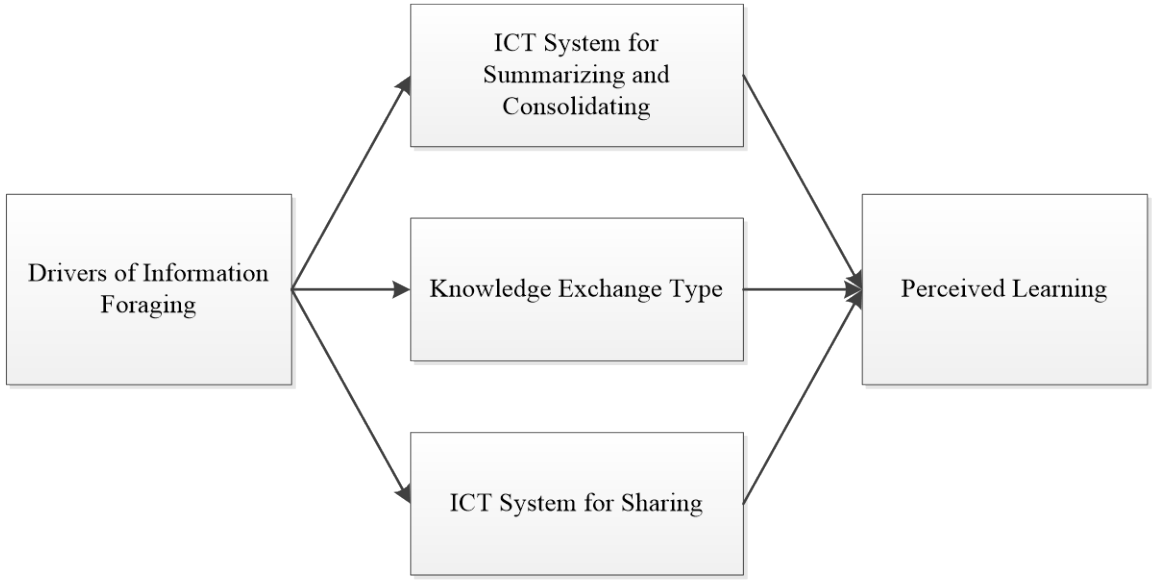


Figure 4.1 The research model shows the variables that informed the semi-structured interview questions.

4.1 Participant Demographics

In total, 54 students were interviewed as part of this research. Students were recruited using two methods. Some students were selected at random based on their presence in a public space on the university campus and their willingness to participate when approached. Other students were recruited through a request for participants from a Master's level Management Information Systems (MIS) course; these students were offered extra credit in the course for participating in the study. A brief demographic summary of interview participants is given in Table 4.1.

Table 4.1 Interview Participant Demographics

Gender	36 Males (66.7%)	18 Females (33.3%)
Education Level	38 Undergraduates (70.4%)	16 Graduates (29.6%)

4.2 Interview Guide Development

To explore the four research questions, a preliminary interview guide was developed based on hypotheses regarding student information foraging and sharing activities and the knowledge building occurring within those activities. Interview questions were built on two underlying theories: 1) Bloom's taxonomy of learning outcomes (1956) informed questions regarding the types of learning tasks requiring external resources and the types of external resources found; and 2) Nonaka and Takeuchi's Socialization, Externalization, Combination, and Internalization (SECI) model of knowledge creation processes (1995) informed interview questions regarding the communication and sharing of external knowledge resources.

So-called "quick and dirty ethnography" (Hughes, King, Rodden, & Andersen, 1994) was used in the development of the interview guide. This methodology involves a first period of field work to familiarize the researcher with the domain. This is followed by an iteration of debriefings and more directed fieldwork. Utilizing this method, a preliminary interview guide was developed, tested, and refined throughout the interview period.

The preliminary interview guide began with a request for demographic information including educational level and degree program. (Gender was noted by the interviewer at the beginning of the interview.) This was followed by course-related questions, including current course load, course delivery mode (face to face, hybrid, or online), and instructor communication mode (paper, e-mail, Moodle, etc.). Subsequent interview questions prompted students to explain 1) how they looked for and assessed information resources, 2) their resource sharing practices, 3) the resource sharing practices of their classmates, 4) how they managed their digital resources, and 5) exploratory questions regarding students' experiences in group projects.

The preliminary interview guide was tested in 10 semi-structured interviews. Summaries of the interviews and key findings were subsequently discussed in a debriefing. Based upon the debriefing, the interview guide was refined and retested through several iterations of interviewing, summarizing, and debriefing. As patterns began to emerge in student responses, questions in the interview guide were refocused to examine information sharing and management activities in greater detail.

The final interview guide was used in 25 (46.3%) of the 54 semi-structured interviews. As in the first interview guide, the final interview guide began with a request for basic demographic information (educational level and degree program). Participants were then asked to list their current courses along with delivery mode and whether or not each course included online discussions and group projects. Asked to think about their current or recent courses, students were asked if they had ever searched for information online to assist with specific knowledge needs related to learning. Additional questions prompted students to describe the complexity of their foraging activities (how difficult it was to find relevant information) and how many resources they felt were required to fulfill their information needs. Subsequent questions explored 1) students' sharing practices, 2) the sharing practices of their classmates, and 3) their experiences with learning in group projects. The final interview question asked students to describe their perceptions of the value of asynchronous online discussions. The first and final interview guides are included in Appendix B of this document.

4.3 Coding and Analysis

From the 54 interview notes summarized throughout the ethnography process, 16 interviews (8 undergraduate, 8 graduate students) were identified as most informative. These interviews were fully transcribed by the researcher; the other interviews were summarized. The transcribed interviews were subsequently analyzed using NVivo following a combination of thematic analysis (Braun & Clarke, 2006) for responses directly addressing the research questions and open coding using grounded theory (Glaser & Strauss, 1967) for other information provided by respondents during the interviews. The nodes created based on major interview themes addressed asynchronous online discussions (AODs), the use of external resources, the curation of those resources, information foraging, resource sharing (or not sharing), and information and communication technologies (ICTs).

Focusing on asynchronous online discussions, several themes emerged, such as the importance of instructor support, the benefit of exposure to different viewpoints, and the overall value of AODs. The use and management (curation) of external resources elicited themes such as 1) types of resources preferred, 2) tools and strategies for managing links to resources and documents such as PDFs, 3) the use of multiple resources to resolve a complex information need, and 4) cases where external resources were not necessary. Information foraging also provided several interesting themes, such as searching for multiple similar resources and the complexity of foraging to find suitable resources.

Analysis of statements related to sharing resources yielded interesting themes such as the importance of pedagogical interventions, formal sharing (required by the instructor), informal sharing with friends or classmates, and reasons for not sharing, including embarrassment/learned helplessness and selfishness. A more comprehensive analysis of the interview results is provided in the following sections.

4.4 Findings

Interviews revealed that, as expected, students are already foraging for external knowledge resources on the Internet. An analysis of student statements relating to INT RQ1 reveals that information foraging activities are either 1) *instructor-driven* based on assignments or class requirements, or 2) *student-driven* based on a student's own internal information needs. In the case of instructor-driven activities, the decision of whether or not to share external knowledge resources (INT RQ2) is determined by the type of activity and its final product or deliverable. In student-driven activities, sharing was infrequent and was predominantly limited to friends or group members, although some students reported sharing with the whole class for personal reasons such as altruism, reciprocity or reputation (Davenport & Prusak, 2000).

4.4.1 Instructor-Driven Foraging

Instructor-driven information foraging is typically performed in conjunction with a specific assignment such as finding sources for a research paper, gathering data for a presentation or topic summary, or adding value to asynchronous online discussions (AODs). How the results of these foraging activities are utilized and shared depends heavily on the type of pedagogical activity and desired learning outcome implemented by the instructor.

For example, online courses rely heavily on asynchronous online discussions (AODs) to encourage students to interact by sharing their understandings and viewpoints on a topic. These same activities are also frequently used to enhance traditional classroom activities in blended learning environments. Depending on the guidelines established by the professor, AODs can be spontaneous discussions or postings of formal summaries and replies about particular topics. Regardless of the specific format, AODs require students to share knowledge with their classmates and so provide relevant examples of resource sharing already occurring in the educational domain.

During the interviews, participants were asked if they had been exposed to AODs in any of their courses and what value, if any, they perceived from such activities. Students at the undergraduate level reported minimal exposure to AODs; in most cases, students reported that their professors did not integrate this type of activity into their courses. A few undergraduate students reported that some of their professors had tried to incorporate AODs but that students did not participate. Charles, a sophomore in the Mechanical Engineering program, said, "*One of my teachers tried to get that going but he never really followed through with it…*" Other professors posted information for the students but did not expect students to respond or to add their own relevant information. Stated Jeremy, "*My biology professor shares news articles relating to what we learned in class… through Moodle*."

At the graduate level, participants' perceptions of AODs and knowledge sharing were more mixed. Graduate students in some courses reported negative experiences with AODs. Brad, a graduate Information Systems student, said that AODS were "…*time consuming. It's something I don't like really a lot. Nobody contributes… the student* *want[s] to just finish what he have and get the grades. And the teacher want[s] to see two replies, three replies … So you don't find anything useful."* Another student said, *"… most of my grad classes were online and the one that doesn't ask you to get involved through summary, I barely share or, if I do, I put the least comment." – John*

However, in other graduate classes, a very different picture emerged. Students in a Management Information Systems (MIS) class reported that the instructor had carefully integrated AODs into the traditional class using specific assignments and guidelines such as adding value through discussions. These students generally agreed that the AODs added to their learning experiences, citing exposure to different viewpoints and understandings as the primary benefit of such activities. Said Annie, a graduate student in the Engineering Management program, *"… we read others' comments and then we realize okay, we have missed on this. And then there is – there were more articles on the website or maybe more articles on the online which I didn't review. Basically, it helps in putting in more knowledge."* Another student in the course stated, *"I actually do find value in it a lot of times because, typically, somebody has a different viewpoint than me so I can see what their perspective of something is or maybe they thought of something that I didn't. So it gives me the ability to then look at their report or a part of their report and think, okay, they thought of it differently than me or they thought of it outside the box and then I can actually take that information and bring it back and then research it if I'm interested or look something up as well. So I feel it adds value if you actually use it correctly." – Dean*

These perspectives suggest that the instructor's guidance and the integration of the AOD activities into the coursework and learning goals play critical roles in the activity's success as a learning experience. By specifying that students had to "add value" and by carefully selecting relevant topics, the instructor of the Management Information Systems course created an environment in which students not only participated in the required summaries and discussions but also reported enhanced learning because of it. Additionally, students in that course reported spontaneously sharing other relevant information they found online with their classmates through Moodle. These insights informed the design of the learning activities implemented in the pilot and larger studies of this research. In particular, clear guidelines were provided regarding not only expectations of student contributions to shared knowledge but also the learning goal of the sharing activity.

4.4.2 Student-Driven Foraging

Based upon interview results, student-driven foraging activities fell into three distinct categories: 1) seeking resources to get more information about a complex concept covered in class; 2) defining or understanding an unfamiliar term or concept mentioned by the instructor; and 3) assisting in the application of newly acquired skills to solve problems. These activities reflect various levels of Bloom's taxonomy of learning outcomes (1956) and are discussed in more detail below.

The Internet can be an invaluable resource for students to catch up or come up to speed on a topic. For example, several students reported looking up concepts that the instructor assumed were already familiar. John, an MBA student, said, "*… I have an engineering background. In the Accounting classes, they use a lot of terms that [are] really related to Accounting like the balance sheet… [the professor] referred to it as [if] everybody was supposed to know so… it wasn't in the book – I looked at it, it wasn't* *there. So I had to go to Wikipedia…"* Another graduate student reported looking up something he had learned in the past but could not remember accurately. "*In business courses, there are fundamentals that every class requires you to know… you just have to know that information offhand because the teacher pretty much expects it of you." – Don.* These activities reflect the lower levels (Knowledge and Comprehension) of Bloom's taxonomy of learning outcomes.

Students also reported looking on the Internet for clarification of concepts discussed in class, suggesting the Comprehension and Application levels of Bloom's taxonomy. For example, several students mentioned relying on YouTube videos to provide additional details about complex topics. John reported looking for videos to understand data packet transfer, saying, *"…each network has its own way to transfer packet, so I have to go on YouTube mostly ..."* Similarly, Don found videos to help understand supply chain: "*… I took a class last semester on Supply Chain … there were videos that helped me from YouTube to understand what the professor was talking about… clarify what he's saying."*

Other types of clarification included understanding a professor's handwriting: *"The teacher goes very fast and so it's a little sloppy, so sometimes the i's and j's – it really matters so I had to go on the Internet just to see it done again by someone else." – David*. These types of activities suggest Bloom's Application learning outcome and possibly even Analysis and Synthesis, as the student must compare his notes with the information found on the Internet to resolve the conflicts and synthesize the multiple sources. Analysis and Synthesis are more clearly suggested in Dean's statement reporting searching for supplemental information on the Internet. "*If there's a topic or a* *subject I don't fully understand I'll have to try to read another article or some kind of white paper to then try to educate myself a little further on the specific subject or matter."*

Applying knowledge learned in class to do homework was a frequent driver for information foraging. David, a senior majoring in Mathematics, reported looking online for resources to help him solve homework problems, saying *"… it's a Math 400 course so it's demanding… I usually just look online to try to get some information about it… I'm not really looking for the answer, I'm just really looking for the technique – how to get there."* Darren, a Biomedical Engineering sophomore, looked for resources to help with homework in most of his classes: *"I guess as far as in Calculus maybe searching how to do a certain problem – how to approach it, maybe something we didn't necessarily cover in class that I can't figure out for myself. I guess the same goes with Physics and most aspects of Chemistry."* Again, these activities clearly suggest the Application level of Bloom's taxonomy but may also integrate Analysis and Synthesis if multiple resources are required to fulfill the student's knowledge need.

Although informal, student-driven foraging activities are more difficult to capture in experimental studies, the information obtained from these interviews is nevertheless informative. It will be used to develop formal learning activities for the larger studies; based on the interview responses, these formal learning activities will address some of the knowledge needs described by students and will reflect a variety of Bloom's learning outcomes.

4.4.3 Sharing the Results of Student-Driven Foraging

Most students reported rarely sharing the results of student-driven information foraging except with friends or group members. As identified in previous research, some students were reticent to share because of a feeling of learned helplessness (Guzdial et al., 2002). Said Hank, a graduate student, *"I didn't want other people to feel like I didn't know the work."* Other students felt that the information was for their own personal benefit. When asked if she shared resources she found helpful, Lisa, an MBA student, replied, *"No, not necessarily. I did it for my own purpose, for myself."* Charles, a sophomore in the Mechanical Engineering program, reported not sharing because nobody asked: *"If somebody asked I'd be more than glad to share but…"* When asked if other students shared helpful resources, one undergraduate student replied, *"Usually maybe when I ask. If they find something they don't just, like, broadcast it." – David*

Other students reported not sharing because of other issues. Hank, a graduate student, said that the resources he found *"…were personal, I didn't really share. Maybe it might be a good idea to share, but I didn't know… I wasn't too familiar with Moodle…"* Darren reported sharing knowledge he gained from YouTube videos during class to initiate discussions, but not on Moodle: *"There are some things I find in YouTube videos that haven't been covered by the professor so I would mention them in class. Like certain tips and tricks… During the classroom I would mention it. I would see what the professor knows about it and then I would have him or her further explain it as well."*

Of the students who chose to share resources, a few students reported simply sending their friends links to helpful resources, but most students reported sharing the knowledge gained from the resource – as Darren put it, *"… what I learned as opposed to* *how I learned it."* Joseph stated he would share information with his lab partners: *"… I try to explain it a little bit. Like, you know, explain where exactly on the page it was needed and what part of the report it was for."* Similarly, John reported sharing summaries of helpful videos with his lab partners, saying *"I kind of provide the summary … I will just tell them, 'Oh, this is a simulation of this, this and this…'"*

When asked about how they shared resources, most students reported sharing information through an in-person discussion or through texts or e-mails, reflecting the socialization activities proposed by Nonaka and Takeuchi (1995). David said: *"I don't really post on Moodle with the Math courses… the Math people don't check the Moodle because we don't use it as a class. Usually we – I share it with them in person, like in study groups…"* However, other students preferred to use externalization methods. Brad, an Information Systems graduate student, described sharing resources he found with his friends via social media: *"…when I find something interesting, I usually share it with Facebook. I share it with Twitter. And I share it with friends. I open a couple repositories, actually, in Dropbox and… I share it with, uh, friends. When they go there, they find – they will find all of the things what I have… we have the same major, same interests. Which is very helpful, sharing this."*

Only a small number of students reported sharing their personal knowledge resources with the entire class through Moodle, noting the lack of response from the professor or other students as a demotivator. Darren related, *"… no one really responds in the Moodle discussion forums… I remember in History class I posted – we were studying for a quiz on the map of Europe, and I found an interactive quiz online where you could actually… they ask you which country is this one and you click on the country.*

And I posted that – a link on Moodle. No one really responded. But I'm sure it helped some people out, so…" This comment suggests the importance of the instructor's encouragement of such impromptu sharing and acknowledgement of students who share.

However, other students reported deriving intrinsic value from sharing helpful resources with classmates through Moodle. "…*you want to [share] yourself just because sometimes you read an article you really enjoy, and then you want to kind of share it to showcase what you were able to find, and then, vice versa you'll find other stuff that's really interesting in [Moodle] as well." – Dean*

These results suggest that informal sharing requires not only technological affordances to simplify sharing but also an environment of collaborative knowledge building in a course. For example, by providing a shared space in which students could informally share interesting and relevant resources, the instructor of the Management Information Systems course provided opportunities for *Socialization* and the exchange of informal, tacit knowledge. Asynchronous Online Discussions (AODs), which the instructor stated had to "add value", enabled *Externalization* through the formalization of each student's knowledge for sharing in a discussion forum. Because students had to read and respond to each other's postings, there were intrinsic opportunities for *Combination* of different viewpoints and understandings. Finally, *Internalization* was achieved through the activities of reading, evaluating, and integrating the information into each student's own knowledge.

4.5 Technologies for Managing and Sharing Resources

Interview research question 4 (INT RQ4) explores the technologies students use to share, summarize and consolidate Internet resources they use for their learning. When asked how they managed their own knowledge resources, participants reported using a variety of tools. In addition to bookmarking pages or adding them to their Favorites on their toolbar, students also used a variety of creative solutions. For example, several students stored helpful links in a draft e-mail or in a Notepad or Word document with annotations to describe the link's relevance. Other students took screenshots of helpful Internet resources and stored them in their Photos folder. Files downloaded from the Internet were stored on a special flash drive to ensure that the resources would not be lost in case of a system crash, saved to cloud storage such as Dropbox, or saved on the student's laptop in a "special" folder.

The fact that students use a variety of tools when storing and sharing informal knowledge resources suggests that the affordances of Moodle (the university's learning management system) may not adequately support the management of knowledge resources for the exchange of tacit knowledge (Socialization) or collaborative knowledge building, or that the learning environment created in the course does not encourage the use of Moodle for informal communication and knowledge sharing. These issues are further explored in the experimental studies as part of this research through the use of two different yet comparable systems as the digital learning environment.

4.6 Summary

Interview research question one (INT RQ1) asks, "What drives students to search for external information resources?" Interview responses revealed that, as expected, students utilized Internet resources for learning, and that their motivation for finding and using Internet resources was either instructor-driven (an assignment) or student-driven (a personal knowledge need). Instructor-driven information foraging typically involved an assignment such as a research paper, a lab requiring supplementary information or, in most cases, asynchronous online discussions to supplement in-class discussions. Student-driven information foraging addressed personal knowledge needs such as obtaining additional information, defining or understanding unfamiliar terms or concepts, or assisting in the application of new skills.

Interview research question two (INT RQ2) asks, "What factors influence the sharing, summarizing, and consolidation of these information resources?" In instances of instructor-driven information foraging for assignments, students were often required to consolidate the relevant Internet resources they found, summarize them in an asynchronous online discussion, and share the resources used to develop their summary in the form of references. In the case of student-driven information foraging, students' decisions to share depended largely on the motivations and personality of the student, although instructor encouragement and acknowledgement was often cited as a motivation for sharing. Summarizing and consolidation were driven by students' own needs and preferences. While some students simply stored links (for example as bookmarks), others stored annotated links in draft e-mails or files.

Interview research question three (INT RQ3) asks, "How do these activities support learning?" Interview responses suggested that, when properly integrated into learning activities, the sharing of resources and multiple viewpoints through asynchronous online discussions added value to students' learning experiences. However, when not properly integrated, such activities were viewed as chores that simply counted towards the student's final grade. Results further suggested that, when instructors required the use of Internet resources (for example, to provide support for discussions), the assignment had to be carefully constructed to ensure that students actually added value through these external sources. This reinforces the pedagogical importance of explaining the value of such activities to the student's learning outcomes, as the type of assignment requiring the use of Internet resources, as well as the perceived value of the task, is important to the learning outcomes of such assignments.

Interview research question four (INT RQ4) asks, "What technologies do students use to support these activities?" Results suggested that students used a variety of technologies and techniques to manage, share, and consolidate information resources. To manage resources, some students used traditional tools such as browser bookmarks while others stored annotated links in files or draft e-mails or even stored screen-captured images in their photo libraries.

In response to technologies used to share resources, when the resources were related to student-driven information needs, many students reported sharing not the resource itself but the knowledge gained from it; these activities were typically conducted using rich exchange formats including face to face discussions and e-mails that facilitated directed communication with the ability to question and respond through multiple exchanges. Some students also reported using social media (Facebook, Twitter, and even Dropbox) to widely broadcast helpful resources they had found to all their friends. Only a few students reported sharing student-driven knowledge resources with classmates through Moodle.

However, Moodle was the primary technology used to share and summarize information resources that were found as part of instructor-driven information foraging. Typically, these resources were summarized and shared through asynchronous online discussions (AODs) that were integrated into blended courses. These results suggest that there are differences in sharing activities depending on the driver (student or instructor) as well as the student's own preferences. Most importantly, these results suggest that there is no single system that facilitates these types of activities. Therefore, in this research, two digital environments supporting Internet knowledge resource management, sharing, summarization, and consolidation are evaluated. These two systems are the university's learning management system Moodle and the Web 2.0 digital curation service Pearltrees. Each of these systems is discussed in more detail in Chapter 5.

Interview results also informed different types of learning activities implemented in the learning assignments integrated into this research. Although student-driven activities are too informal to capture effectively, similar activities were implemented in formal learning tasks. To do so, the researcher worked with instructors to develop varied assignments that required 1) the use of Internet resources to complete an individual response and 2) the sharing of those resources to complete a group response.

CHAPTER 5

RESEARCH MODEL AND HYPOTHESES

In seeking to understand how the activities of using, managing, and sharing Internet knowledge resources can lead to learning, this research is grounded in the socio-cognitive model of learner as active participant in the learning process (Bandura, 2006). Following the 21st century skills of learning for life and work (National Research Council, 2012), the theoretical model begins by exploring the intrapersonal domain through self-reported research variables capturing student characteristics such as self-efficacy, learning goal orientation, and perceived value of the learning task. Other student characteristics explored in the theoretical model include gender and level of study. The theoretical model explores the interpersonal domain through an analysis of communications between learners during the group (collaborative knowledge building) portion of the assignment, perceptions of learner-learner interactions, and perceptions of the quantity and quality of shared knowledge. The cognitive domain is captured through perceived learning as well as actual learning at the individual and group level.

However, the impact of the digital environment is equally important in this research. The digital environment introduces affordances such as asynchronous communication, the ability to organize and annotate Internet resources, and the ability to easily share those resources with others. In that sense, the digital environment serves as the process in an input > process > output paradigm such as that suggested by the Online Interaction Learning Model (Benbunan-Fich, Hiltz, & Harasim, 2005). In the theoretical model proposed in this research, the inputs to the process are the learning task and student characteristics, the process is the activity occurring within the digital environment, and the output is the resulting learning that occurs. The research questions, hypotheses, research variables, and proposed theoretical model are described in more detail in this chapter.

5.1 Research Questions

This research explores learning through the management and sharing of Internet-based learning resources. Interviews with students have suggested that many students utilize Internet resources to augment their classroom learning and that students frequently share these resources with friends or classmates. This research explores these activities through the following research questions:

RQ1 *Do assignments requiring the use, management, sharing, and consolidation of Internet information resources lead to positive learning outcomes at the individual and group level?*

RQ2 *Are characteristics of the student (e.g. gender, level of study, and degree program) related to the variables of interest in the study?*

RQ3 *Are characteristics of the course (e.g. group formation method) related to the variables of interest in the study?*

RQ4 *What pedagogical guidelines/practices best support sharing and managing Internet resources for learning?*

RQ5 *Do students have a preference for type of knowledge exchange (socialization versus externalization) when sharing Internet resources for learning?*

RQ6 *Do learning outcomes differ depending on the ICT system students used for the assignment?*

RQ7 *What theoretical model best describes learning by using, managing, sharing, and consolidating Internet resources?*

RQ8 *What design guidelines characterize a system that best supports sharing and managing Internet resources for learning?*

The research questions and related hypotheses are discussed in the following sections.

5.2 Sharing and Consolidating Resources

The first research question explores whether assignments requiring the use, management, sharing, and consolidation of Internet resources lead to positive learning outcomes at the individual and group level. Research variables capturing sharing and consolidation activities include the quality and quantity of shared knowledge, the knowledge exchange form, and perceptions of learner-learner interactions. These variables and their corresponding hypotheses are discussed below.

5.2.1 Social Capital and Shared Knowledge

Researchers have explored the effects of social capital, specifically interactions within a community, on both the quality and quantity of knowledge created or shared within that community. Some researchers have found that interactions among community of practice members affected the quantity, but not the quality, of the knowledge shared (Chiu, Hsu, & Wang, 2006). In that study, the researchers adapted measures from McKinney, Yoon, and Zahedi (2002) to capture participants' perceptions regarding the quality of the shared knowledge. The quantity of knowledge shared was calculated as an average volume of knowledge shared per month which was then categorized to a seven point scale ranging from one (less than once per month) to seven (more than 30 times per month).

Other researchers have reported that social interactions had a positive effect on the quality but not the quantity of knowledge sharing behavior (Chang & Chuang, 2011). The researchers used some of the measures from the Chiu et al. study (2006) to capture perceptions of the quality of shared knowledge and adapted a second measure to capture participants' perceptions of the quantity of shared knowledge (Wasko & Faraj, 2005).

Both of these studies treated quality and quantity of shared knowledge as outcome variables. In this research, quantity and quality of shared knowledge serve as independent variables that are theorized to affect both actual and perceived learning, suggesting the following two hypotheses:

H1a: *The quality of shared knowledge will have a positive effect on actual learning (individual and group) and perceived learning.*

H1b: *The quantity of shared knowledge will have a positive effect on actual learning (individual and group) and perceived learning.*

Quality and quantity of shared knowledge are captured through participants' perceptions using the scale items from Chang and Chuang (2011). Quantity is also captured as a count of actual resources collected individually and as a group.

5.2.2 Knowledge Exchange Form

The Socialization Externalization Combination Internalization (SECI) model (Nonaka & Takeuchi, 1995) proposes four knowledge creation processes that emerge through the interchange of tacit and explicit knowledge. These knowledge creation processes inform the knowledge exchange form variable captured as part of the theoretical model.

Research has examined the effects of self-explanation and interactive explanation in learning, suggesting that requiring learners to form an explanation of new knowledge improves learning (Dillenbourg, 1999). Because explanation of new knowledge is more likely to occur in Socialization knowledge exchanges, it is expected that participants using the Socialization knowledge exchange form will experience improved learning. This leads to the following hypothesis:

H1c: Knowledge Exchange Form will moderate the relationship between quality of social capital and actual and perceived learning.

H1d: Knowledge Exchange Form will moderate the relationship between quantity of social capital and actual and perceived learning.

This variable was to be calculated based on the nature of the resource-sharing interactions between learners during the group activity. Exchanges would be categorized as either Socialization (a message explaining, assessing, or enhancing a resource) or Externalization (a message announcing or introducing a resource). However, as discussed in Chapter 8, during the quasi-experimental field study, students generally did not use either ICT system to discuss their shared resources. Knowledge exchange form was therefore removed from the final theoretical model.

5.2.3 Learner-Learner Interactions

Interactions between social network members have been shown to improve group communications and information exchange. These improvements subsequently lead to increased social capital (Lu et al., 2013; Wasko, Teigland, and Faraj, 2009). Participants' perceptions of learner-learner interactions (Benbunan-Fich & Arbaugh, 2005) are therefore captured in the post-assignment survey and are explored as an independent variable that may lead to improved learning. This suggests the following hypothesis:

H1e: Learner-learner interactions will have a positive effect on actual and perceived learning.

5.3 Student Characteristics

The second research question (RQ2) explores whether learning results vary according to student characteristics. Some of these questions are exploratory in nature, while others inform hypotheses to be tested as part of the theoretical model. These student characteristics include GPA, gender, level of study, and degree program, as well as familiarity with the topic or technology (ICT system assigned), previous sharing experience, perceived task value, learning goal orientation, and perceived self-efficacy. These variables and their related hypotheses are discussed in the following sections.

5.3.1 Familiarity with Topic and Technology

A student's previous experience with either the technology or the assignment topic may affect their experiences with this type of assignment. For example, students assigned to use Moodle will most likely be familiar with Moodle's capabilities from previous coursework because Moodle is the university's Learning Management System (LMS). Students assigned to Pearltrees are more likely to be using that system for the first time as part of the study; therefore, there may be a learning curve at the beginning of the assignment period for these students to adjust to the new system. Alternatively, the requirement to use an additional system in addition to the university's learning management system may impact the participant's actual use of the system. This suggests the following questions related to Research Question 6 exploring learning outcomes based on ICT system used.

RQ6a: Does participants' familiarity with the technology positively affect their use of their assigned ICT system?

Similarly, students already knowledgeable about the (course-specific) assignment topic are more likely to report higher perceived self-efficacy for that assignment. This suggests two research sub-questions, one relating to student characteristics (RQ2) and one relating to ICT system (RQ6).

RQ2a: *Does participants' familiarity with the topic have a positive relationship with self-efficacy?*

RQ6b: *Does participants' familiarity with the topic positively affect their use of their assigned ICT system?*

At the same time, students more familiar with the assignment topic may contribute less knowledge resources because the topic is already known, so that fewer resources are required to achieve understanding and complete the assignment. Topic familiarity is therefore explored as a mediator in the theoretical model.

H2a: *Topic familiarity will positively mediate the relationship between quality of social capital and actual and perceived learning.*

H2b: *Topic familiarity will negatively mediate the relationship between quantity of social capital and actual and perceived learning.*

5.3.2 Gender and Self-Efficacy

Research has suggested that gender may exert a moderating effect on an individual's perceived self-efficacy, particularly in domains seen as "traditionally" male such as Science, Technology, Engineering and Mathematics (STEM). For example, when students were asked to judge their capabilities to successfully complete the educational requirements and job duties of 10 traditionally female and 10 traditionally male occupations, researchers found that males reported equal self-efficacy with regard to both classes of occupations, while females reported significantly higher levels of self-efficacy for the traditionally female occupations and significantly lower levels of self-efficacy for the traditionally male occupations (Betz & Hackett, 1981). Similarly, gender differences emerged in perceived self-efficacy regarding ability to complete complex computer tasks (Busch, 1995). Bandura (1982) explored the role of self-efficacy in human agency, stating that perceived self-efficacy impacted outcomes such as changes in coping behavior, resignation to failure and even career pursuits. Self-efficacy is particularly critical in explorations of learning because previous research has suggested that individuals with greater perceptions of self-efficacy persevere and expend more effort to master a challenging task (Bandura & Schunk, 1981).

Because this research is conducted at a technological university focusing on STEM disciplines and consisting of an approximately 75 percent male student population, the effect of gender on self-efficacy is explored. This suggests the following gender-based research question:

RQ2b: Do female students report lower self-efficacy than male students?

Gender is also tested as a control in the theoretical model to explore the following hypothesis:

H4a: Female students will report lower perceived learning than male students.

Perceived self-efficacy is captured through a scale developed as part of a study exploring the relationships between student motivation, self-regulated learning, and academic performance of seventh graders (Pintrich & De Groot, 1990). The researchers found that self-efficacy was positively related to students' cognitive engagement and academic performance. This self-efficacy scale was more recently used to investigate learners' locus of control, self-efficacy, and task value as predictors of learner satisfaction, achievement, and persistence in an online university (Joo, Lim, & Kim, 2013). Locus of control, self-efficacy and task value were significant predictors or learner satisfaction, while achievement was predicted by self-efficacy and task value. Perceived self-efficacy is explored as a possible mediator in the theoretical model through the following hypotheses:

H2c: *Self-efficacy will positively mediate the relationship between quality of social capital and actual and perceived learning.*

H2d: *Self-efficacy will positively mediate the relationship between quantity of social capital and actual and perceived learning.*

5.3.3 Learning Goal Orientation

Individuals are driven by two types of goals during task performance: learning goals and performance goals (Nicholls, 1984). In a learning environment, students driven by performance goals are more concerned with getting a good grade than with acquiring new knowledge or skills. Individuals driven by learning goals, on the other hand, seek challenging tasks that result in mastery of new competencies.

Learning goal orientation, application-specific self-efficacy, and enjoyment of using a computer system were introduced into the Technology Acceptance Model (TAM) (Davis, 1989) as motivation variables predicting the use of web-based information systems (Yi & Hwang, 2003). Results of the study suggested that all three motivation variables (self-efficacy, enjoyment, and learning goal orientation) impacted the actual use of the system. However, because the focus of the study was on technology acceptance, the researchers explored technology-specific self-efficacy and defined enjoyment as enjoyment using a computer system. This research therefore adopts the learning goal orientation scale (Yi & Hwang, 2003) but uses other scales to measure self-efficacy and satisfaction with technology. The effect of learning goal orientation in the theoretical model is explored through the following hypotheses:

H2e: *Learning goal orientation will positively mediate the relationship between quality of social capital and actual and perceived learning.*

H2f: *Learning goal orientation will positively mediate the relationship between quantity of social capital and actual and perceived learning.*

5.3.4 Task Value

Task value – the extent to which a learning task is perceived as being of value to the learner – has been shown to be a significant predictor of learner satisfaction and achievement (Joo et al., 2013). Perceived task value is therefore captured in the pre-activity survey of this research and will be tested as a mediating variable in the theoretical model. Task value informs the following hypotheses:

H2g: *Task value will positively mediate the relationship between quality of social capital and actual and perceived learning.*

H2h: *Task value will positively mediate the relationship between quantity of social capital and actual and perceived learning.*

Task value is also expected to be affected by whether or not the course is part of the student's degree program, as courses or activities not directly related to the student's field of study may be perceived as less relevant. This suggests the following research question:

RQ2c: Is perceived task value higher for students enrolled in a course that is part of their degree program?

5.3.5 Degree Program

Degree program may also exert a moderating effect on perceived self-efficacy. For example, if the course implementing the research study is not in the student's degree program, this may impact the student's perceptions regarding his ability to do well in the assigned task. Degree program is captured in the pre-activity survey as part of the demographic information of the participant and is explored through the following research question:

RQ2d: Is perceived self-efficacy higher for students enrolled in a course that is part of their degree program?

Degree program is also tested as a control in the theoretical model to determine if students perform better when the course in which the research assignment occurs is part of their degree program, leading to the following hypothesis:

H4b: Students for whom the course is part of their degree program will report higher perceived learning.

5.3.6 Other Learner Characteristics

Students having a higher GPA may perform better on the research assignment than students with lower GPAs. Therefore, a participant's GPA (for the semester during which they participated in the research) will be requested from the Institutional Research department of the university if the student agrees to release this information by signing a Family Educational Rights and Privacy Act (FERPA) waiver in addition to the research consent form. (See Appendix A for a copy of the FERPA waiver.)

Because GPA is a measure of overall performance, rather than performance on a single assignment or in a single course, GPA is expected to be related to the perceived learning resulting from the research assignment, as well as students' reported self-efficacy and learning goal orientation, as listed in the following research questions.

RQ2e: Do students with higher GPAs report higher levels of perceived learning than students with lower GPAs?

RQ2f: Do students with higher GPAs report higher self-efficacy?

RQ2g: Do students with higher GPAs report higher learning goal orientation?

The participant's level of study (undergraduate or graduate student) is captured in the pre-activity survey as part of the demographic information. This data is explored as a control variable to determine if there are any differences between undergraduate and graduate students in terms of performance, participation, and perceptions.

H4c: Graduate students will report higher perceived learning than undergraduate students.

5.3.7 Previous Sharing Experience

The pre-activity survey prompts students to provide information regarding previous sharing habits, asking if they had ever shared helpful resources from the web with friends or classmates. If students respond positively, the pre-activity survey further prompts them to select all the methods used to share (discussion, e-mail, social media, etc.). Previous sharing of Internet resources may influence 1) participants' willingness to share resources during the assignment, and 2) participants' satisfaction with the technology. This suggests the following research sub-questions:

RQ2h: Do participants reporting previous sharing experiences also report higher satisfaction with their assigned system?

RQ2i: Do participants reporting previous sharing experiences also report higher perceived quality and quantity of shared knowledge?

5.4 Satisfaction with ICT System

Wang (2003) developed and tested a scale capturing learner satisfaction with an e-learning system. The scale captured four distinct features of satisfaction with an e-learning system: Interface, Learning Community, Content, and Personalization. In the original study, the Content construct captured students' satisfaction with the instructor-provided content in an e-Learning system, while the Personalization construct measured the extent to which the e-Learning system monitored individual student progress and allowed customization of learning modules. Therefore, these two constructs were not considered as applicable to capturing learner satisfaction with technology in this research. Instead, only the learner satisfaction with the Interface and learner satisfaction with the amount of support for the Learning Community are captured in this research through the post-activity survey. System satisfaction is explored through the following hypotheses:

H2i: System satisfaction will positively mediate the relationship between quality of social capital and actual and perceived learning.

H2j: System satisfaction will positively mediate the relationship between quantity of social capital and actual and perceived learning.

5.5 Managing Knowledge Resources

The act of locating, organizing and managing Internet resources for education has been shown to improve learning (Antonio & Stagg, 2012; Marchionini, 2006). Research question six (RQ6) explores differences resulting from performing these activities using two different information and communication technologies (ICTs), each with similar yet different capabilities.

Students participating in this research will be randomly assigned to use either Moodle or Pearltrees to complete their individual and group assignments. Although the affordances of each system are different, the experimental design utilizes the capabilities of each system to best support the desired activities. For more information on the tasks and their implementations in each system, see Chapter 7.

The affordances of Pearltrees are more closely aligned with Web 2.0 technologies, knowledge management activities, and are also owned by the student rather than the university. Additionally, Pearltrees has been shown to encourage peer-to-peer learning in MOOCs (Purser et al., 2013). Research question six (RQ6) therefore explores the effect of the assigned ICT technology on learning outcomes. A related sub-question explores whether the number of resources stored by students in their assigned systems affects perceived learning.

RQ6c: Do students who store more resources in their assigned system report higher perceived learning?

5.6 Outcome Variables

Outcome variables include actual learning and perceived learning. Actual learning was to be captured at the individual and group level by scoring of individual and group submissions against an instructor-approved rubric by two independent scorers with prior training to achieve an acceptable rate of inter-rater agreement. However, several factors required the elimination of the independent scoring component of this research. First, despite training, the independent raters of the pilot study assignments had difficulty in reaching agreement on many of the scores. To further complicate this matter, several assignments in the larger study allowed students to select different topics or case studies for research; this would have made it impossible to adequately train raters to achieve any sort of agreement. Therefore, instructor assignment grades were used to capture actual learning for students who consented to release their assignment grades by signing the Family Educational Rights and Privacy Act (FERPA) waiver included in the consent form.

The use of instructor grades, however, is also problematic. An analysis of the grades (discussed in detail in Chapter 8) revealed that grades suffered from highly kurtote distributions and were also subject to significant instructor inconsistences as instructors varied in terms of whether they tended to give high or low grades. Additionally, it should be noted that grades are often not an “objective” measure of learning. Suppose a student starts with very little knowledge on a topic that would yield a score of, for example, 10% on an examination, but at the end has improved their knowledge to a score of 60%. This would still be considered poor learning according to the grade, but the student would actually have learned a great deal. For these reasons, actual learning is reported but should be taken as an indicator and not as a true measure of learning.

Because actual (measured by grades) and perceived learning have been shown to be distinct constructs and should be treated as such (Alavi, 1994; Hiltz, 1994), this research also captures students' perceptions of their learning (Benbunan-Fich & Arbaugh, 2006) in the post-activity survey. Because of the inconsistencies found in actual grades, perceived learning is used as the output variable in the theoretical model.

5.7 Initial Theoretical Model

Figure 3.1 illustrates the proposed research model, including all the independent, dependent, mediating, moderating, and control variables. Mediating variables are those variables that explain the relationship between the predictor or independent variables and the criterion or dependent variables; moderator variables are variables that moderate the direction or strength of the relationship between the independent variables and the dependent variables (Baron & Kenny, 1986). Not all of the possible relationships proposed were significant; hypotheses and variables were subsequently eliminated from the final model tested if bivariate or moderating (3 variable) relationships, tested individually, were not statistically significant at the 95% confidence level. The revisions to the theoretical model are discussed in detail in Chapter 9.

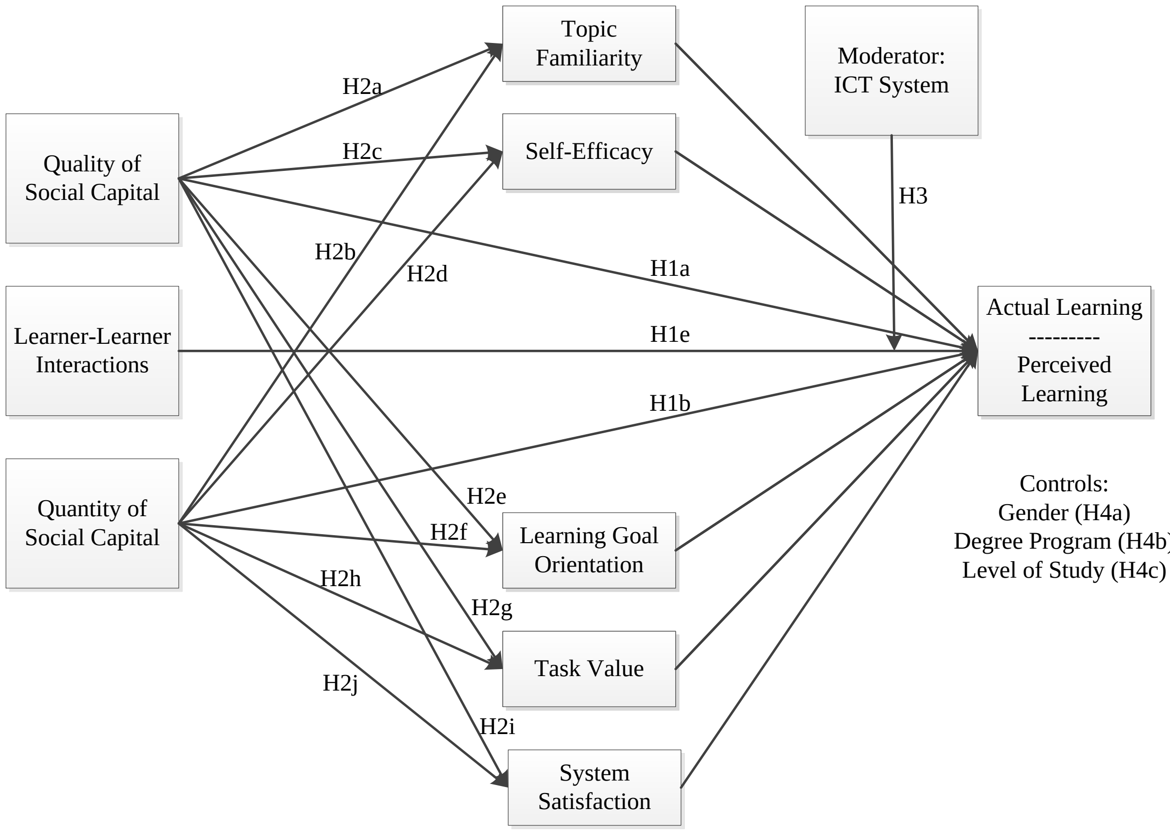


Figure 5.1 Initial theoretical model showing all proposed relationships between research variables.

5.8 Design Guidelines and Pedagogical Practices

Research questions four (RQ4) and eight (RQ8) are exploratory and are not captured in the theoretical model. RQ8 explores design guidelines that would characterize a system that best supports sharing and managing digital resources for learning. Design guidelines were evaluated through participants' responses to measures capturing their satisfaction with the ICT technology, their participation in their assigned systems, and any comments/feedback provided through the post-assignment surveys in courses in which students were exposed to both systems. Similarly, pedagogical guidelines (RQ4) were explored through the use of a variety of assignment types (pre-learning, business case studies, deeper exploration of topics). Participants' experiences with these pedagogical practices and assignment styles were evaluated through their participation in the assignments and any comments/feedback provided through their courses or instructors. The results of these exploratory research questions can provide recommendations for new or enhanced KM systems for learning and best practices for implementing assignments utilizing Internet resources in coursework.

CHAPTER 6

RESEARCH METHODOLOGY

The results of the semi-structured interviews informed the development of the subsequent research questions and theoretical model discussed in Chapter 5. These research questions and theoretical model were tested in a quasi-experimental field study (Campbell & Stanley, 1963) over the course of two semesters. To develop and refine the design of the larger study, several preliminary studies were conducted: 1) a think-aloud protocol testing the systems, instructions and instruments to be used in the pilot and larger-scale studies; 2) a pilot study implementing individual and small group learning activities using one of two systems (Moodle or Pearltrees); and 3) instructor discussions to solicit participation and input regarding appropriate course activities to be used in the larger scale study.

Information collected from the think aloud protocol, pilot study, and sampling plan discussions with instructors (described in more detail in this chapter) were used to finalize the design details of the larger, quasi-experimental field study conducted over two semesters using at least three different Information Systems courses. More specifically, these design details included the method of collecting resources and capturing system utilization, the adequacy of the survey instruments (pre- and post-assignment surveys) and the assignment instructions, and the usability of the two experimental environments (Moodle and Pearltrees). Discussions with instructors willing to integrate the research activity into their courses yielded a preliminary sampling plan design and pedagogical recommendations for suitable learning activities for the research assignments. Finally, the literature review and preliminary analysis of the pilot study data suggested categories of validity evidence.

6.1 Preliminary Studies

To understand how students currently use Internet resources for learning, this research began with semi-structured interviews exploring 1) the drivers of information foraging for learning; 2) the use of various information and communication technology (ICT) systems for summarizing, consolidating, and sharing the identified resources; 3) the method used to exchange or share the resources or the knowledge gained from them; and 4) the perceived learning occurring through such activities. These results informed the development of the theoretical model and the design of the preliminary studies which were subsequently used to finalize the details of the larger scale, quasi-experimental field study. To test the instructions and the ICT systems to be used in the pilot study and larger field study, think aloud protocols were conducted. After refinements informed by the think aloud protocols, the pilot study was implemented to further test the instructions and systems. The pilot also tested the survey instruments and an assignment requiring individual and group work based on Internet learning resources in an actual classroom setting. At the same time, sampling plan discussions were conducted with instructors to identify an acceptable sample of students to be invited to participate in this research. These instructor discussions also identified suitable assignments for use in their respective courses. Each of these preliminary studies is discussed in the following sections.

6.1.1 Protocol Analysis

To test assignment instructions, ICT system instructions, and system compatibility, think-aloud protocol analysis (Boren & Ramey, 2000; Hayes, 1978) was used to observe and record students performing a mock assignment using either Moodle or Pearltrees. For this study, a group of five students were recruited through the Junior level Writing for Science, Technology and Society course and were offered $10 for their participation in a 45 minute study. Participants were randomly assigned to use either Moodle or Pearltrees to perform two activities; three participants used Pearltrees and two participants used Moodle.

The think-aloud protocol studies were conducted in a computer laboratory environment. Sessions were scheduled at times convenient for each individual participant. Upon arrival, the participant was informed of his rights as a research study participant and was then asked to complete a consent form and an optional FERPA waiver to allow the researcher to obtain a current GPA for the student.

Upon completion of the consent forms, the participant was given basic instructions describing the research task, her assigned system, and the format of the think-aloud protocol. Because participants were using two different systems (Moodle and Pearltrees), the instructions provided system-specific information in addition to the general task instructions. Participants using Moodle received instructions regarding the use of a Moodle wiki; participants using Pearltrees received instructions in the use of that system. (The Pearltrees instructions for the think aloud protocol are included in Appendix C of this document.) At that point, the student was given a computer equipped with Camtasia Relay to record the participant's on-screen activities and utterances. The student then read the detailed study instructions and was given 15 minutes to complete the first task. This task required the participant to respond to the following question:

"Describe the key elements of the traditional Japanese tea ceremony. Save and cite your sources."

The question was provided on the printed instructions and was also made available in the participant's assigned system. Participants assigned to Moodle were provided a private Moodle wiki; participants using Pearltrees were provided an empty Pearltrees account for the individual task.

During the think aloud protocol, the researcher limited her interaction with the student, only intervening when necessary or to remind the student to think out loud, although some students tried to initiate conversations with the researcher during the protocol.

Upon completion of the first activity, the participant was provided with instructions for the second activity. In this activity, the participant compared and contrasted different types of tea (white, green, oolong, and black). To simulate a group activity, three resources of varying relevance were provided in the Moodle group wiki and in the team Pearltree to simulate resources shared by others. The participant was given the opportunity to review the provided resources and was asked to find at least three additional sources to assist in explaining the different varieties of tea. Each participant was given sufficient time (anticipated to be about 15-20 minutes but up to 30 was allowed) to evaluate the existing resources, identify some additional resources, add them to the system, and respond to the questions.

Upon completion of the think-aloud protocol, a brief post-activity interview was conducted. This interview prompted participants for immediate reactions to their assigned systems, the task and instructions, and the perceived value of the shared knowledge resources.

Data collected through the think-aloud protocol study included 1) the spoken thoughts and utterances of the participants which were transcribed for analysis; 2) the resources stored for the two parts of the study; 3) the resources cited in the responses; and 4) the responses themselves. The responses were evaluated against a rubric to assess their quality and to pretest the design of subsequent evaluation rubrics.

Some problem areas became clear during the think aloud protocol study period. In particular, students generally skimmed the instructions; therefore, assignment instructions for the pilot study were revised to highlight key instructions such as the storing of resources. Additionally, instructions for using the assigned system (Moodle or Pearltrees) were removed from the assignment instructions and put into a separate document to reduce the risk of the information becoming "lost" when students skimmed through the packet. Students had difficulty editing in a Moodle wiki as the interface is not self-explanatory and the wiki feature in Moodle is not widely used. In general, however, results of the think-aloud protocol study suggested that Moodle and Pearltrees were both adequate systems for use in this research, providing the necessary affordances to explore learning through the use and sharing of Internet resources.

6.1.2 Pilot Study

To adequately test the experimental design in a classroom setting, an entire section of the Information Systems graduate-level Systems Analysis and Design course (IS_663_FL13) was invited to participate in a pilot study during the fall semester of the 2013 academic year. Implemented as a three-week long, graded course assignment and developed with the instructor's approval, the pilot study required students to explore a previously introduced topic. (The assignment was extended over three weeks due to a holiday that occurred in the second week of the assignment.) During the first two weeks of the assignment, students worked individually. After submitting individual summaries with citations, students worked with their group members to consolidate the information from their individual resources and summaries to create a group summary, again providing citations to the resources used.

Students managed and shared their individual and group-level resources for the assignment using their assigned system. The researcher had access to students' accounts in both Moodle and Pearltrees, and during the individual assignment period, the researcher collected the following data: 1) the number of resources saved to the system; 2) the URLs of the resources; and 3) any annotations made by the students regarding the resources. During the group assignment period, the researcher collected the following data: 1) the number of resources shared in the group area; 2) the number and percentage of resources shared with the group by each individual; 3) the number and type of annotations or comments made by the students regarding the group resources; 4) any direct discussions between students (to explore the social networks of students during learning activities); and 5) the number of resources appropriated (if any) by individual students (for students using Pearltrees). Table 6.1 lists the research variables collected and their methods of collection.

Table 6.1 Data/Variables Collected and Collection Method

Collection Method	Variables/Data
Pre-assignment survey	Self-efficacy, task value, learning goal orientation, previous sharing experience, familiarity with technology, topic familiarity, level of study, and degree program
Post-assignment survey	Learner-learner interactions, quality of shared knowledge, quantity of shared knowledge, assigned ICT system, system satisfaction, and perceived learning
Assigned system usage	Quantity of individual, shared, and group resources, interactions, knowledge exchange form
Submitted assignments	Number of resources cited (individual and group), URLs of resources cited, and quality of submissions

As an additional method of evaluating the learning that occurred through the research assignments, the following information was also requested: 1) the individual and group grades for this assignment were requested from the instructor; and 2) the student's current GPA (at time of participation in this research) was requested from the Office of Institutional Research. In order to obtain this data, students were asked to sign a Family Educational Rights and Privacy Act (FERPA) waiver in addition to the research participation consent form. For students who consented to participate in the research but did not give permission to disclose their assignment grade and GPA, these fields were omitted from their research data. The approved consent form and FERPA waiver are included in Appendix A of this document.

6.1.3 Sampling Plan Instructor Discussions

Because this research had to be conducted in a classroom environment, instructors willing to participate in this research were solicited through an e-mail prepared by the researcher and approved by the Information Systems department chair. Courses offered every semester were given higher priority so that assignment tasks could be repeated over the course of the spring and fall 2014 semesters. Once several instructors and courses had been identified, the researcher worked with these instructors to determine the time period during which the research assignment would be conducted and outline an appropriate learning activity and constructed response task.

Based on the instructors' input, the researcher created constructed response tasks for the individual and group submissions for each course. These constructed response tasks were submitted to the instructors for approval prior to modifying the instructions and creating the required forums in Moodle. To ensure consistency across all courses, the overall assignment instructions remained unchanged; only the questions in the constructed response task were changed to suit each course's assignment. The assignment instructions and constructed response task prompts for the pilot study are provided in Appendix D of this document. Instructions and constructed response task prompts for the larger study are provided in Appendix E.

Courses included in this research are:

- Requirements Analysis and Systems Design (undergraduate)
- Database Design Management and Applications (undergraduate)
- System Analysis and Design (graduate)
- Information Systems Principles (graduate)
- Information Systems Strategy (graduate)

Additionally, one course from the Science, Technology and Society program) was also included.

6.2 Quasi-Experimental Field Studies

Over the course of two semesters (Spring 2014 and Fall 2014), students from the courses listed above were invited to participate in the quasi-experimental field study (Campbell & Stanley, 1963). As described earlier, appropriate one- to two-week long graded assignments requiring the use, management and sharing of Internet resources were developed with instructor input and were subsequently incorporated into course activities. These activities occurred at any point throughout the semester; scheduling was coordinated with the instructor to ensure that the research assignment was introduced and completed without disruption to the existing course syllabus.

The field studies followed a modified nonequivalent control group design (Campbell & Stanley, 1963) in which students completed a pre-assignment observation (O) in the form of a survey, were exposed to the assignment and one of two ICT systems (X), and then completed a post-assignment observation (O) through a second survey.

O	X	O
O	(X)	O

Examples of activities that were incorporated into the courses for the purposes of this research include:

- A pre-learning activity in which students researched an upcoming topic prior to its introduction in class
- A case study in which students explored and proposed solutions to a controversial or ethical issue
- A supplemental learning activity in which students explored in greater detail a topic introduced in class

Regardless of the specific activity, students were asked to first explore the topic individually, save any relevant resources, and submit an individual assignment with citations. After the individual assignment was completed, students were asked to share their resources with their groups and submit a group assignment that would include citations to the relevant resources.

Although the completion of the assignment was mandatory because the activity was a graded assignment, participation in the research portion of the assignment (completing the pre- and post-assignment surveys) was optional and was awarded with extra credit. The equivalent amount of extra credit was offered to students not wishing to participate in the research by providing an alternate assignment, typically a summary of a relevant journal or conference paper. This information is explained in the consent form approved by the Institutional Review Board (IRB) on October 9, 2013 (IRB Protocol Number F172-13). (See Appendix A for a copy of the consent form and FERPA waiver.)

6.3 Experimental Design

The proposed experimental design involves two related learning activities. In the first part of the study, students conduct individual research, collecting Internet resources and composing an individual summary or response to an assignment integrated into their regular coursework. In the second part of the study, students share the relevant Internet resources they used for their individual summaries to discuss the same topic and compose a group summary or response. The use of individual and group responses to the same assignment allows a comparison between the two submissions to assess any changes in quality or completeness.

Based upon the requirements for supporting both individual and group management of Internet resources and knowledge management processes, two systems were evaluated and determined to provide comparable capabilities for implementing the experimental design. The capabilities of these two systems, Moodle and Pearltrees, were evaluated to determine the optimal means of implementing the research activities in each system. In addition, existing instructor practices (such as students working in groups) informed certain study design decisions to alleviate any disruptions to participating instructors and students' learning.

6.3.1 Individual Activity

In the first part of the study, implementation of the experimental design required a private "space" in which each participant could store and annotate her Internet resources. This required that the space be visible only to the participant, the instructor, and the researcher. In Moodle, a private space could be created in two ways. A discussion forum could be made private by labeling each student as a "group" with only one member, and then creating group discussion forums. However, this approach was initially rejected because it was anticipated that some courses participating in the research study may already have created student groups and group discussion forums for actual student group work. The remaining alternative was to use a Moodle wiki. During creation, Moodle wikis offer multiple combinations of visibility and contribution. The *Student-No Groups* wiki type creates an individual wiki for each student that is visible only to the student and any users designated as teacher or teaching assistant. Therefore, a Moodle wiki set to *Student-No Groups* was implemented for the individual portion of the experiment. (Based on results from the pilot study, the quasi-experimental field study utilized private discussion forums which did not conflict with students' existing group forums. This modification is described further in Chapter 7.)

In the Moodle wiki, participants were informed that they could organize their private Moodle area however they saw fit. They could store all their resources on a single page or they could create and link multiple pages. Instructions provided information on utilizing Moodle's capabilities to store resources so that students could organize and annotate their resources if desired.

In Pearltrees, students can create a free, individual account in which they can store links to Internet resources. Students were informed that they could install the browser add-on to store webpages while browsing the Internet, or they could add webpages by going to the Pearltrees.com site and manually creating webpage "pearls." Instructions also provided a brief overview of how the Internet resources (pearls) could be organized within the system. Pearltrees instructions also described the creation of notes within Pearltrees if students chose to annotate their Internet resources, and described the processes of commenting on and picking pearls.

6.3.2 Group Activity

During the second part of the experimental study, students were expected to share the Internet resources they found most relevant for their individual responses with their groups in order to create a group response. In this portion of the study, students required a space in which they could share resources, annotations, and discussions so that they were visible only to their fellow group members and the instructors and researcher.

In Moodle, there are two resources that enable group discussions. The Moodle *Groups-Separate Groups* wiki type creates one wiki for each designated Moodle group;

only students in that group (as well as instructors) can view and edit their group wiki. Moodle discussion forums support a similar setting in which only group members (and instructors) can contribute to the discussion forum and the forum is only visible to the group's members and instructors. In this case, the choice of wiki or discussion forum was less clear. In the think-aloud protocol analysis, wikis were used for the first and second parts of the study to simplify the instructions for participants; however, in the pilot study and larger, quasi-experimental field study, the discussion forum was found to be a more appropriate selection for the group activity as many of the students were already using group discussion forums for group project work. This is the case in the Systems Analysis and Design course (IS_663_FL13) in which the pilot study was conducted and is also the case for some of the other courses included in the larger study as per discussions with instructors.

Pearltrees allows the creation of teams in which groups can share resources and discuss them using comments or notes. Pearltrees teams enable only invited team members to contribute resources to the team's tree. During the individual assignment, the researcher requested the account names for students using Pearltrees. During the group part of the assignment, the researcher created Pearltrees teams for each group; Pearltrees sends e-mail invitations to students who have been invited to join a team. Once students joined, the researcher observed the interactions but did not interact with the students in either condition.

6.4 Pre-Assignment Survey

The pre-assignment survey was administered prior to the pilot study and the quasi-experimental field study. The survey was made available online using

Surveymonkey.com. For students, the use of an online survey enables them to complete the survey at a convenient time and also reduces the risk of lost or forgotten paper survey responses. For the researcher, the use of an online survey simplifies data collection and eliminates data transcription errors.

The pre-assignment survey begins with a request for demographic data including gender, level of study, degree program, and English language proficiency. It subsequently explores the student's previous knowledge sharing habits, familiarity with the two systems (Moodle and Pearltrees), and familiarity with the topic of the assignment or study. Finally, the pre-assignment survey captures the participant's self-efficacy, perceived task value, and learning goal orientation. The questions from the pre-assignment survey are provided in Appendix F.

6.5 Post-Assignment Survey

The post-assignment survey was made available upon completion of the course assignment and submission of the final deliverables to the instructor. The survey was made available online via Surveymonkey.com on the group assignment due date. To correctly correlate the post-assignment survey responses with the appropriate student, the post-assignment survey begins with a request for the student's name and UCID, course name or number, assigned group number, and assigned system. Once responses from the two surveys were matched, student identifiers were used to ensure anonymity of students during analysis.

The post-assignment survey provides several statements exploring learner interactions; these statements are all negatively worded to guard against common method bias. Two additional questions, unrelated to this research, are also included in the post-assignment survey to check for common method bias. The post-assignment survey also captures learner satisfaction with her assigned system, perceptions of the quality and quantity of social capital shared during the group portion of this activity, and perceived learning. The questions from the post-assignment survey are provided in Appendix F.

6.6 Repeated Measures Study

One instructor teaching two of the courses in the sampling plan (Information Systems Principles and Information Systems Strategy) was willing to allow a repeated measures study in his courses by including two research assignments during each semester. Students would complete one assignment using one ICT system (Moodle or Pearltrees) and a second assignment later in the semester using the other ICT system. Both sets of assignment instructions were identical other than 1) the actual questions to be answered as part of the constructed response tasks, and 2) in the second assignment, the instructions remind students to use the system they did not use in the first research assignment.

The repeated measures study asks students to complete two sets of surveys: a pre-assignment survey before each of the two research assignments and a post-assignment survey after each. To reduce the burden on the student during the repeated measures study, the second pre- and post-assignment surveys were modified slightly. Because self-efficacy and learning goal orientation were not expected to change because of the assignment or the system, these items were removed from the second pre-assignment survey. At the same time, several new questions were added to the second post-assignment survey. Three questions are introduced by the following statement:

This was the second assignment of this type you completed for this class. Compare your experience this time to the first time you did this type of assignment and respond to the following statements:

1) During the second assignment, I learned …

2) I liked this second system …

3) During the second assignment, my group members worked....

All three questions provided responses on a five-point Likert-type scale with responses as follows: A great deal less (1), Slightly less (2), About the same (3), Slightly more (4), and A great deal more (5).

The final post-assignment survey also included five open-ended questions asking students what they liked most and least about each system and which system they thought was better suited for this type of assignment.

6.7 Subjects

Because the research activity is a graded, one to two week assignment that is part of the regular coursework, all students in the class were required to complete the assignment. However, participation in the research portion of this activity through the completion of pre- and post-assignment surveys was optional and was awarded with extra credit.

Students were typically assigned to groups of three to four. Whether the groups were randomly assigned or were self-organized depended on the instructor and the organization of the course. In courses where students were already working in groups, the existing group structure was not disturbed. The group selection process (self-selected or instructor assigned) was noted as a course characteristic to be explored in this research.

6.8 Individual and Shared Resources

During the individual portion of the study, the researcher collected the number of resources gathered by the student as well as the URLs of the resources. Any annotations made by the student regarding the resource were also captured. For example, if a student saved a resource to a Moodle wiki and included a brief description of the resource, the description was captured along with the resource. Similarly, if a student assigned to the Pearltrees system added a note to her Pearltree, the note was captured along with the resources added to the tree.

During the group portion of the study, the researcher collected the number and details of the resources shared by students, and all annotations made regarding the resources. Originally, the types of annotations were to be evaluated against the Socialization Externalization Combination Internalization (SECI) model of knowledge creation processes (Nonaka & Takeuchi, 1995) and were to be classified as either Socialization (if the annotation provided an explanation of the resource or provided additional information to the group) or Externalization (if the annotation was only a reference to the resource). However, during the research assignments, students rarely used their assigned systems for anything but resource sharing. Therefore, the categorization of annotations and interactions was not included in subsequent analysis.

6.9 Social Networks

Collaborative activities enable the growth of social networks between students in the same course. During the group portion of the research activity, directed messages were to be used to build a social network identifying direct connections between students. For example, if a student had directly addressed another student in the group, rather than directing annotations to the group as a whole, this connection was to be captured as a connection in each student's network. However, due to the lack of messages between students in either system, social networks of learner-learner interactions could not be built and analyzed.

However, networks were created showing students/groups and the resources they cited in their submissions. The goal of creating such networks was to develop a framework explaining the network structures that result from different types of assignments and identifying key network measures indicating learning outcomes. These student citation networks were also used to investigate cited resources having potential value as educational resources or as indicators of student approaches to the learning activity. To explore these network measures, networks were created for each assignment in the Organizational Risk Analyzer (ORA) tool developed by Kathleen Carley at Carnegie Mellon University. In these networks, students and resources serve as two different types of nodes. ORA provides the capability to calculate centrality measures for each node and store them as attributes. These centrality measures were then exported for subsequent analysis. Results of the social network analysis are discussed in detail in Chapter 11.

6.10 Data Analysis

Data collected as part of this research includes students' self-reported perceptions, counts of participation (resources cited and shared), and actual learning as evidenced by instructor grades. Data collected through the pre- and post-assignment surveys includes demographic information and self-reported perceptions including perceived task value, self-efficacy, learning goal orientation, perceived learning, satisfaction with the technology, and perceptions of the interactions between students in the group portion of the assignment.

Participation and interaction at the individual level were coded as counts of the number of unique resources identified. To analyze ICT system use, the number of resources stored in the student's assigned system was captured. However, to construct the student citation networks, resources stored in the student's assigned system, as well as resources cited in the actual assignment submitted, were included.

At the group level, the number of resources shared and the number of resources cited in the group submission were counted; additionally, a percentage was calculated to reflect how many of the individual resources were cited in the group response. This percentage may indicate if students included all available resources in their group submissions or if they reviewed the available resources and selected only the most relevant resources for inclusion in the group submission.

The empirical data was checked for normality and kurtosis to determine its suitability to the proposed statistical analyses using IBM SPSS Version 22.0.0.1. For univariate analysis, t-tests, Pearson correlations, and Chi-square tests were used to explore research variables of interest having approximately normal distributions. Nonparametric tests such as the Wilcoxon Rank Sum test were used to compare research variables in cases where their distributions were not approximately normal or their kurtosis values were outside acceptable limits (Sposito, Hand, & Skarpness, 1983).

Bivariate analysis was conducted using Pearson correlations to explore relationships between variables. In the repeated measures study, paired sample t-tests and two-way ANOVA were used to determine differences between first and second assignments.

Exploratory and confirmatory factor analysis was used to test the factor loadings of the scale items for the model variables. Using maximum likelihood analysis with Promax rotation, only components with eigenvalues greater than 1.0 and items with factor loadings greater than 0.4 were considered representative (Hair, Black, Babin, Anderson, & Tatham, 2006). Confirmatory factor analysis was used to assess the convergent and discriminant validity of the model constructs, and structural equation modeling was used to test the theoretical model using IBM SPSS AMOS Version 22.0.0.0.

CHAPTER 7

PILOT STUDY

A pilot study was conducted in the fall of 2013 to test the experimental design proposed in this research prior to beginning the larger, quasi-experimental field study. Although the number of participants in the pilot study was too small to achieve statistical significance, the results reported in this chapter were important in evaluating the measurement instruments, other data collection methods, and the use of the two proposed systems for the larger field study.

Students were recruited for the pilot study with the consent of the instructor in a Master's level Information Systems course (Advanced Systems Analysis and Design). Students were informed that the assignment was part of their coursework but that their participation in the research study by completing the pre- and post-assignment surveys was voluntary and would result in extra credit. Students not wishing to participate in the research were offered an equivalent assignment (reviewing a journal paper relating to the same topic) to obtain the same amount of extra credit.

For the pilot study, the instructor suggested a supplemental learning task as the assignment. The instructor briefly introduced the topic of object oriented modeling (OOM) in class. Students were then responsible for researching additional information about this topic using reliable (not necessarily scholarly) sources from the Internet and using these sources to individually respond to five questions. Students were also instructed to create a class model using the concepts of OOM; the class model detailed a theoretical system described by the instructor. Students were given two weeks to complete their individual responses and class model diagrams and submit them for grading through Moodle; two weeks were allotted to account for a holiday weekend that occurred during the individual assignment period.

After the individual summaries were submitted, students were instructed to share their resources with their group members to respond to the same five questions, citing the Internet resources which were most relevant. The class model did not have to be repeated in the group assignment. Students were given one week to complete their group assignment.

During both the individual and group activities, students were assigned to use either Moodle or Pearltrees to collect and organize Internet resources for their individual responses and subsequently share their most relevant resources with their groups to discuss and develop their group responses.

The individual and group summaries were designed as constructed response tasks. The questions that had to be answered in the summaries were developed to reflect five of the six levels of cognitive learning outcomes defined by Bloom's taxonomy (1956). The use of detailed constructed response tasks enables the capture of targeted (specific) items evidencing the perceived and actual learning variables proposed in the theoretical model. Table 7.1 provides the constructed response task questions and their corresponding learning outcomes for the pilot study.

Table 7.1 Constructed Response Task Questions and Corresponding Learning Outcomes

Question	Learning Outcome
Explain the concept of Object Oriented Modeling.	Comprehension
Use this explanation to describe the impact of OOM on software development.	Application
Find at least three (3) online resources that describe an essential characteristic of OOM (e.g. inheritance, aggregation). Analyze any similarities and differences between the resources you find.	Analysis
Provide your own description of this characteristic.	Synthesis
Defend the importance of this characteristic in OOM or argue why it is not applicable or helpful.	Evaluation

Results from the data collection and preliminary analysis are described below.

7.1 Participants

Of the 33 students enrolled in the course implementing the pilot study, 32 indicated their willingness to participate by completing the consent form. Of these 32 participants, 27 also completed the FERPA form agreeing to provide access to their current semester's GPA and course grade on the assignment.

Students had already formed into self-selected groups to work on a semester-long group project. These groups were then randomly assigned to use either Moodle or Pearltrees for the purposes of the graded activity. The distribution of students assigned to each system is shown in Table 7.2.

Table 7.1 Group Sizes and System Assignments

Group	Assigned System	Number of Students
1	Moodle	6
2	Pearltrees	6
3	Moodle	5
4	Pearltrees	6
5	Pearltrees	4
6	Moodle	6
Total	Moodle Pearltrees	17 16

Prior to beginning the course assignment, students were asked to complete a pre-assignment survey. The pre-assignment survey collected basic student demographics including gender, degree program, and if English was their first language. All 32 students (male = 22, female = 10) completed the pre-assignment survey. However, of the 32 students who completed the consent form and the pre-assignment survey, only 25 completed the post-assignment survey. The seven students who did not complete the post-assignment survey consisted of six male students and one female student. Because the research data for these students was incomplete, their pre-assignment survey responses were not included in subsequent analysis. Additionally, of the seven students excluded due to incomplete data, two did not submit individual assignments through Moodle and did not use their assigned systems to collect resources.

The results of the pilot study reported in the remainder of this chapter are limited to the 25 students (16 male, 9 female) for whom complete research data is available.

Because of the small number of complete responses, it is difficult to perform any meaningful inferential statistical tests; statistical results are reported here for informational purposes only. Basic demographic information for the students for whom there is complete data is shown in Table 7.3.

Table 7.3 Pilot Participant Demographics

Gender and Degree Program (N = 25)	Students reporting English as 1st language
Male (n = 16)	10
▪ 6 Master of Science in Information Systems ▪ 3 Master of Business Administration ▪ 3 Other	
Female (n = 9)	4
▪ 6 Master of Science in Information Systems ▪ 1 Master of Business Administration ▪ 2 Other	

7.2 Previous Sharing Experience

To understand students' attitudes and experiences of sharing Internet knowledge resources, the pre-assignment survey prompted participants to indicate whether they had ever shared helpful resources with other students in the past. Of the 25 participants, 20 (80%) responded that they had previously shared helpful resources. The survey then prompted these students to select all the methods they had used in the past for knowledge sharing. Results suggest that sharing was a fairly common activity among students, and that their preferred methods of sharing supported the exchange of tacit knowledge (the Socialization knowledge creation process) through media-rich formats such as face to face discussions, e-mail, and forum postings in Moodle. The most common

Externalization (exchange of explicit knowledge) tools used were text messaging (SMS), Facebook and Dropbox. Only three participants reported using Twitter.

Table 7.2 Sharing Methods (Pilot Study)

System Used to Share	Number of students
Face to face/discussing	16
E-mail	19
Text messaging	8
Facebook	8
Twitter	3
Moodle	12
Dropbox	9

Three students additionally reported using other means to share knowledge, including Wiggio, Blackboard, and postal mail.

7.3 Familiarity with Technology

At the beginning of the study period, students were assigned to use either Moodle or Pearltrees to collect and manage the Internet resources they would be using for their individual and group assignments. Four questions were included in the pre-assignment survey to capture students' familiarity with these two systems. As expected, most students were familiar with Moodle while very few students were familiar with Pearltrees.

Table 7.5 shows the descriptive statistics (mean, median, mode, skewness and kurtosis) for each variable capturing familiarity with technology (measured on a Likert-type scale with values from Strongly Disagree (1) to Strongly Agree (5) with a Neutral option (3)). Additionally, the distribution of responses for each variable was tested for normality using the Shapiro-Wilk test. Results indicate that, with the small sample size of the pilot study (N=25), none of the variables are normally distributed, although this is not uncommon in Likert-type scale variables. The two variables measuring familiarity with Moodle (FTC1 and FTC2) are both negatively skewed, suggesting that participants had experience using the university's Moodle learning management system. Results of the two variables measuring familiarity with Pearltrees (FTC3 and FTC4) are positively skewed, suggesting that students had little experience with the Pearltrees digital curation service.

Table 7.5 Familiarity with Technology Descriptive Statistics

Variable	Mean	Median & Mode	Skewness & Kurtosis	Shapiro-Wilk
FTC1	μ = 4.8 SD = 0.41	Median = 5.0 Mode = 5.0	Skewness = -1.60 Kurtosis = 0.59	W = 0.493 *p* < .0001
FTC2	μ = 4.72 SD = 0.56	Median = 5.0 Mode = 5.0	Skewness = -1.04 Kurtosis = -1.00	W = 0.565 *p* < .0001
FTC3	μ = 1.96 SD = 0.98	Median = 2.0 Mode = 2.0	Skewness = 1.54 Kurtosis = 3.13	W = 0.772 *p* < .0001
FTC4	μ = 1.84 SD = 0.90	Median = 2.0 Mode = 1.0	Skewness = 0.71 Kurtosis = -0.43	W = 0.817 *p* = .0004

The normality tests and descriptive statistics shown above are based on the results of the pilot study (N=25). Tests for normality were reapplied to the data from the larger, quasi-experimental field study. For data not normally distributed, transformations such as logarithm, square root, and multiplicative inverse could be applied to attempt to achieve a normal distribution. If transformations did not result in normally distributed data, non-parametric tests were used for subsequent data analysis.

The results for the individual items are shown in Table 7.6.

Table 7.6 Familiarity with Technology Individual Items

Item #	Statement	Results
FTC1	I have used Moodle in other courses for online discussions.	Agree = 5 (20%) Strongly Agree = 20 (80%)
FTC2	I have used Moodle to submit assignments or download course materials.	Agree = 7 (28%) Strongly Agree = 18 (72%)
FTC3	I am familiar with the Pearltrees digital curation system.	Strongly Disagree = 8 (32%) Disagree = 13 (52%) Neutral = 2 (8%) Agree = 1 (4%) Strongly Agree = 1 (4%)
FTC4	I have used the Pearltrees digital curation system to manage knowledge resources.	Strongly Disagree = 11 (44%) Disagree = 8 (32%) Neutral = 5 (20%) Agree = 1 (4%)

These results again suggest that, while all participants were familiar with Moodle, most participants had little or no experience using Pearltrees. This dichotomy may subsequently affect participant satisfaction with her assigned system because 1) the lack of familiarity requires an initial learning curve which may frustrate students, and/or 2) the need to access another system in addition to Moodle may be perceived as a hardship by the participant. To explore this further, the post-assignment survey was modified to include additional questions regarding the use of Pearltrees.

First, for participants reporting using Pearltrees for the assignment, the following additional questions were included in the post-assignment survey:

- Did you watch the Pearltrees tutorial video provided in Moodle?
- Did you install the Pearltrees “pearler” browser add-on?

These questions are included to ascertain which resources participants used to simplify their use of the Pearltrees system. These two questions were followed by eight items capturing two scale variables: 1) complexity (Thompson et al., 1991) measures the degree to which a system is perceived as relatively difficult to understand and use; and 2) compatibility (Moore and Benbasat, 1991) measures the degree to which an innovation is perceived as being consistent with existing values, needs, and experiences of potential adopters. A final item was included to capture participants’ attitudes towards the requirement of using another system (Pearltrees) in addition to the university learning management system (Moodle).

In addition, some students were invited to participate in the study more than once if their coursework aligned with the courses implementing the larger study. If a sufficient number of students participated in the research across semesters, their familiarity with the technology should have increased, which may have affected their system satisfaction.

7.4 Mediating Scale Variables

Five scale variables were included in the theoretical model as mediating variables: 1) self-efficacy, 2) task value, 3) learning goal orientation, 4) system satisfaction, and 5) topic familiarity. For each individual item in these scale variables, participants were prompted to provide a response based on a five point Likert-type scale ranging from Strongly Disagree (1) to Strongly Agree (5) with a Neutral option (3).

The individual item scores (N=25) were summed by variable prior to calculating the descriptive statistics shown below. Additionally, a standardized Cronbach's alpha was calculated for all items in each variable as a preliminary test of the validity and reliability of the constructs. These statistics are shown in Table 7.7 below.

Table 7.7 Mediating Variable Descriptive Statistics

Variable	Mean	Median / Mode (Range)	Skewness / Kurtosis	Shapiro-Wilk	Cronbach's alpha
Self-efficacy	µ = 36.96 SD = 4.81	35 / 35 (28 – 45)	Skew = 0.406 Kurt = -0.758	W = 0.922 *p* = 0.058	0.906
Learning Goal Orientation	µ = 21.56 SD = 2.08	21 / 20 (17 – 25)	Skew = 0.224 Kurt = -0.228	W = 0.922 *p* = 0.058	0.730
Task Value	µ = 24.96 SD = 3.06	24 / 24 (19 – 30)	Skew = 0.136 Kurt = -0.727	W = 0.959 *p* = 0.4004	0.855
System Satisfaction	µ = 32.20 SD = 8.08	33 / 37 (9 - 45)	Skew = -0.631 Kurt = 0.159	W = 0.964 *p* = 0.494	0.890
Topic Familiarity	µ = 6.36 SD = 1.78	6 / 6 (2 – 10)	Skew = -0.064 Kurt = 0.427	W = 0.954 *p* = 0.305	0.591

These results suggest that the internal consistencies of four of the five mediating variables are acceptable, with the Cronbach's alpha for topic familiarity falling slightly below the recommended 0.7 level. Given that the sample size for the pilot study is small (N=25), exploratory and confirmatory factor analysis was conducted for all of these variables using the data collected during the larger, quasi-experimental field study to re-assess the item and scale reliability. The results for the individual scale items for each mediating scale variable are briefly summarized in the following sections.

7.4.1 Self-Efficacy

The nine items in the self-efficacy scale captured participants' expectations of their performance on the assignment through the pre-assignment survey. The individual items and their preliminary results are listed in Table 7.8.

Table 7.8 Self-Efficacy Individual Items

Item	Statement	Results
SE1	Compared with other students in this class, I expect to do well on this assignment.	Neutral = 3 (12%) Agree = 13 (52%) Strongly Agree = 9 (36%)
SE2	I'm certain I can understand the ideas taught in this assignment.	Neutral = 3 (12%) Agree = 10 (40%) Strongly Agree = 12 (48%)
SE3	I expect to do very well on this assignment.	Neutral = 2 (8%) Agree = 14 (56%) Strongly Agree = 9 (36%)
SE4	Compared with others in this class, I think I'm a good student.	Disagree = 1 (4%) Neutral = 4 (16%) Agree = 13 (52%) Strongly Agree = 7 (28%)
SE5	I am sure I can do an excellent job on the problems and tasks in this assignment.	Neutral = 4 (16%) Agree = 12 (48%) Strongly Agree = 9 (36%)
SE6	I think I will receive a good grade for this assignment.	Neutral = 2 (8%) Agree = 10 (40%) Strongly Agree = 13 (52%)
SE7	My study skills are excellent compared with others in this class.	Neutral = 9 (36%) Agree = 12 (48%) Strongly Agree = 4 (16%)
SE8	Compared with other students in this class, I think I know a great deal about the subject.	Strongly Disagree = 1 (4%) Disagree = 2 (8%) Neutral = 14 (56%) Agree = 3 (12%) Strongly Agree = 5 (20%)
SE9	I know that I will be able to learn the material for this assignment.	Neutral = 1 (4%) Agree = 17 (68%) Strongly Agree = 7 (28%)

These results suggest that, having reviewed the assignment instructions, participants generally had positive perceptions about their ability to do well in the assignment compared to their classmates.

7.4.2 Learning Goal Orientation

Five items in the pre-assignment survey captured students' learning goal orientation. These items explore participants' attitudes towards taking on challenging tasks that provide more meaningful learning experiences. The individual items and their preliminary results are listed in Table 7.9.

Table 7.9 Learning Goal Orientation Individual Items

Item	Statement	Results
LGO1	I am willing to work on a challenging assignment that I can learn from.	Neutral = 1 (4%) Agree = 14 (56%) Strongly Agree = 10 (40%)
LGO2	I often look for opportunities to develop new skills and knowledge.	Agree = 11 (44%) Strongly Agree = 14 (56%)
LGO3	I enjoy challenging and difficult tasks where I'll learn new skills.	Neutral = 3 (12%) Agree = 12 (48%) Strongly Agree = 10 (40%)
LGO4	For me, developing my knowledge is important enough to take risks.	Agree = 14 (56%) Strongly Agree = 11 (44%)
LGO5	I prefer to work in situations that require a high level of ability and talent.	Strongly Disagree = 1 (4%) Neutral = 4 (16%) Agree = 15 (60%) Strongly Agree = 5 (20%)

These results suggest that participants were generally learning goal oriented and were willing to take on challenging learning tasks.

7.4.3 Task Value

Participants' perceptions about the value of the assignment task were captured through six items in the pre-assignment survey. The individual items and their preliminary results are listed in Table 7.10 below.

Table 7.10 Task Value Individual Items

Item	Statement	Results
TV1	I think I will be able to use what I learn in this assignment throughout the course.	Neutral = 4 (16%) Agree = 11 (44%) Strongly Agree = 10 (40%)
TV2	It is important for me to learn the material in this assignment.	Neutral = 3 (12%) Agree = 10 (40%) Strongly Agree = 12 (48%)
TV3	I am very interested in the content area of this assignment.	Neutral = 3 (12%) Agree = 17 (68%) Strongly Agree = 5 (20%)
TV4	I think the material in this assignment is useful for me to learn.	Neutral = 3 (12%) Agree = 12 (48%) Strongly Agree = 10 (40%)
TV5	I like the subject matter of this assignment.	Neutral = 9 (36%) Agree = 12 (48%) Strongly Agree = 4 (16%)
TV6	Understanding the subject matter of this assignment is very important to me.	Neutral = 3 (12%) Agree = 14 (56%) Strongly Agree = 8 (32%)

These results suggest that the assignment used for this research was perceived as relevant and valuable to the participants. For each course in the larger study, relevant assignments were created with input and approval from the course instructor to ensure that the learning task provided a meaningful learning activity.

7.4.4 System Satisfaction

The post-assignment survey included nine items to capture participants' perceptions about their assigned ICT system (Moodle or Pearltrees). Several of the system satisfaction items are negatively worded. The items and their preliminary results are listed in Table 7.11. Because this variable is expected to differ significantly between students assigned to the two different systems, distributions of responses were calculated to allow an examination of responses by system.

Although some differences in perceptions regarding system satisfaction between the two systems (Moodle and Pearltrees) are evident in the individual item responses, Wilcoxon Rank Sum tests (used to account for the small sample size) indicated that there were no statistically significant differences. This suggests that, for the pilot study, participants' satisfaction with their assigned system is roughly equivalent for both platforms.

Table 7.11 System Satisfaction Individual Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
SS1: The system was difficult to use.					
Moodle	14.29%	64.29%	7.14%	14.29%	0%
Pearltrees	18.18%	18.18%	9.09%	36.36%	18.18%
SS2: The system was user-friendly.					
Moodle	7.14%	0%	7.14%	57.14%	28.57%
Pearltrees	18.18%	9.09%	9.09%	27.27%	36.36%
SS3: The content provided through the system was hard to understand.					
Moodle	28.57%	50.00%	7.14%	14.29%	0%
Pearltrees	27.27%	27.27%	27.27%	0%	18.18%
SS4: The operation of the system was stable.					
Moodle	0%	0%	21.43%	64.29%	14.29%
Pearltrees	9.09%	0%	18.18%	36.36%	36.36%
SS5: The system made it hard for me to find the content I needed.					
Moodle	7.14%	64.29%	7.14%	21.43%	0%
Pearltrees	27.27%	18.18%	18.18%	18.18%	18.18%
SS6: The system made it easy for me to discuss questions with other students.					
Moodle	0%	7.14%	14.29%	64.29%	14.29%
Pearltrees	18.18%	18.18%	18.18%	18.18%	27.27%
SS7: The system made it hard for me to access the shared content from the group.					
Moodle	21.43%	50.00%	0%	28.57%	0%
Pearltrees	27.27%	27.27%	9.09%	18.18%	18.18%
SS8: The system made it easy for me to discuss questions with others.					
Moodle	7.14%	7.14%	21.43%	50.00%	14.29%
Pearltrees	9.09%	27.27%	18.18%	27.27%	18.18%
SS9: The system made it hard for me to share what I learned with my group members.					
Moodle	28.57%	42.86%	21.43%	0%	7.14%
Pearltrees	36.36%	9.09%	18.18%	9.09%	27.27%

7.4.5 Topic Familiarity

Two items in the pre-assignment survey were created to measure students' familiarity with the topic of the assignment. Participants who feel knowledgeable about the topic of the assignment may expend less effort or require fewer resources to complete the assignment. In the pilot study, results suggest that, although the instructor had briefly introduced the topic in the classroom, most students felt there was more information about the topic to be discovered during the assignment.

Table 7.12 shows the descriptive statistics (mean, median, mode, skewness and kurtosis) for each variable capturing familiarity with the topic (measured on a Likert-type scale with values from one to five). Additionally, the distribution of responses for each variable was tested for normality using the Shapiro-Wilk test. Results indicate that none of the variables are normally distributed although, as mentioned previously, this is not unusual for variables reported using Likert-type scales. The two variables measuring familiarity with the assignment topic of object oriented modeling suggest that students were only somewhat familiar with this topic.

Table 7.12 Familiarity with Topic Descriptive Statistics

Variable	Mean	Median & Mode	Skewness & Kurtosis	Shapiro-Wilk
TPF1	$\mu = 3.2$ SD = 1.08	Median = 3.0 Mode = 3.0	Skewness = 0 Kurtosis = -0.65	W = 0.919 $p = .0482$
TPF2	$\mu = 3.16$ SD = 1.03	Median = 3.0 Mode = 3.0	Skewness = -0.35 Kurtosis = 0.20	W = 0.903 $p = .0211$

The normality tests and descriptive statistics shown above are based on the results of the pilot study (N=25). Tests for normality were reapplied to the data from the larger, quasi-experimental field study. These results are discussed in greater detail in Chapter 8.

The results for the individual items are shown in Table 7.13.

Table 7.13 Familiarity with Topic Individual Items

Item	Statement	Results
TPF1	I have a working knowledge of this topic.	Strongly Disagree = 1 (4%) Disagree = 6 (24%) Neutral = 8 (32%) Agree = 7 (28%) Strongly Agree = 3 (12%)
TPF2	I am already very knowledgeable about this topic.	Strongly Disagree = 2 (8%) Disagree = 3 (12%) Neutral = 11 (44%) Agree = 7 (28%) Strongly Agree = 2 (8%)

Because the assignment varies by course, results from these two items can provide meaningful insights into the effect students' existing knowledge has on their perceptions of learning from research about a familiar topic.

7.5 Individual and Group Resources

The first part of the pilot study assignment required students to collect Internet knowledge resources to gather sufficient information to individually respond to five questions regarding the topic of object oriented modeling (OOM). Students were assigned to use either a Moodle wiki or the Pearltrees system to collect resources for their individual responses. Eight of the 14 students (57.14%) who were assigned to use a Moodle wiki did not store any resources in the wiki, although all of these students did cite Internet resources in their individual responses. Of the students assigned to use Pearltrees, four of the 11 students (36.36%) created accounts but did not store any resources in the system. Of these four students, only one did not provide any citations in his individual assignment submission.

Participants' non-compliance with the use of their assigned systems was addressed through several modifications to the larger study. First, although Moodle is familiar to the participants because it is the university's learning management system (LMS), most students are familiar with Moodle discussion forums and assignment submission processes, while few have used Moodle's wiki feature. In addition to this lack of experience with the wiki, the wiki's editing interface is perceived as non-intuitive by those who have used it. Therefore, in the larger study, participants used a Moodle "group" forum that was private to themselves, the instructor, and researcher for the individual part of the assignment and used private group forums shared with their team members for the group part of the assignment.

As discussed previously in this chapter, the non-use of Pearltrees may be the result of difficulty learning the system or resistance to having to access another system in addition to Moodle. Participants' attitudes towards using Pearltrees was therefore explored through additional questions added to the post-assignment survey. Additionally, the assignment instructions were modified to encourage participants to use their assigned systems when storing their individual resources to facilitate sharing those resources during the group part of the assignment, and a video tutorial was created and was provided to students along with the system instructions.

Means, medians, and modes of the count of Internet resources stored in each ICT system, as well as the count of Internet resources cited in the students' submissions, are shown in Table 7.14.

Table 7.14 Internet Resources by System

System	Range	Mean	Median	Mode
Moodle (n=14)	0 – 13	3.57	0	0
Pearltrees (n=11)	0 – 9	4.18	4	0

To explore Internet resources as a form of social capital, a social network was created using the Organizational Risk Analyzer (ORA) program. This network is a two-mode, bipartite network made up of students and their cited Internet resources. In Figure 7.1 below, the red circles represent students and the blue triangles represent their cited resources. Surprisingly, few of the cited resources were common to more than a few students, and most resources were unique to individual students, as evidenced by the low density of the network (density = 0.047). Network density compares the number of links that exist in the network with the maximum possible links; a low density is interesting because it is expected that most students used the same entry point to locate the resources (Google, Bing, etc.) yet they found mostly unique resources.

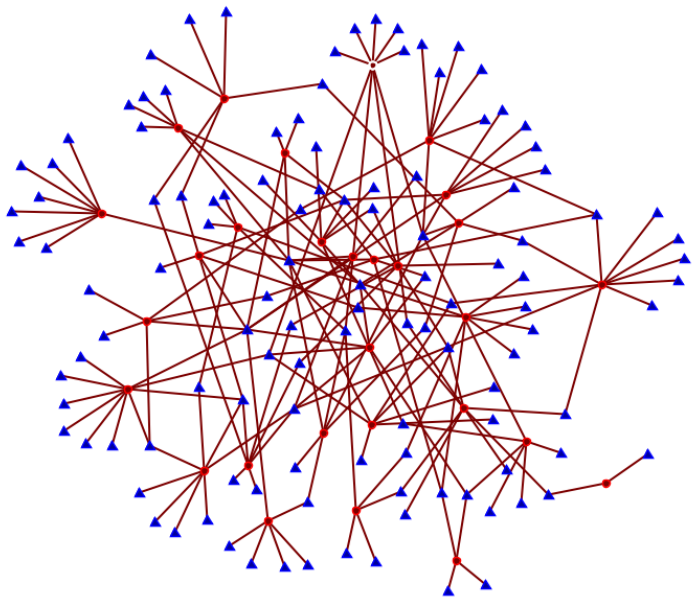


Figure 7.1 Network showing students and their cited knowledge resources. The density of the network suggests that many of the resources cited were unique to a student.

After their individual responses were submitted, students were instructed to share their resources with group members to further discuss the topic of OOM and to respond to the same set of questions as a group. Students had already been working together in groups on a semester-long group project in this course; therefore, the six existing groups were maintained to minimize disruption to their coursework. Three of these groups were provided with private group discussion forums in Moodle in which to share their resources and discuss their group responses; the other three groups were invited to join private teams on Pearltrees in which they could share and discuss resources. (During the individual assignment, participants were assigned to systems based on their group membership to ensure that they would use the same system for their individual and group work.)

In general, students did not simply share their resources with group members; they shared their individual submissions. This enabled them to review each other's responses and build on them for their group submissions. The number of resources cited in the group responses was collected to explore whether groups simply copied all of the citations from the individual responses into the group response or if they reviewed the citations and selected only those most relevant or those considered most reliable. Of the six groups, only one group copied all of the Internet resources from the individual submissions into the group submission. The other five groups selected only the most relevant resources to cite in their group submissions. Table 7.15 displays the number of collective resources available from individual summaries and the number of resources actually included in the group summary by group.

Table 7.15 Resources Available versus Cited by Group

Group Number and System	Resources Available from Individual Submissions	Resources Cited in Group Submission
Group 1 - Moodle	31	7
Group 2 - Pearltrees	14	14
Group 3 - Moodle	27	12
Group 4 - Pearltrees	37	3
Group 5 - Pearltrees	19	6
Group 6 - Moodle	31	9

It is interesting to note that Group 4 had the most resources available based on their combined individual submissions yet cited only three resources in their group submission. Figure 7.2 displays the network map for resources by group. In this diagram, red circles represent groups, and blue triangles represent the resources cited by the group in their assignment submission.

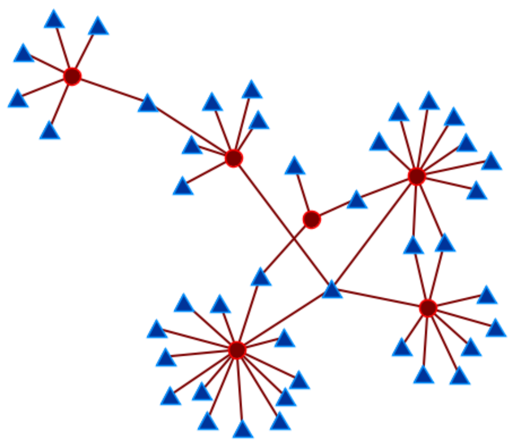


Figure 7.2 Network of resources by group. Most groups filtered their list of cited resources; only one group copied all the resources from their combined individual submissions into their group summary.

It is interesting to note that one group assigned to use Moodle and one group assigned to use Pearltrees did not use their assigned systems at all to complete their group submissions. It could be that these students met face to face to complete the assignment or used some other means of communication.

To capture methods of knowledge exchange (Socialization, Externalization, and Combination), the interactions between group members were captured for coding and evaluation. However, during the pilot study, few groups interacted in any meaningful way through their assigned systems. The assignment instructions were modified to try to encourage students to communicate in their assigned systems. However, even after modification of assignment instructions, students still chose to communicate through other means (face to face meetings or e-mails, for example), resulting in insufficient data available to perform a meaningful analysis of the knowledge exchange method.

7.6 Individual and Group Response Evaluations

Two independent raters were employed to score the individual and group responses. These raters (undergraduate Information Systems students) were selected because of their familiarity with the concept of object oriented modeling. This familiarity would enable them to better assess the quality of the individual and group responses. All responses were anonymized prior to scoring so that the two raters had no information about the author(s) of the submissions.

Training was required to ensure consistent scoring between the two independent raters. Prior to training, five sample submissions were evaluated and scored by the researcher; these samples, along with the scoring rubric (categories provided in Table 7.16 below, rubric provided in Appendix D), were subsequently given to the raters to review. After reviewing the samples, the raters scored each of the five sample submissions in each category included in the rubric. Their scores were subsequently discussed to achieve a common understanding for each category.

After training, the raters independently evaluated the submissions and input their scores using a web-based scoring system originally created to support web-based rating of e-Portfolios for composition courses at the university (Collins, 2010; Collins et al., 2013). Responses in the scoring rubric were based on a 6 point scale, with 1 representing Very Strongly Disagree and 6 representing Very Strongly Agree. The scale provided no neutral measure to force the raters to provide a meaningful score representing whether the work was above or below average. Cohen's weighted Kappa was calculated for each question to determine the level of agreement between the two raters.

Table 7.16 Rubric, Rater Scores, and Inter-Rater Agreement

Competency	Mean (Rater 1)	Mean (Rater 2)	Cohen's Weighted Kappa
The submission discusses the key elements of object oriented modeling including abstractions of entities, their relationships (associations/multiplicity), attributes and services/methods and messages.	$\mu = 5.17$ SD = 0.878	$\mu = 4.83$ SD = 1.056	0.247
The submission discusses the abstraction of entities in a system through OOM and the use of design patterns.	$\mu = 4.56$ SD = 1.362	$\mu = 4.47$ SD = 1.108	0.387
The submission discusses any one characteristic of OOM classes such as inheritance, aggregation, abstraction, encapsulation and polymorphism. The submission provides a description of the characteristic and mentions discrepancies between different descriptions.	$\mu = 2.56$ SD = 1.182	$\mu = 3.72$ SD = 1.406	0.413
The submission draws on the previous descriptions to create a single, coherent description that accounts for any differences from various sources.	$\mu = 3.97$ SD = 1.765	$\mu = 3.19$ SD = 1.508	0.350
The submission provides relevant and supported arguments about the benefits of OOM and Class Models or provides relevant arguments as to why OOM is not useful.	$\mu = 3.64$ SD = 1.676	$\mu = 3.22$ SD = 1.641	0.451
The class model displays all relevant classes, attributes, services, relationships, and cardinality.	$\mu = 3.31$ SD = 1.600	$\mu = 2.92$ SD = 1.422	0.256
In general, the submission provides a thorough description of the topics and provides evidence of an understanding of the topics of OOM and software design patterns.	$\mu = 4.03$ SD = 1.183	$\mu = 3.58$ SD = 1.273	0.273

The resulting Cohen's Kappa scores suggest that additional training would have been required for the larger, quasi-experimental field study analysis to ensure improved agreement between the raters. However, it was ultimately determined that independent scoring of assignments was impractical for the larger field study.

7.7 Independent and Dependent Variables

After completing the individual and group assignments, study participants were asked to complete a post-assignment survey. This survey included the independent and dependent scale variables: learner-learner interactions, quality of social capital, quantity of social capital, and perceived learning. All items used a Likert-type scale with values ranging from Strongly Disagree (1) to Strongly Agree (5) with a Neutral option (3). Pilot study results (N=25) for these variables are shown in Table 7.17.

Table 7.17 Independent and Dependent Variable Descriptive Statistics

Variable	Mean	Median / Mode (Range)	Skewness / Kurtosis	Shapiro-Wilk	Cronbach's alpha
Learner-learner Interactions	$\mu = 11.68$ SD = 3.97	11 / 11 (4 - 20)	Skew = 0.075 Kurt = -0.399	W = 0.975 $p = 0.776$	0.807
Quality of Social Capital	$\mu = 15.92$ SD = 2.60	16 / 16 (5 - 25)	Skew = -0.743 Kurt = 0.813	W = 0.952 $p = 0.276$	0.861
Quantity of Social Capital	$\mu = 11.20$ SD = 2.48	12 / 12 (3 - 15)	Skew = -0.852 Kurt = 1.900	W = 0.918 $p = 0.047$	0.686
Perceived Learning	$\mu = 34.28$ SD = 5.69	35 / 31 (9 - 45)	Skew = -0.126 Kurt = -0.387	W = 979 $p = 0.858$	0.881

These results suggest that the internal consistencies of two of the three independent variables were acceptable as they exceeded the desired 0.7 level, with Cronbach's alpha for the quantity of social capital variable slightly below the 0.7 level. However, given the small sample size for the pilot study, all results were reassessed with data from the larger field study. The results for the individual scale items for each independent and dependent scale variable are briefly summarized in the following sections.

7.7.1 Learner-Learner Interactions

The learner-learner interactions scale items capture participants' perceptions of the interactions occurring within their group as part of the group assignment activity. The individual items and their preliminary results by system are listed in Table 7.18. Because the four items in this variable are all negatively worded, the results shown below have been reverse coded.

Table 7.18 Learner-Learner Interactions Individual Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
IN1: Students in my group seldom answered each other's questions.					
Moodle	7.14%	42.86%	14.29%	28.57%	7.14%
Pearltrees	27.27%	27.27%	9.09%	27.27%	9.09%
IN2: During this assignment, students seldom stated their opinions to each other.					
Moodle	0%	28.57%	7.14%	50.00%	14.29%
Pearltrees	9.09%	36.36%	27.27%	18.18%	9.09%
IN3: There was little interaction between students.					
Moodle	7.14%	28.57%	28.57%	21.43%	14.29%
Pearltrees	36.36%	9.09%	9.09%	36.36%	9.09%
IN4: The students seldom asked each other questions.					
Moodle	7.14%	7.14%	21.43%	50.00%	14.29%
Pearltrees	9.09%	27.27%	18.18%	18.18%	27.27%

Results for learner-learner interactions suggest that there were some differences in perceptions of interactions between the two systems, with Pearltrees respondents indicating stronger disagreement with the negatively worded items. However, these differences were not statistically significant, suggesting that both systems are similar in their support of learner-learner interactions and are acceptable platforms for this research.

7.7.2 Quality of Social Capital

The post-activity survey included four items to capture participants' perceptions regarding the quality of the shared Internet resources. The individual items and their preliminary results are listed in Table 7.19.

Table 7.19 Quality of Social Capital Individual Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
QLSC1: The knowledge shared by members of my group was understandable.					
Moodle	0%	7.14%	7.14%	57.14%	28.57%
Pearltrees	0%	0%	18.18%	45.45%	36.36%
QLSC2: The knowledge shared by members of my group was accurate.					
Moodle	0%	0%	21.43%	71.43%	7.14%
Pearltrees	0%	9.09%	27.27%	54.54%	9.09%
QLSC3: The knowledge shared by members of my group was complete.					
Moodle	7.14%	0%	14.29%	42.86%	35.71%
Pearltrees	0%	0%	18.18%	54.54%	27.27%
QLSC4: The knowledge shared by members of my group was reliable.					
Moodle	0%	0%	28.57%	57.14%	14.29%
Pearltrees	0%	0%	18.18%	45.45%	36.36%

Wilcoxon Rank Sum tests indicate that, for the pilot study, there were no statistically significant differences between the perceptions of the quality of resources shared between the two systems. This suggests that the affordances of each system for storing and sharing knowledge resources are sufficient to serve as acceptable platforms for this research.

7.7.3 Quantity of Social Capital

The post-activity survey included three items to capture participants' perceptions regarding the quantity of the Internet resources shared by group members. The individual items and their preliminary results are listed in Table 7.19.

Table 7.20 Quantity of Social Capital Individual Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
QNSC1: New content and knowledge was shared or posted frequently by my group.					
Moodle	14.29%	0%	28.57%	42.86%	14.29%
Pearltrees	0%	18.18%	18.18%	45.45%	18.18%
QNSC2: Group members could obtain abundant content and knowledge from the shared information.					
Moodle	0%	7.14%	14.29%	57.14%	21.43%
Pearltrees	0%	18.18%	9.09%	36.36%	36.36%
QNSC3: Group members provided meaningful comments to the shared information.					
Moodle	7.14%	0%	7.14%	71.43%	14.29%
Pearltrees	0%	27.27%	18.18%	18.18%	36.36%

Again, results suggest that both systems are acceptable platforms for use in this research.

7.7.4 Perceived Learning

The post-activity survey included nine items to capture participants' perceived learning. The individual items and their preliminary results are listed in Table 7.20.

Table 7.21 Perceived Learning Individual Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
PL1: I developed a good understanding of the basic concepts during this assignment.					
Moodle	0%	0%	0%	50.00%	50.00%
Pearltrees	0%	9.09%	9.09%	36.36%	45.45%
PL2: I was able to identify central issues in the field.					
Moodle	0%	0%	21.43%	64.29%	14.29%
Pearltrees	0%	9.09%	27.27%	36.36%	27.27%
PL3: The quality of this assignment compared favorably with other activities in the course.					
Moodle	0%	0%	21.43%	42.86%	35.71%
Pearltrees	0%	9.09%	45.45%	9.09%	36.36%
PL4: I developed an improved ability to integrate facts through this assignment.					
Moodle	7.14%	0%	28.57%	50.00%	14.29%
Pearltrees	0%	9.09%	45.45%	18.18%	27.27%
PL5: I learned to see relationships between ideas during this assignment.					
Moodle	0%	0%	35.71%	50.00%	14.29%
Pearltrees	0%	0%	45.45%	27.27%	27.27%
PL6: This assignment improved my ability to communicate clearly.					
Moodle	7.14%	7.14%	28.57%	42.86%	14.29%
Pearltrees	0%	18.18%	27.27%	27.27%	27.27%
PL7: This assignment served my needs well.					
Moodle	0%	0%	14.29%	64.29%	21.43%
Pearltrees	0%	9.09%	45.45%	27.27%	18.18%
PL8: I am satisfied with this assignment.					
Moodle	0%	0%	21.43%	71.43%	7.14%
Pearltrees	0%	9.09%	27.27%	36.36%	27.27%
PL9: I feel that the assignment resulted in high quality interactions.					
Moodle	7.14%	14.29%	35.71%	35.71%	7.14%
Pearltrees	0%	9.09%	36.36%	36.36%	18.18%

Some system differences for the perceived learning measures are suggested in the individual item results; however, Wilcoxon Rank Sum tests indicate that, for the pilot study, there were no statistically significant differences between perceived learning on the two platforms, suggesting that both are sufficiently similar to serve as acceptable platforms for this research.

7.8 Social Connections

An exploratory item was added to the post-assignment survey to capture participants' perceptions of whether the activity and ICT system enabled them to make new connections with students. However, the students in the pilot study had already been working in groups with their team members, so that there was limited opportunity for the creation of new social capital through this assignment. The items and their preliminary results are listed in Table 7.21.

Table 7.22 Social Connections Item

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
SC1: I made new connections with other students during this assignment.					
Moodle	14.29%	21.43%	28.57%	14.29%	21.43%
Pearltrees	9.09%	36.36%	18.18%	18.18%	18.18%

7.9 Common Method Bias

The post-assignment survey included two items to ensure that students were actually reading and responding to the survey questions in order to avoid common method bias. These two items and their preliminary results are listed in Table 7.22.

Table 7.23 Common Method Bias Items

System	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
CMB1: I am satisfied with the parking availability on campus.					
Moodle	7.14%	21.43%	57.14%	7.14%	7.14%
Pearltrees	27.27%	27.27%	36.36%	0%	9.09%
CMB2: I am satisfied with the selection of dining options available on campus.					
Moodle	7.14%	7.14%	57.14%	7.14%	21.43%
Pearltrees	0%	9.09%	81.82%	9.09%	0%

7.10 Conclusion

The purpose of the pilot study was to test the experimental design prior to beginning the larger, quasi-experimental field study. In terms of the basic assignment and systems, the pilot study confirms that the study design is adequate and can be used for the larger study. The majority of students were able to use their assigned systems and were generally satisfied with them and, most importantly, the participants perceived that they learned from the assignment.

Results suggest that the pre- and post-assignment surveys were simple for students to complete, although in the larger field study, the researcher worked closely with instructors to ensure that students were encouraged and reminded to complete the post-assignment survey. There was some confusion regarding submission of the individual assignments and the use of the ICT system to store resources for the assignment; these issues were addressed through a revision of the assignment instructions to clarify the saving of Internet resources and the assignment submission process. (The process of submitting assignments was coordinated with each instructor; in all casealmost all coursess, students submitted their assignments through a forum in Moodle.)

Although the instructions for the group submission requested that students share their resources with each other when discussing and creating their group response, it is understandable that students would choose to share their individual assignments, not just their individual resources, with each other. This difference, however, did not impact the exploration of shared resources as social capital; therefore, the group instructions were not modified.

Preliminary results suggest that some students found their respective systems difficult to use. To address the non-use of Moodle wikis, the individual assignment was modified to use private (individual) Moodle forums that are more familiar to students. To remove any barriers to Pearltrees use, a video tutorial was created using Camtasia Relay; this video was made available in each course on Moodle along with the assignment instructions. Additionally, questions about the complexity of Pearltrees and its compatibility with the student's preferred learning activities were added to the post-assignment survey.

Based on the limited interactions captured during the group activity, it is likely that groups used other means to communicate, whether through face to face meetings, e-mails, or some other communication method. This lack of interaction impacted the ability to test the research question exploring knowledge exchange processes.

Inconsistencies in the scoring of the assignments by the two independent raters suggested that additional training would have been required when scoring the submissions from the larger study. However, due to the complexity of training raters to score assignments in which students could select their own case studies or topics, the use of independent raters was ultimately dropped from this research. Instead, actual assignment grades (given by the instructors) were captured for students who gave permission by signing the Family Educational Rights and Privacy Act (FERPA) waiver.

In summary, although the pilot study did suggest some modifications to the larger scale study, it also showed that 1) the two information and communication technology (ICT) systems used in the study were sufficiently comparable and provided similar affordances to support the activities required for the larger study; 2) the variables were adequately captured and the internal consistencies of the various scale items were generally acceptable; and 3) the methods of capturing data about actual system usage were generally manageable and sufficient.

CHAPTER 8

UNIVARIATE ANALYSIS

The pilot study was conducted during the fall semester of 2013. After modifications suggested by the pilot study were implemented, the larger, quasi-experimental field study began in the spring semester of 2014. This chapter describes the results of univariate analysis of the data from this nonequivalent control group study. Bivariate analysis, factor analysis, and model testing is discussed in Chapter 9. Results of the repeated measures study are discussed in Chapter 10. Finally, results of exploratory social network analysis are discussed in Chapter 11.

This chapter begins with a description of the preliminary data screening conducted to remove unengaged responses and incomplete data. Once the final cohort for analysis is determined, the following research questions are addressed using univariate statistical analysis:

RQ1 *Do assignments requiring the use, management, sharing, and consolidation of Internet information resources lead to positive learning outcomes at the individual and group level?*

RQ2 *Are characteristics of the student (e.g. gender, level of study, and GPA) related to the variables of interest in the study?*

RQ3 *Are characteristics of the course (e.g. group formation method) related to the variables of interest in the study?*

RQ4 *What pedagogical guidelines/practices best support sharing and managing Internet resources for learning?*

RQ5 *Do students have a preference for type of knowledge exchange (socialization versus externalization) when sharing Internet resources for learning?*

RQ6 *Do learning outcomes differ depending on the ICT system students used for the assignment?*

RQ8 What design guidelines characterize a system that best supports sharing and managing Internet resources for learning?

This chapter ends with univariate analysis of the measurement scales that will be used to build and test the structural model discussed in Chapter 9.

8.1 Survey Data

Students were invited to participate in this research through completion of a pre-assignment survey prior to starting work on the individual assignment and a post-assignment survey after submitting the group portion of the assignment. (Students in courses integrating two assignments for the repeated measures studies were asked to complete four surveys, discussed in greater detail in Chapter 10.) Survey data was collected through the online service Surveymonkey.com. To ensure that students did not complete the post-assignment survey before completing the group portion of the assignment, the post-assignment survey link was not made available until after the due date for the group assignment.

Data from the pre- and post-assignment surveys was first analyzed individually and was subsequently merged using the students' identifiers to correlate their pre- and post-assignment responses. Survey data was analyzed using IBM SPSS Version 22.0.0.1.

8.2 Preliminary Screening of Sample Set

Data from the pre- and post-assignment surveys was first analyzed separately for unengaged responses. For each respondent, the mean and standard deviation of their Likert-type item responses were calculated. Participants whose responses had a standard deviation less than 0.3 were removed because this level of standard deviation suggests that the students were not engaged in responding to the survey but instead responded with the same or a similar response to every question. Of the 259 respondents to the pre-assignment survey, four were removed for unengaged responses (STDEV < 0.3) and one was deleted due to a significant number of missing survey responses.

Of the 222 respondents to the post-assignment survey, four were removed based on unengaged responses and five were removed for incomplete survey responses. The responses of the remaining 213 participants were matched with their pre-assignment survey responses. Three post-assignment survey respondents had not completed the pre-assignment survey and were therefore removed from the sample. Of the 254 remaining pre-assignment survey responses, 44 respondents did not complete the post-assignment survey and were therefore removed from the final sample. The total number of respondents who completed both surveys was 210 (N=210).

8.3 Participant Demographics

Students who participated in the research surveys were asked to provide basic demographic data including their gender, educational level (Undergraduate/Graduate), degree program, whether or not English was their first language, and whether or not they had shared Internet resources for learning before. The results shown in Table 8.1 are based on the pre-screened data (N=210).

Table 8.1 Participant Demographics

Demographic Data		
Gender	147 Male (70%)	63 Female (30%)
Assigned System	115 Moodle (54.8%)	95 Pearltrees (45.2%)
Educational Level	74 Undergraduate (35.2%)	136 Graduate (64.8%)
English is 1st Language	97 Yes (46.2%)	113 No (53.8%)
Previously Shared Internet Resources for Learning	163 Yes (77.6%)	47 No (22.4%)
Degree Program		
Information Systems		76 (36.2%)
Computer Science		5 (2.4%)
MBA		16 (7.6%)
Other (Information Technology, Business Information Systems, Computer Engineering)		113 (53.8%)
Participants Per Course		
IS_331_SPR14 – Database Design Management and Applications		22
IS_331_FL14 – Database Design Management and Applications		20
IS_390_SPR14 – Systems Analysis and Design		25
IS_663_FL13 – Advanced Systems Analysis and Design		25
IS_677_SPR14 – Information Systems Principles		34
IS_677_FL14 – Information Systems Principles		50
IS_679_SPR14 – Information Systems Strategy		21
STS_342_FL14 – Women in Technological Culture		13

Gender distribution was not equally distributed; however, the distribution was representative of the overall gender make-up of the university's student population and was therefore expected. Educational level was also not equally distributed because, although the eight courses were equally split (four undergraduate and four graduate-level courses), the graduate courses typically had higher enrollments, with one class having over 50 students enrolled (IS_677_FL14). The number of students who had shared before was also not approximately equally distributed. This was ascertained using the non-parametric binomial test which evaluated whether the distribution of responses differed significantly from the expected approximate distribution (50% yes, 50% no). In this case, the observed distribution was significantly different from the expected distribution of responses ($p < 0.001$). This suggests that, in general, students are sharing knowledge resources even when not required to do so.

Research question 5 (RQ5) explores whether, when sharing for learning, students prefer to use systems that support the exchange of tacit or explicit knowledge. To evaluate this question, students who replied that they had shared before (n = 163) were asked to indicate which methods they had used to share information. Students were able to select all methods that applied to them. These results are shown in Table 8.2.

Table 8.2 Frequencies of Sharing Methods

Sharing Method	Count
Face to face/discussed	120 (73.6%)
Email	146 (89.6%)
Text message/SMS	72 (44.2%)
Facebook	75 (46.0%)
Twitter	7 (4.3%)
Moodle	58 (35.6%)
Dropbox	59 (36.2%)
Other	20 (12.3%)

These results confirm the findings from the interview study conducted earlier in this research: students prefer to share using the socialization knowledge exchange form which requires the sharing of tacit, rather than explicit, knowledge. Although face to face discussion is considered the richest form of tacit knowledge exchange because it facilitates not only verbal communication but also non-verbal cues, e-mail is frequently cited as an effective medium for exchanging tacit information because it enables a dialogue between participants and supports directed (that is, private) communication through which students can exchange not only information but also personal experiences and judgments. This preference for rich communication when sharing knowledge also relates to research question eight (RQ8) which asks what design guidelines characterize a system that best supports sharing and managing digital resources for learning. Systems designed to encourage knowledge sharing for learning should provide enhanced discussion capabilities, as well as a means to direct communication to specific individuals rather than broadcast it publicly.

At the same time, however, forty-six percent of students also reported using Facebook to share Internet resources for learning, suggesting that the line between students' social and academic space is blurring. Students also reported sharing through Moodle, reinforcing the findings of the interview study that some students choose to share helpful Internet knowledge resources with their classmates. Sharing through Moodle and Facebook, and even Dropbox, involves externalization or the sharing of explicit knowledge in the form of a shared link or file. Systems designed to support knowledge sharing for learning must therefore also support this more public, broadcasting form of knowledge exchange. However, pedagogical practices (explored in RQ4) also play a critical role in this type of knowledge exchange, as several students during the interview study stated that, even when they did share resources through Moodle, the lack of response from the instructor or other students made them less inclined to do so in the future.

An exploration of the other sharing methods students mentioned indicated that many students use Google Drive, which is provided by the university as part of the students' webmail system. However, Google Drive does not actually support knowledge sharing; rather, it facilitates collaborative editing of files, suggesting that students who reported using Google Drive may have either misinterpreted the question or are using documents in Google Drive as a shared bookmarking system. Other students cited sharing through applications such as Whatsapp and Wiggio, while four students mentioned QQ and Wechat, suggesting that international students may prefer to use systems that support their native languages and connect them with other students who are culturally similar.

8.4 Student Grades

To capture actual learning, students' grades for the assignments were obtained (assuming that students had given their consent through the Family Educational Rights and Privacy Act form that was an optional part of the consent form for this research). Of the 210 students in the final cohort, 149 (71%) signed the FERPA waiver giving permission for the researcher to obtain their semester GPA and grades for the individual and group assignments.

An analysis of this data revealed several problems. The descriptive statistics for individual and group assignment grades are shown in Table 8.3.

Table 8.3 Descriptive Statistics of Grades

	Mean and SD	Minimum	Maximum	Skewness	Kurtosis
Individual Grade	80.812 SD = 21.353	0.000	100.000	-2.142	5.589
Group Grade	87.127 SD = 18.189	0.000	100.000	-2.201	5.891
GPA (Semester)	3.616 SD = 0.435	2.20	4.00	-1.377	1.454

As can be seen from these results, both individual and group grades suffer from highly kurtote distributions, indicating that instructors' grades were highly clustered towards the high end of the grade range, as supported by the negative skewness of each variable. Although this is expected, an examination of instructors' grades revealed major inconsistencies. While the grades of some instructors showed some level of variance, at least one instructor scored every group assignment as 100, while another instructor's group assignment scores were either 90 or 100. To further complicate this problem, instructors typically gave the identical group score to all members of the group because it was impossible for the instructor to differentiate each member's contribution. Individual assignment scores were slightly more reliable in the sense that there was more variance in individual grades, but overall the distribution of grades still suffered from high kurtosis and negative skewness. This, in combination with instructor grading inconsistencies, means that actual learning is difficult to accurately assess based on the data collected. However, it will be reported where appropriate as a general indicator of actual learning outcomes (Willingham, Pollack, & Lewis, 2002).

Student semester GPA, however, is calculated by the university and is a more objective measure of student engagement and learning, although it is not directly related to the research assignments or even the course in which the research assignment took place. Rather, GPA gives a high level indication of the student's general learning performance; therefore, GPA is retained as an exploratory variable.

8.5 ICT System Usage

ICT system usage was captured through a count of the number of resources students stored in their assigned systems. It is important to note that there was a significant amount of non-use for students' assigned to both Moodle and Pearltrees. Of the 210 students participating in the study, only 121 (57.6%) actually stored resources in their assigned systems for the individual portion of the assignment. It is unclear why over 40 percent of students did not use their assigned system, although one explanation may be that students stored the resources using other methods such as bookmarks or simply copying the resources' links to a document. Future research should include questions asking students if they utilized any other tools for collecting, managing and sharing their resources. For the purposes of this analysis, students who did not store any resources were given an ICT usage value of zero (0). Table 8.4 shows the descriptive statistics for individual and group use of the assigned ICT system.

Table 8.4 Descriptive Statistics of ICT Usage

Measure	Mean	SD	Minimum	Maximum
Individual Use	3.657	4.316	0	25
Group Use	5.514	7.727	0	40

Although the maximum number of resources stored by an individual student was 25, most students individually stored either none (89 students or 42.4%) or between one and eight resources (96 students or 45.6%). Only 25 students (12%) stored more than eight resources.

At the group level, resources that were shared by a group were assigned to all individuals in the group. In other words, if group A stored 19 resources, the group ICT usage value for every student in group A was set to 19. This is because all students had access to the resource sharing area and to the Internet knowledge resources shared there. There was a higher amount of system non-use at the group level; 101 students (48.1%) assigned to collaborate in groups did not share any resources in their group areas. Sixty-two students (29.5%) shared between one and 10 resources in their group areas; 47

students (22.4%) shared between 10 and 40 resources during the group portion of the assignment, although most group resource counts were between 10 and 20.

8.6 Impact of Internet Knowledge Resource Use and Sharing on Learning

In this research, students were required to find, manage, share, and consolidate Internet information resources as part of a learning assignment. Research question one (RQ1) explores the impact of such assignments on learning by asking, "Do assignments requiring the use, management, sharing and consolidation of Internet information resources lead to positive learning outcomes at the individual and group level?" To evaluate this research question, the variables reflecting perceived learning, learner-learner interactions, and quality and quantity of shared social capital are explored, as are variables capturing student grades. Results are discussed in the following sections.

8.6.1 Positive Perceptions of Learning

To assess whether participants' perceptions of the items capturing learner-learner interactions (LLI), perceived learning (PL), and quality (QLSC) and quantity (QNSC) of shared social capital are generally positive, negative, or neutral, a one-sample t-test was used to explore whether the mean for each scale item differed from the neutral response (3). Results are shown in Table 8.5.

Table 8.5 One Sample T-test Results for Learning Outcomes Scale Items

Variable	Mean	SD	t (df=209)
LLI1 – Students in my group seldom answered each other’s questions. (reverse coded)	3.048	1.181	0.584(ns)
LLI2 – During this assignment, students seldom stated their opinions to each other. (reverse coded)	2.938	1.112	-0.807(ns)
LLI3 – There was little interaction between students. (reverse coded)	3.286	1.130	3.664***
LLI4 – The students seldom asked each other questions during the group part of this assignment. (reverse coded)	2.800	1.189	-2.437*
QNSC1 – New content and knowledge was shared or posted frequently by my group.	3.567	0.972	8.446***
QNSC2 – Group members could obtain abundant content and knowledge from the shared information.	3.943	0.840	16.274***
QNSC3 – Group members provided meaningful comments to the shared information.	3.848	0.839	14.640***
QLSC1 – The knowledge shared by members of my group was understandable.	3.971	0.764	18.438***
QLSC2 – The knowledge shared by members of my group was accurate.	3.857	0.711	17.465***
QLSC3 – The knowledge shared by members of my group was complete.	3.933	0.872	15.504***
QLSC4 – The knowledge shared by members of my group was reliable.	3.991	0.692	20.752***
PL1 – I developed a good understanding of the basic concepts during this assignment.	4.133	0.706	23.252***
PL2 – I was able to identify central issues about this topic.	4.024	0.688	21.570***
PL3 – The quality of this assignment compared favorably with other activities in this course.	3.733	0.827	12.844***
PL4 – I developed an improved ability to integrate facts through this assignment.	3.814	0.744	15.856***
PL5 – I learned to see relationships between ideas during this assignment.	3.814	0.751	15.720***
PL6 – This assignment improved my ability to communicate clearly.	3.705	0.863	11.833***
PL7 – This assignment served my needs well.	3.719	0.848	12.282***
PL8 – I am satisfied with this assignment.	3.871	0.823	15.346***
PL9 – I feel the assignment resulted in high quality interactions.	3.633	0.920	9.980***
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, (ns) = not significant			

These results suggest that students generally felt very positively about the learning experience resulting from this type of assignment. All the items capturing perceived learning, quality of social capital, and quantity of social capital showed strongly positive responses, all of which were highly significant. These results confirm that having students individually research a topic by finding Internet resources they feel are reliable, submitting an individual response, and subsequently sharing and discussing those resources with other students to arrive at a group consensus, leads to positive learning outcomes.

Only one variable in Table 8.5, learner-learner interactions, resulted in mixed perceptions. This variable captures students' perceptions of the interactions that occurred during the group part of the assignment. Two of the items (LLI1 and LLI2) did not significantly differ from the neutral response, suggesting that students did not have strong positive or negative responses to statements about the extent to which students answered each other's questions (LLI1) or stated their opinions about the shared Internet resources (LLI2). Students responded positively about the amount of interaction that occurred during the group part of the assignment (LLI3); however, they responded negatively to the statement about the extent to which students asked each other questions during the group assignment (LLI4). These results suggest that, although students felt there were frequent interactions during the group part of the assignment, they did not perceive much benefit from these interactions either in asking or answering questions or sharing opinions. This is supported by an analysis of the interactions that actually occurred within groups. In most cases, group members simply posted the resources they chose to share with their group members; there was little evidence of actual discussion between group members in their respective group areas.

8.6.2 Positive Effect on Actual Learning

To evaluate whether sharing and consolidating the Internet knowledge resources during the group portion of the assignment had a positive impact on learning outcomes, a paired samples t-test was conducted to explore students' individual and group grades (n = 149). Results are shown in Table 8.6 below.

Table 8.6 Paired Sample T-test Results for Assignment Grades

	Mean	SD
Individual Grade	80.812	21.353
Group Grade	87.127	18.189
t statistic	t = -3.263, df = 148, p = 0.001	

Although the grades are problematic due to instructor inconsistencies, the significant increase in the means, and the highly significant results of the paired sample t-test, suggests that allowing students to share the resources they found individually to arrive at a group consensus did have a positive effect on actual learning. Together, these results suggest that research question one (RQ1) is supported: assignments requiring the use, management, sharing and consolidation of Internet information resources do lead to positive learning outcomes at the individual and group level.

8.7 Impact of Student Characteristics

Research question two (RQ2) asks whether assignment activities and the resulting learning outcomes vary according to such student characteristics as the level of the student (undergraduate versus graduate) or gender. This research question informed several related hypotheses, listed below.

H4a *Female students will report lower perceived learning than male students.*

H4b *Students for whom the course is part of their degree program will report higher perceived learning.*

H4c *Graduate students will report higher perceived learning than undergraduate students.*

Research question two (RQ2) also informed a related sub-question exploring student gender and self-efficacy.

RQ2a: *Do female students report lower self-efficacy than male students?*

To test hypotheses H4a, H4b, H4c, and RQ2a, an independent samples t-test was used to compare the means of the research variables based on these student characteristics. When participants were separated by gender, the t-test revealed no statistically significant difference in perceived learning between the groups; thus, hypothesis H4a is not supported. Similarly, there was no difference between self-efficacy reported by male and female students, suggesting that RQ2a is not supported as well.

Table 8.7 shows significant differences in the research variables based on whether the course was part of the student’s degree program or not. These results suggest that hypothesis H4b is also supported; students reported higher perceived learning, and were more engaged in the learning activity, when the course was part of their degree program.

Table 8.7 Differences of Means For Courses In Student's Degree Program

Variable	Mean, SD Elective Course	Mean, SD Required Course	t statistic	Sig.
Individual Use	3.202 SD = 4.094	4.461 SD = 4.600	-2.047	0.042
Task Value	24.157 SD = 3.304	25.605 SD = 2685	-3.271	0.001
Quantity of Social Capital	11.097 SD = 2.190	11.816 SD = 1.944	-2.379	0.018
System Satisfaction	32.164 SD = 6.191	34.368 SD = 5.284	-2.610	0.010
Perceived Learning	33.657 SD = 5.124	35.842 SD = 5.190	-2.956	0.003

Level of education, however, resulted in differences between the means of undergraduate and graduate students for several of the research variables, showing support for hypothesis H4c. These variables and their results are listed in Table 8.8.

Table 8.8 Difference of Means by Level of Study

Variable	Mean, SD Undergraduates	Mean, SD Graduates	t statistic	Sig.
GPA	3.278 SD = 0.537	3.767 SD = 0.270	-7.402	0.000
Individual Use	2.270 SD = 3.377	4.412 SD = 4.587	-3.528	0.001
Group Use	3.405 SD = 4.680	6.662 SD = 8.766	-2.972	0.003
Group Grade	95.489 SD = 15.046	83.509 SD = 18.301	3.861	0.000
Self-Efficacy	34.446 SD = 4.869	36.581 SD = 4.527	-3.178	0.002
Task Value	23.635 SD = 3.390	25.250 SD = 2.875	-3.647	0.000
Learning Goal Orientation	20.108 SD = 3.059	21.603 SD = 2.333	-3.964	0.000
Quantity of Social Capital	10.500 SD = 2.235	11.824 SD = 1.920	-4.500	0.000
Quality of Social Capital	15.284 SD = 16.007	16.007 SD = 2.305	-2.056	0.041
System Satisfaction	31.865 SD = 5.787	33.559 SD = 5.991	-1.981	0.049
Perceived Learning	32.473 SD = 5.108	35.522 SD = 5.014	-4.182	0.000

Since these results confirm that hypotheses H4b and H4c are supported, these variables are also tested as controls in the structural model described in Chapter 9. To further address research question 2 (RQ2), several other research sub-questions guided univariate analysis in exploring the impact of student characteristics on research variables of interest.

RQ2c: *Is perceived task value higher for students enrolled in a course that is part of their degree program?*

RQ2d: *Is perceived self-efficacy higher for students enrolled in a course that is part of their degree program?*

RQ2h: *Do participants reporting previous sharing experiences also report higher satisfaction with their assigned system?*

RQ2i: *Do participants reporting previous sharing experiences also report higher perceived quality and quantity of social capital?*

Research sub-question RQ2c asks if perceived task value is higher for students enrolled in a course that is part of their degree program. As shown in Table 8.8, students for whom the course was part of their degree program did report higher perceptions about the value of the assignment task, suggesting that students see more value from learning experiences directly related to their long-term learning goals. Similarly, research sub-question RQ2d explores if student self-efficacy is affected by whether or not the course in which the assignment occurs is part of the student's degree program. In this case, there was no difference in reported self-efficacy, suggesting that self-efficacy captures students' perceptions of their general capabilities as students rather than their perceptions about performance in a particular assignment.

Finally, two research sub-questions investigate the impact of students' previous sharing behaviors on their system satisfaction (RQ2h) and perceptions of quality and quantity of social capital (RQ2i). Independent sample t-tests showed that none of these constructs differed based on students' previous sharing behaviors. This suggests that assignments requiring students to share Internet resources for learning result in similar perceptions regardless of students' own inclinations regarding sharing knowledge for learning.

8.8 Impact of Course Characteristics

Research question 3 (RQ3) asks if characteristics of the course are related to the research variables of interest in the study. One of the course characteristics of interest is whether groups were self-selected or assigned by the instructor. This decision was up to the instructor of each course; group assignment was not controlled by the researcher. In all courses where students self-selected into groups, students were already interacting with their team members on semester-long group projects. In the other courses, the groups were either purposefully assigned by the instructor or were randomly assigned using the group creation capabilities provided in Moodle. In these courses, students' first interactions with their team members occurred as a result of the research assignment. Table 8.9 lists the eight courses in which this study was conducted, the method of group formation, and level of previous group interaction.

Table 8.9 Group Formation Method by Course

Course	Group Formation Method
IS_331_SPR14	Self-selection – students were already working in groups on a semester-long project
IS_331_FL14	Random assignment – groups were assigned to interact for the learning activity associated with this research
IS_390_SPR14	Self-selection – students were already working in groups on a semester-long project
IS_663_FL13	Self-selection – students were already working in groups on a semester-long project
IS_677_SPR14	Random assignment – groups were assigned to interact for the learning activity associated with this research
IS_677_FL14	Random assignment – groups were assigned to interact for the learning activity associated with this research
IS_679_SPR14	Random assignment – groups were assigned to interact for the learning activity associated with this research
STS_342_FL14	Instructor assignment – groups were assigned to interact for the learning activity associated with this research

Group formation method is an important course characteristic, particularly in research that explores student interaction and social capital formation. Self-selected groups represent students who have chosen to work together. Because self-selected groups have expressed a desire to work together, and because they are already familiar with one another through prior course-related group work, the expectation was that students in these courses would share more resources and would report higher perceptions of learning. Results of an independent samples t-test, however, suggest that the opposite is true, as shown in Table 8.10.

Table 8.10 Differences Based On Method of Group Formation

Variable	Mean, SD Assigned (n = 138)	Mean, SD Self-Selected (n = 72)	t-statistic	Sig.
ICT Use (individual)	4.036 SD = 4.722	2.931 SD = 3.316	1.972	0.050
Quantity of social capital	11.594 SD = 1.969	10.803 SD = 2.351	2.257	0.025
Perceived Learning	35.094 SD = 4.929	33.208 SD = 5.627	2.505	0.013

These results suggest that students may be more engaged in learning activities when they are assigned to groups in which they may not know the other students. One possible explanation for this difference at the individual level could be that students feel a greater need to earn the respect of their teammates by participating and contributing to the group's success. Another explanation may be that students work more during the individual part of the assignment because they are not sure to what extent their teammates will contribute during the group part of the assignment. Further research is required to better understand this finding.

Although the difference in ICT system use was only significant for resources stored individually (the number of resources shared by groups did not differ), students' perceptions regarding the quantity of social capital shared by group members was higher for students in assigned rather than self-selected groups. Again, additional research is required to better understand this finding, but one possible explanation may be that, because students did not know one another, they had lower expectations of their group members' contributions, meaning that even moderate sharing caused positive perceptions of the quantity of shared knowledge.

Finally, perceived learning was also significantly higher for students in assigned rather than self-selected groups. One possible explanation for this result is that students who are not familiar with one another must expend additional effort to develop a shared language when discussing their findings, and that this additional effort increased their perceptions of learning from the assignment. Another possible explanation is that students who self-select into groups are more like-minded and therefore find more similar resources for the research assignment, while students who are assigned to groups may discover a broader range of Internet resources that, when shared, introduce them to different perspectives about the topic, thereby increasing their perception of learning.

Courses were also evaluated based on whether they were required courses or electives. However, there were no statistically significant differences between these two types of courses. Finally, to evaluate differences between individual courses, a one-way ANOVA was conducted for all of the research variables of interest. For research variables exhibiting significant differences, a Bonferroni adjustment was applied to the multiple comparisons to identify specific courses exhibiting differences. Table 8.11 lists the variables having differences between courses, their mean differences, and significance.

Table 8.11 One-Way ANOVA for Differences Between Courses

Variable	Course 1	Course 2	Mean difference (1-2)	Sig.
Individual ICT System Use F (209) = 3.903, p = 0.001	IS 331 (SPR 14)	IS 677 (FL 14)	-3.547	0.026
		IS 679 (SPR 14)	-4.394	0.016
	IS 677 (FL 14)	STS 342 (FL 14)	4.820	0.006
	IS 679 (SPR 14)	STS 342 (FL 14)	5.667	0.004
Quantity of Social Capital F (209) = 8.671, p = 0.000	IS 331 (SPR 14)	IS 679 (SPR 14)	-1.978	0.041
	IS 331 (FL 14)	IS 677 (SPR 14)	-1.986	0.016
		IS 677 (FL 14)	-2.270	0.001
		IS 679 (SPR 14)	-2.774	0.000
Quality of Social Capital F (209) = 4.539, p = 0.000	IS 331 (FL 14)	IS 677 (FL 14)	-2.100	0.032
Perceived Learning F (209) = 4.025, p = 0.000	IS 331 (SPR 14)	IS 679 (SPR 14)	-5.020	0.033
	IS 331 (FL 14)	IS 677 (FL 14)	-4.800	0.010
		IS 679 (SPR 14)	-6.429	0.002

All results having negative mean differences in Table 8.10 have, as Course 1, either IS_331_SPR14 or IS_331_FL14. These two courses have two common attributes: the nature of their assignments and the types of instructors. These differences both relate directly to pedagogical differences and are discussed in more detail in the next section.

8.9 Pedagogical Differences

The two courses having negative mean differences in Table 8.11 (IS_331_SPR14 and IS_331_FL14) have in common two attributes. First, the assignments in these two courses involved students researching a topic not yet covered in the course. In the case of IS_331_SPR14, the assignment came at the end of the semester and gave students the option of researching one of three supplemental topics not covered in class. As this was a Database Management and Application class, students could choose to research data warehouses, object oriented databases, or database security. Similarly, in IS_331_FL14, the research assignment was introduced shortly after the midterm exam and required students to pre-learn the upcoming topic of non-relational databases. Table 8.12 describes the details for the research assignments integrated into each course.

Table 8.12 Pedagogical Differences Between Course Assignments

Course	Assignment Description
IS_331_SPR14	Students were given a choice of one of three topics to research as a supplement to the course materials: database security, data warehouses, or object oriented databases.
IS_331_FL14	Students were told to research the topic of non-relational databases, including NoSQL and MongoDB, prior to its introduction in class.
IS_390_SPR14	Students were instructed to research two high-profile security breaches (TJMaxx and Target) and compare and contrast various aspects of the events.
IS_663_FL13	Students were introduced to the concept of object oriented modeling in class and were then assigned to research this topic in more detail.
IS_677_SPR14	Students were asked to apply the four components of information systems to an evaluation of high-profile system failures.
IS_677_FL14	Students were instructed to evaluate the failure of an IT system introduced in the Federal Bureau of Investigation.
IS_679_SPR14	Students were required to apply Hofstede's cultural dimensions to an analysis of global corporations located in India.
STS_342_FL14	Students were tasked with creating a video about gender and technology and were instructed to find Internet resources as sources and exemplars.

The differences between the assignments for the first two courses (IS_331_SPR14 and IS_331_FL14) and other assignments suggest that allowing students to research a broad topic with little guidance may reduce students' perception of learning from the assignment because students may feel overwhelmed when given little guidance about what, specifically, they should be researching. Although providing less guidance means that students may discover a diversity of perspectives which should expose them to more knowledge, this same diversity may increase frustration when a cohesive group response is sought. In response to research question four (RQ4), this suggests that instructors should not only provide information relating the topic students are researching back to specific course material, but that assignment instructions should be detailed enough that students can identify the key elements of the required research.

The second common attribute between IS_331_SPR14 and IS_331_FL14 is that the instructors for both courses were Doctoral students. For the other courses, the instructors were typically seasoned instructors who had taught their particular course for several years at least. This suggests that instructor differences also play a critical role in encouraging student participation in novel learning activities. It suggests that experienced instructors were more adept at introducing a new style of research into their coursework and informing students of the expected learning outcomes from such research activities.

8.10 ICT Usage By System

Research question six (RQ6) explores whether learning outcomes differed depending on the ICT system students used for the assignment. Because the affordances of Pearltrees are more closely aligned with the activities of Internet resource collection, management, and sharing, hypotheses H5a and H5b proposed that students using Pearltrees would store more resources individual (H5a) and share more resources as a group (H5b) than students using Moodle for the assignment. This was evaluated using an independent samples t-test; results are shown in Table 8.13.

Table 8.13 Differences in ICT System Usage by System

	System	Mean and SD	Results
Items stored individually	Moodle	2.922, SD = 3.860	t = -2.759, df = 208**
	Pearltrees	4.547, SD = 4.679	
Items shared by group	Moodle	6.571, SD = 9.851	t = 1.272, df = 194 (ns)
	Pearltrees	5.143, SD = 4.511	
* p < 0.05, ** p < 0.01, *** p < 0.001, (ns) = not significant			

These results show that hypothesis H5a is supported; students assigned to use Pearltrees stored significantly more resources during the individual part of the assignment than students assigned to use Moodle. Even though Pearltrees provides an Internet browser plug-in to facilitate the storage of Internet URLs and also supports a visual, drag and drop interface for management of the stored resources, this result is nevertheless surprising because Pearltrees was unfamiliar to almost all students participating in the study. This suggests that an engaging interface, visual interaction paradigms, and affordances to facilitate the capture and organization of Internet resources can overcome system unfamiliarity, indicating important design implications for future systems (RQ8). In fact, while most students who used Pearltrees stored all their resources in one tree, some students developed more hierarchical organizations, as is evidenced in Figure 8.1.

Although the average number of items stored individually by students differed by their assigned ICT system, no difference was exhibited at the group level. This could be a result of how group usage was calculated. Because it was sometimes difficult to distinguish which student shared which resource, the resources shared by a group were summed and that value was assigned to each group member. Future research should attempt to identify individual group members who shared resources to further explore sharing at the group level. For this research, H5b is not supported.

Figure 8.1 An example of a hierarchically organized Pearltrees account for one research participant. Resources (referred to as pearls in Pearltrees) having white silhouettes on a blue background indicate the participant's connections to other individuals and to his team. The pearls containing the students' image are Pearltrees which are similar to file folders in that they support the hierarchical organization of the actual resources. The other pearls represent the actual URLs of websites the student stored as part of his individual research assignment.

Independent sample t-tests were also used to evaluate whether there were any differences in the measured research variables between students who used Moodle and those who used Pearltrees. None of the research variables exhibited statistically significant differences based on ICT system used. Thus, in response to research question six (RQ6), the only impact that ICT system had on learning outcomes was in the number of resources stored by individual students, with Pearltrees users storing significantly more Internet resources than students using Moodle.

8.11 Between System Biases

Students were recruited for this research based on their enrollment in participating courses. In each course, students in odd numbered groups were instructed to use Moodle while students in even numbered groups were instructed to use Pearltrees. Because some courses had an odd number of groups, more students were assigned to Moodle than to Pearltrees. Of the 210 total survey participants, 115 used Moodle and 95 used Pearltrees.

To evaluate whether there were any pre-existing differences between the students assigned to use the two systems, Chi-squared tests were used to evaluate all ordinal variables. Results showed that the students assigned to use Moodle and those assigned to use Pearltrees did not differ regarding if English was their first language and if they had previously shared Internet resources for learning. In exploring the methods that students had previously used to share Internet resources for learning, the only method that exhibited a statistically significant difference was e-mail (χ^2 (1) = 5.875, p=0.015). The results of this Chi-squared test are shown in Table 8.14.

Table 8.14 Distribution of Students Using E-mail to Share

System	Did not use e-mail	Used e-mail	Total
Moodle	27 (12.9%)	88 (41.9%)	115 (54.8%)
Pearltrees	37 (17.6%)	58 (27.6%)	95 (45.2%)
Total	64 (30.5%)	146 (69.5%)	210 (100%)

Because no other method differed significantly between students using the two systems, this difference is not considered problematic, suggesting that there were no systematic biases between students assigned to use either system.

8.12 Univariate Data Screening For Measurement Scales

To prepare the data for exploratory and confirmatory factor analysis and model testing, the individual items comprising the measurement scales were analyzed to ensure that there were no issues which would make them unsuitable for inclusion in subsequent analysis. For these Likert-type scale variables, there was no reason to exclude variables based on skewness unless they exhibited no variance. Therefore, this study focused on kurtosis which measures whether a probability distribution is more peaked or flat than a normal distribution. Kurtosis values greater than 2.00 or less than -2.00 indicated a lack of sufficient variance (Sposito et al., 1983); items with severe kurtosis values were removed prior to factor analysis.

Several variables exhibited borderline kurtosis issues (having an absolute value between 1.00 and 2.00). These variables were flagged for potential future issues in subsequent analysis. Table 8.15 lists the removed and flagged items and provides their kurtosis values.

Table 8.15 Scale Items Having Kurtosis Issues

Variables Removed Due to Kurtosis Issues	**Kurtosis**
SE2 – I'm certain I can understand the ideas taught in this assignment.	5.094
FTCH1 – I have used Moodle in other courses for online discussions	2.066
PL1 – I developed a good understanding of the basic concepts during this assignment.	3.279
PL2 – I was able to identify central issues about this topic.	2.953
PL8 – I am satisfied with this assignment.	2.390
QLSC1 – The knowledge shared by members of my group was understandable.	2.042
QLSC2 – The knowledge shared by members of my group was accurate.	2.561
Variables Flagged for Further Examination	
LGO1 – I am willing to work on a challenging assignment that I can learn from.	1.534
LGO3 – I enjoy challenging and difficult tasks where I'll learn new skills.	1.771
SE9 – I know that I will be able to learn the material for this assignment.	1.582
I4 – The students seldom asked each other questions during the group part of this assignment. (Reverse coded)	-1.025
PL3 – The quality of this assignment compared favorably with other activities in this course.	1.514
QNSC2 – Group members could obtain abundant content and knowledge from the shared information.	1.007
QNSC3 – Group members provided meaningful comments to the shared information.	1.185
QLSC3 – The knowledge shared by members of my group was complete.	1.816
QLSC4 – The knowledge shared by members of my group was reliable.	1.650
SS2 – My assigned system was user-friendly.	1.554
SS3 – The content provided through the system was hard to understand. (Reverse coded)	1.234
SS4 – The operation of the system was stable.	1.920

As can be seen from Table 8.15, the items capturing Quality (QLSC) and Quantity (QNSC) of Social Capital are problematic. Of the three scale items measuring Quantity of Social Capital, only one had kurtosis indicating sufficient variance and two were borderline. Of the four items measuring Quality of Social Capital, two had kurtosis greater than 2 and were subsequently removed from the construct. The other two scale items had kurtosis greater than 1; these items were retained but will be carefully evaluated in subsequent analysis.

In general, all variables with borderline kurtosis values (between negative and positive two) will be further evaluated and may ultimately be removed from the theoretical model during bivariate data screening and exploratory factor analysis. Results for the remaining scale items are summarized in the following sections. The items in each construct were tested for similar distributions across systems using the Pearson Chi-square test and for differences in means based on ICT system using an independent samples t-test.

8.12.1 Univariate Results for Self-Efficacy

After removing the SE2 variable due to insufficient kurtosis, eight items remained in the self-efficacy scale. Univariate analysis revealed that students generally expressed high levels of self-efficacy, and none of these items exhibited significant differences between the students assigned to use Moodle and those using Pearltrees. Results are shown in Table 8.16.

Table 8.16 Distribution of Self-Efficacy Items

Label		Choice (SD to SA)	1	2	3	4	5
SE1	Compared with other students in this class, I expect to do well on this assignment. Mean = 4.08, SD = 0.735 (N=210)						
		Moodle (n=115)	0	1	25	61	28
		Pearltrees (n=95)	0	0	21	38	36
SE3	I expect to do very well on this assignment. Mean = 4.15, SD = 0.672						
		Moodle	0	2	18	64	31
		Pearltrees	0	0	10	53	32
SE4	Compared with others in this class, I think I'm a good student. Mean = 3.97, SD = 0.751						
		Moodle	0	2	28	60	25
		Pearltrees	0	2	22	44	27
SE5	I am sure that I can do an excellent job on the problems and tasks in this assignment. Mean = 4.14, SD = 0.677						
		Moodle	0	2	20	57	36
		Pearltrees	0	0	9	59	27
SE6	I think I will receive a good grade for this assignment. Mean = 4.20, SD = 0.677						
		Moodle	0	1	19	58	37
		Pearltrees	0	0	9	51	35
SE7	My study skills are excellent compared with others in this class. Mean = 3.59, SD = 0.786						
		Moodle	0	5	50	44	16
		Pearltrees	2	2	43	38	10
SE8	Compared with other students in this class, I think I know a great deal about the topic. Mean = 3.34, SD = 0.878						
		Moodle	2	14	54	31	14
		Pearltrees	2	9	49	27	8
SE9	I know that I will be able to learn the material for this assignment. Mean = 4.17, SD = 0.594						
		Moodle	0	2	6	78	29
		Pearltrees	0	1	7	61	26

8.12.2 Univariate Results for Task Value

Six items were used to capture students' perceptions regarding the value of the assigned task. Responses showed no statistically significant differences between students assigned to Moodle or Pearltrees. Results for these six items are shown in Table 8.17. Note that expectations about the value of the assignment tended to be very positive.

Table 8.17 Distribution of Task Value Items

Label	Choice (SD to SA)	1	2	3	4	5
TV1	I think I will be able to use what I learn in this assignment throughout the course. Mean = 4.28, SD = 0.677 (N=210)					
	Moodle (n=115)	0	1	10	54	50
	Pearltrees (n=95)	0	0	14	47	34
TV2	It is important for me to learn the material in this assignment. Mean = 4.26, SD = 0.671					
	Moodle	0	2	6	64	43
	Pearltrees	0	1	12	47	35
TV3	I am very interested in the content area of this assignment. Mean = 4.00, SD = 0.722					
	Moodle	0	4	17	69	25
	Pearltrees	0	3	17	53	22
TV4	I think the material in this assignment is useful for me to learn. Mean = 4.24, SD = 0.651					
	Moodle	0	1	8	70	36
	Pearltrees	0	1	11	45	38
TV5	I like the subject matter of this assignment. Mean = 3.89, SD = 0.686					
	Moodle	0	4	27	66	18
	Pearltrees	0	1	20	58	16
TV6	Understanding the subject matter of this assignment is very important to me. Mean = 4.02, SD = 0.670					
	Moodle	0	1	21	69	24
	Pearltrees	0	2	15	56	22

8.12.3 Univariate Results for Learning Goal Orientation

Learning goal orientation includes five items that capture students' perceptions regarding to what extent their learning efforts are driven by a desire for knowledge rather than a focus on grades or extrinsic rewards. None of the five items displayed statistically significant differences between the two systems. Results are shown in Table 8.18. Most students expressed a high level of desire for knowledge suggesting that they are intrinsically motivated learners.

Table 8.18 Distribution of Learning Goal Orientation Items

Label	Choice (SD to SA)		1	2	3	4	5
LGO1	I am willing to work on a challenging assignment that I can learn from. Mean = 4.26, SD = 0.636 (N=210)						
		Moodle (n=115)	0	4	6	65	40
		Pearltrees (n=95)	0	0	4	58	33
LGO2	I often look for opportunities to develop new skills and knowledge. Mean = 4.35, SD = 0.640						
		Moodle	0	1	10	57	47
		Pearltrees	0	0	6	45	44
LGO3	I enjoy challenging and difficult tasks where I'll learn new skills. Mean = 4.29, SD = 0.708						
		Moodle	1	1	14	51	48
		Pearltrees	0	1	5	51	38
LGO4	For me, developing my knowledge is important enough to take risks. Mean = 4.22, SD = 0.693						
		Moodle	0	2	15	54	44
		Pearltrees	0	1	8	54	32
LGO5	I prefer to work in situations that require a high level of ability and talent. Mean = 3.96, SD = 0.784						
		Moodle	1	3	26	59	26
		Pearltrees	1	1	19	50	24

8.12.4 Univariate Results for Topic Familiarity

Topic familiarity includes two items that capture students' existing knowledge about the assignment topic. Results suggest that students' familiarity with the topics of the assignments were generally neutral, and a Chi-square test indicated that there were no differences between the distributions of responses for students assigned to Moodle and those assigned to Pearltrees. However, an independent samples t-test showed that there was a difference in the mean of the responses to TPF1, with the Pearltrees group reporting slightly higher topic familiarity than the Moodle group. Results are shown in Table 8.19.

Table 8.19 Distribution of Topic Familiarity Items

Label		Choice (SD to SA)	1	2	3	4	5
TPF1	I have a working knowledge of the topic of this assignment. Mean = 3.186, SD = 0.853 (N=210)						
		Moodle (n=115) Mean = 3.061, SD = 0.958*	4	28	49	25	9
		Pearltrees (n=95) Mean = 3.337, SD = 0.918*	1	17	35	33	9
		t = -2.118, df = 208, p = 0.035					
TPF2	I am already very knowledgeable about the topic of this assignment. Mean = 3.095, SD = 0.853						
		Moodle	4	21	58	27	5
		Pearltrees	2	17	49	21	6
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$							

Upon further examination, there was no systematic difference between students using Pearltrees or Moodle when the independent samples Mann-Whitney U test was used to evaluate the distribution of TPF1 by course. Therefore, the TPF1 variable was retained.

8.12.5 Univariate Results for Interactions

Students' perceptions of the interactions that occurred during the assignment were captured through the four items shown below. An analysis of the responses of students assigned to use Moodle or Pearltrees revealed no statistically significant differences between the two groups. The results shown in Table 8.20 are reverse coded due to the negative wording of the original items.

Table 8.20 Distribution of Learner-Learner Interaction Items

Label		Choice (SD to SA)	1	2	3	4	5
LLI1	Students in my group seldom answered each other's questions. Mean = 3.05, SD = 1.181 (N=210)						
		Moodle (n=115)	13	29	25	36	12
		Pearltrees (n=95)	10	23	22	32	8
LLI2	During this assignment, students seldom stated their opinions to each other. Mean = 2.94, SD = 1.111						
		Moodle	10	36	30	31	8
		Pearltrees	10	27	20	33	5
LLI3	There was little interaction between students. Mean = 3.29, SD = 1.130						
		Moodle	5	26	30	39	15
		Pearltrees	10	15	19	40	11
LLI4	The students seldom asked each other questions during the group part of this assignment. Mean = 2.80, SD = 1.189						
		Moodle	15	41	23	29	7
		Pearltrees	14	29	18	25	9

These results suggest that students were generally neutral about how often students answered each other's questions (LLI1) and how often students shared opinions (LLI2). However, students felt positively about the amount of interaction that occurred between students, but felt negatively about the frequency of questions asked during the group part of the assignment. These results are supported by an analysis of the actual interactions that took place in the students' assigned systems during the group portion of the assignment. Students used the group area to share their resources, impacting the positive perceptions of interactions, but there was little to no dialogue between students occurring in either system, which could explain the neutral and even negative perceptions of asking questions, answering questions and sharing opinions.

8.12.6 Univariate Results for Perceived Learning

After removing PL1, PL2, and PL8 due to insufficient kurtosis, the perceived learning scale retained six items, shown in Table 8.21. This scale captures students' perceptions about the learning activity and its outcomes; results suggest that students' perceptions of learning through this type of assignment were generally positive. None of the items revealed statistically significant differences between students using Moodle or Pearltrees for the assignment.

Table 8.21 Distribution of Perceived Learning Items

Label	Choice (SD to SA)		1	2	3	4	5
PL3	The quality of this assignment compared favorably with other activities in this course. Mean = 3.73, SD = 0.827 (N=210)						
		Moodle (n=115)	3	0	31	63	18
		Pearltrees (n=95)	2	7	25	50	11
PL4	I developed an improved ability to integrate facts through this assignment. Mean = 3.81, SD = 0.744						
		Moodle	1	3	32	61	18
		Pearltrees	0	4	22	55	14
PL5	I learned to see relationships between ideas during this assignment. Mean = 3.81, SD = 0.751						
		Moodle	0	2	30	63	20
		Pearltrees	1	6	22	54	12
PL6	This assignment improved my ability to communicate clearly. Mean = 3.71, SD = 0.863						
		Moodle	1	8	27	63	16
		Pearltrees	2	9	22	48	14
PL7	This assignment served my needs well. Mean = 3.72, SD = 0.848						
		Moodle	0	9	26	63	17
		Pearltrees	4	4	24	51	12
PL9	I feel the assignment resulted in high quality interactions. Mean = 3.63, SD = 0.920						
		Moodle	1	9	38	47	20
		Pearltrees	2	10	28	39	16

8.12.7 Univariate Results for Quantity of Social Capital

The quantity of social capital scale captures students' perceptions regarding the amount of knowledge and comments posted by their group during the assignment. There were no statistically significant results between responses for students using either system. Results are shown in Table 8.22. In general, the results suggest that students were satisfied with the quantity of social capital shared during the group portion of the assignment.

Table 8.22 Distribution of Quantity of Social Capital Items

Label	Choice (SD to SA)		1	2	3	4	5
QNSC1	New content and knowledge was shared or posted frequently by my group. Mean = 3.57, SD = 0.972 (N=210)						
		Moodle (n=115)	2	12	31	54	16
		Pearltrees (n=95)	4	14	19	45	13
QNSC2	Group members could obtain abundant content and knowledge from the shared information. Mean = 3.94, SD = 0.840						
		Moodle	1	3	21	62	28
		Pearltrees	1	9	11	52	22
QNSC3	Group members provided meaningful comments to the shared information. Mean = 3.85, SD = 0.839						
		Moodle	1	5	21	65	23
		Pearltrees	2	7	17	53	16

8.12.8 Univariate Results for Quality of Social Capital

After removing QLSC1 and QLSC2 due to insufficient kurtosis, the remaining two items capturing students' perceptions about the quality of the knowledge resources shared during the group part of the assignment showed no statistically significant differences between Moodle and Pearltrees users, although an independent samples t-test resulted in a difference for QLSC4 at the 90% confidence level, with Moodle users having a slightly higher perception of the reliability of the shared knowledge. This difference could be the result of Moodle's enhanced communication affordances compared to those of Pearltrees. A more detailed discussion of students' perceptions regarding the affordances of both systems is provided in Chapter 10.

Results of the analysis of the two quality of social capital items are shown in Table 8.23. Students' perceptions of the quality of shared social capital were generally positive.

Table 8.23 Distribution of Quality of Social Capital Items

Label	Choice (SD to SA)	1	2	3	4	5
QLSC3	The knowledge shared by members of my group was complete. Mean = 3.93, SD = 0.872					
	Moodle	3	3	21	59	29
	Pearltrees	2	5	12	55	21
QLSC4	The knowledge shared by members of my group was reliable. Mean = 3.99, SD = 0.692					
	Moodle (Mean = 4.070, SD = 0.659)	0	1	18	68	28
	Pearltrees (Mean = 3.895, SD = 0.722)	1	3	15	62	14
	t = 1.833, df = 208, $p = 0.068^{\dagger}$					
† $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$						

8.12.9 Univariate Results for System Satisfaction

The system satisfaction scale captures students' perceptions about their assigned system. The odd-numbered items (SS1, SS3, SS5, SS7, and SS9) were negatively worded and were therefore reverse coded prior to analysis. Of the nine system satisfaction items, only one resulted in a statistically significant difference between Moodle and Pearltrees users: SS6, "The system made it easy for me to discuss questions with other students." For this item, the results of the independent samples t-test indicated that students who were assigned to use Moodle responded more positively than students who used Pearltrees ($t = 2.22$, $p = 0.027$). This result could again be a reflection of Moodle's enhanced discussion forum capability. Although Pearltrees does provide Note and Comment capabilities for discussion purposes, these affordances are not as intuitive or sophisticated as Moodle's discussion forums. More detailed analysis of students' perceptions of the affordances of both systems is provided in Chapter 10.

Results for the system satisfaction scale are shown in Table 8.24. Students generally reported being satisfied with their assigned system when completing a learning activity requiring the use, management, and sharing of Internet resources.

Table 8.24 Distribution of System Satisfaction Items

Label	Choice (SD to SA)		1	2	3	4	5
SS1	The system was difficult to use. Mean = 3.63, SD = 0.961 (Reverse coded)						
		Moodle	3	10	21	65	16
		Pearltrees	4	13	18	48	12
SS2	My assigned system was user-friendly. Mean = 3.84, SD = 0.898						
		Moodle	4	3	17	67	24
		Pearltrees	2	8	18	50	17
SS3	The content provided through the system was hard to understand. Mean = 3.66, SD = 0.942 (Reverse coded)						
		Moodle	4	9	26	60	16
		Pearltrees	6	2	22	53	12
SS4	The operation of the system was stable. Mean = 3.88, SD = 0.739						
		Moodle	0	4	20	71	20
		Pearltrees	2	3	18	59	13
SS5	The system made it hard for me to find the content I needed. Mean = 3.55, SD = 1.040 (Reverse coded)						
		Moodle	6	16	18	62	13
		Pearltrees	5	12	14	51	13
SS6	The system made it easy for me to discuss questions with other students. Mean = 3.72, SD = 0.1.008						
		Moodle Mean = 3.86, SD = 0.907*	2	8	20	59	26
		Pearltrees Mean = 3.55, SD = 1.100*	6	9	25	37	18
		t = 2.22, p = 0.027					
SS7	The system made it hard for me to access the shared content from the group. Mean = 3.51, SD = 1.064 (Reverse coded)						
		Moodle	7	17	15	61	15
		Pearltrees	5	13	17	49	11
SS8	The system made it easy for me to discuss questions with others. Mean = 3.58, SD = 0.931						
		Moodle	4	8	29	59	15
		Pearltrees	3	13	20	51	8
SS9	The system made it hard for me to share what I learned with my group members. Mean = 3.60, SD = 1.103 (Reverse coded)						
		Moodle	6	12	21	55	21
		Pearltrees	9	9	12	50	15

* p < 0.05, ** p < 0.01, *** p < 0.001

8.13 Summary

Using univariate analysis, this chapter addresses a number of research questions, each of which is summarized below.

RQ1: Do assignments requiring the use, management, sharing, and consolidation of Internet information resources lead to positive learning outcomes at the individual and group level?

Results of univariate analysis exploring RQ1 suggest that student perceptions of learning outcomes from this type of assignment were generally very positive in terms of the social capital developed through the assignment and the learning that resulted from it. Requiring students to share their resources to develop a group response also resulted in improved learning, as evidenced by a comparison of individual and group grades.

RQ2: Are characteristics of the student (e.g. gender, level of study, and GPA) related to the variables of interest in the study?

In response to RQ2, students' gender did not have any relationship to students' self-reported data, usage data or grades. However, students' level of education (undergraduate versus graduate) did result in significant differences for the following research variables: GPA, individual use, group use, group grade, self-efficacy, task value, learning goal orientation, system satisfaction, perceived learning, and quality and quantity of social capital. If the course was part of the student's degree program, students reported more positive perceptions for task value, quantity of social capital, system satisfaction, and perceived learning. If the course was part of the student's degree program, students also stored more resources in their assigned systems during the individual assignment.

RQ3: Are characteristics of the course (e.g. group formation method) related to the variables of interest in the study?

Course characteristics, in particular whether groups were allowed to self-form or were assigned by the instructor, had a significant effect on many of the research variables of interest in this study, with individual ICT system use, quantity of social capital, and perceived learning all being more positive for courses in which groups were assigned rather than self-formed.

RQ4: What pedagogical guidelines/practices best support sharing and managing digital resources for learning?

An exploration of differences between the eight courses included in this research revealed the impact of pedagogical factors, with instructor experience and topic focus emerging as important differences. These differences can help inform best practices for future assignments integrating these types of activities, addressing RQ4.

RQ5: Do students have a preference for type of knowledge exchange when sharing Internet resources for learning?

An exploration of students' self-reported sharing histories and the systems they used to share Internet knowledge resources suggests that, although most of the students who had shared previously reported using rich, directed communication forms such as face to face discussion and e-mail, a significant percentage also reported sharing through externalization of explicit knowledge by sharing links to resources through Facebook, Moodle and Dropbox.

RQ6: Do learning outcomes differ depending on the ICT system students used for the assignment?

Differences in learning outcomes were evaluated based on the ICT system students used for the research assignment. Results suggest that students who used Pearltrees stored more resources individually than students who used Moodle. However, there was no statistically significant difference in number of resources stored during the group sharing part of the assignment. Learning outcomes did not differ based on ICT system used, suggesting that students felt they learned from the activity regardless of system.

RQ8: What design guidelines characterize a system that best supports sharing and managing digital resources for learning?

Understanding students' previous methods of sharing (RQ5) is important in suggesting to designers of new or improved learning management systems the types of communication and sharing capabilities that they should provide to best support students' knowledge sharing activities. Although socialization is the preferred method, a large number of students also reported using externalization methods to share knowledge resources for learning. At the same time, however, instructors must also ensure that these sharing activities are required, recognized and rewarded in order to encourage such exchanges (RQ4).

Finally, this chapter concludes with univariate screening of the measurement items in preparation for the multivariate analysis, exploratory and confirmatory factor analyses, and model testing discussed in the next chapter. Items with kurtosis issues were identified and, where necessary, removed, and the distributions of the remaining items were explored.

CHAPTER 9

MULTIVARIATE ANALYSIS AND HYPOTHESIS TESTING

9.1 Overview

This chapter describes the results of multivariate analysis of the data for the nonequivalent control group study. Multivariate analysis begins with evaluations of the data to explore the following research questions:

RQ2 *Are characteristics of the students related to the variables of interest in the study?*

RQ6 *Do learning outcomes differ depending on the ICT system students used for the assignment?*

RQ7 *What theoretical model best explains individual and group learning by sharing and managing digital resources?*

Student characteristics are explored in the following section. This is followed by multivariate analysis of the research variables to be included in the exploratory and confirmatory factor analyses. The chapter ends with model and hypothesis testing.

9.2 Bivariate Analysis of Student Characteristics and Learning

Research question two (RQ2) asks whether assignment activities and the resulting learning outcomes vary according to such student characteristics as the level of the student (undergraduate versus graduate) or gender. Univariate analysis (discussed in Chapter 8) indicated that gender did not have any significant effect on the research variables of interest, while educational level and required course did. Student characteristics are further evaluated using bivariate analysis to test the following sub-questions related to RQ2.

RQ2a Does topic familiarity have a positive relationship with self-efficacy?

RQ2e Do students with higher GPAs report higher levels of perceived learning?

RQ2f Do students with higher GPAs report higher self-efficacy?

RQ2g Do students with higher GPAs report higher learning goal orientation?

These four research sub-questions proposed that students who are familiar with the assignment topic would report higher self-efficacy (RQ2a), and that students with higher GPAs would report higher levels of perceived learning (RQ2e), self-efficacy (RQ2f), and learning goal orientation (RQ2g). These sub-questions were tested using Pearson's correlation to explore the relationships between these variables. In response to RQ2a, topic familiarity was positively correlated with self-efficacy (r = 0.463, $p < 0.000$). Because correlation does not indicate causation, it is unclear whether students reported higher self-efficacy because they were familiar with the topic or whether students' more positive self-efficacy caused them to report a greater familiarity with the topic.

Although perceived learning was not correlated with GPA (meaning that sub-question RQ2e was not supported), GPA was weakly correlated with perceptions of self-efficacy (r = 0.194, $p = 0.018$) and learning goal orientation (r = 0.203, $p = 0.013$); therefore, research sub-questions RQ2f and RQ2g are supported. These results suggest that students who have higher GPAs tend to have a more intrinsic learning goal orientation and have higher perceptions of their learning abilities as captured through self-efficacy. The lack of a relationship between GPA and perceived learning could be due to the fact that perceived learning was measured on a single assignment which may not accurately reflect a student's overall characteristics as a learner. Interestingly, GPA was also weakly but positively correlated ($r = 0.193$, $p = 0.018$) with the number of resources individual students stored in their assigned systems. One possible explanation for this correlation is that students with higher GPAs may be more engaged in learning activities and may therefore participate more actively.

9.3 Bivariate Analysis for ICT System and Learning

Research question 6 (RQ6) explores the differences in perceived learning based on the information and communication technology (ICT) students used to complete the assignment. This broad research question suggested several sub-questions exploring the interactions between system usage and other research variables of interest. These sub-questions are listed below.

RQ6a *Does students' familiarity with the technology affect their use of their assigned system?*

RQ6b *Does students' familiarity with the topic positively affect their use of their assigned system?*

RQ6c *Do students who store more resources in their assigned system report higher perceived learning?*

Pearson correlation was computed for the individual system usage measure, the familiarity with topic measure, the two familiarity with technology measures, and perceived learning. Although individual system usage was not correlated with any of these variables (thus showing no support for RQ6a, RQ6b, and RQ6c), perceived learning was correlated with the two familiarity with technology items. The Pearson correlation between familiarity with Moodle and perceived learning was 0.265 ($p < 0.001$), and the correlation between familiarity with Pearltrees and perceived learning was slightly stronger ($r = 0.292$, $p < 0.001$), suggesting that perceptions of learning improve when students are at least somewhat familiar with the technologies supporting the learning activities.

9.4 Bivariate Data Screening

After completing the univariate analysis, the totals for the scale variables were computed based on the remaining items. At that point, the relationships between variables that were proposed in the theoretical model were evaluated. Relationships indicating a lack of statistical significance were further explored to determine if one or both variables should be removed from the theoretical model. Exploratory and confirmatory factor analysis and model testing were subsequently conducted, followed by hypothesis testing. The remainder of this chapter discusses the results of these analyses.

The first step in bivariate data screening was to compute the Pearson correlation for all variables in the theoretical model. Table 9.1 shows the resulting correlation matrix for self-efficacy (SE), task value (TV), learning goal orientation (LGO), topic familiarity (TPF), learner-learner-interactions (LLI), perceived learning (PL), quantity of social capital (QNSC), and quality of social capital (QLSC).

Table 9.1 Correlations of Research Variables

	SE	TV	LGO	TPF	LLI	PL	QNSC	QLSC
SE								
TV	.695***							
LGO	.611***	.662***						
TPF	.461***	.338***	.327***					
LLI	-.143*	-.141*	-.059 (ns)	-.128 (ns)				
PL	.362***	.489***	.465***	.261***	-.097 (ns)			
QNSC	.270***	.337***	.395***	.279***	.028 (ns)	.732***		
QLSC	.284***	.318***	.320***	.147*	.021 (ns)	.610***	.742***	
SS	.128 (ns)	.275***	.233**	.043 (ns)	.122 (ns)	.445***	.366***	.309***
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, (ns) = not significant								

The results show that most of the research variables are significantly correlated with each other. However, the learner-learner interactions variable (LLI) is only weakly (and negatively) correlated with self-efficacy and task value, and is not correlated with any other variables, including the dependent variable perceived learning. Because of this, the learner-learner interactions variable was not included in the exploratory and confirmatory factor analysis and it was excluded from the subsequent structural model. All other variables exhibit significant correlations except for topic familiarity and system satisfaction. However, because these variables are correlated with other variables including perceived learning, these variables were retained for further analysis.

9.5 Multivariate Data Screening

Linearity of the data was tested using curve estimation regression for all scale variables having proposed direct effects in the theoretical model. The results showed that the relationships between the variables were sufficiently linear (all *p*-values were less than 0.05). All variables were also tested for homoscedasticity (homogeneity of variance) by evaluating the scatter plot of zPred on zResid for each variable. The results suggested that all variables were homoscedastic.

Finally, the Variable Inflation Factor (VIF) was tested for all of the exogenous variables simultaneously to evaluate the severity of multicollinearity. The VIFs for the exogenous variables were all less than 3.0, indicating that the exogenous variables were all distinct (O’Brien, 2007).

9.6 Linear Regression and Power

Linear regression was performed using all eight exogenous variables as predictors and perceived learning as the endogenous (outcome) variable using the listwise linear regression method. The model adjusted R^2 is 0.626 (F (8) = 44.72, $p < 0.001$). Given eight predictors, the calculated adjusted R^2, and a sample size of 210, the power is calculated as 1.0, indicating that there is sufficient power to identify statistically significant effects.

9.7 Exploratory Factor Analysis

The theoretical model was developed using variables from a number of previous studies (described in detail in Chapter 5). To evaluate whether the variables have sufficient convergent and discriminant validity and reliability, exploratory factor analysis (EFA) was conducted on the scale items. Factor analysis assumes that there is an underlying structure in the variable (Hair et al., 2006) and that this structure can be detected with a sufficient sample size. When conducting a factor analysis, important issues to consider are the number of factors extracted and the percentage of variance explained. These are usually apparent in an initial, unrotated solution. Factor loadings of ±.30 to ±.80 are considered acceptable for initial factor analysis. Factor loadings should be ±.50 for practical significance, and the goal is factor loadings of ±.70.

Following the process described in Hair et al. (2006), the measures for the seven remaining constructs (learner-learner interactions was omitted due to its lack of correlation with the dependent variable) were extracted using maximum likelihood analysis. The next step was to further clarify the factors by creating a rotated solution. The rotation method used for this study was the Promax method. Promax rotation is an alternative non-orthogonal rotation in which the factors are allowed to be correlated. The goal for the various rotation methods is to simplify the loadings so that each measure loads on only one factor. When a measure loads on more than one factor, it is referred to as cross loading. If the cross loading cannot be resolved, that measure becomes a candidate for deletion (Hair et al., 2006).

Although the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was acceptable and Bartlett's test of sphericity was significant for the initial rotated solution, there were several issues that needed to be addressed. First, at least one of the communality estimates in the initial solution was greater than one. Additionally, there were a number of items that had significant cross loadings. The task value construct was particularly problematic, loading on several other constructs. The quality of social capital and quantity of social capital constructs loaded together, creating a new factor called social capital. The final rotated solution, shown in Table 9.3, achieved a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.847. Bartlett's test of sphericity achieved an approximate χ^2 of 2539.885 (df = 276, $p < 0.001$). All communalities for the individual items were greater than 0.4. The Goodness of fit test achieved a χ^2 of 243.241 (df = 147, $p < 0.001$). Only four percent of nonredundant residuals had an absolute value greater than 0.05.

Although some of the items loaded below the recommended 0.7 value, they were retained because of the exploratory nature of this research. Additionally, the results of validity and reliability testing suggested that all the factors had sufficient convergent and discriminant validity and reliability as determined by Cronbach's alpha, composite reliability (CR), average variance extracted (AVE), maximum shared variance (MSV), and average shared variance (ASV). These values are shown in Table 9.2 for all of the items in the final factor solution.

Table 9.2 Measures Indicating Validity and Reliability of Factors

	Cronbach's alpha	CR	AVE	MSV	ASV
Self-Efficacy	0.877	0.932	0.700	0.179	0.499
Social Capital	0.835	0.889	0.617	0.196	0.582
System Satisfaction	0.893	0.886	0.610	0.017	0.037
Learning Goal Orientation	0.832	0.917	0.735	0.204	0.499
Perceived Learning	0.770	0.842	0.641	0.200	0.582
Topic Familiarity	0.668	0.714	0.556	0.101	0.194

Table 9.3 Final Rotated Solution Pattern Matrix

		Factor					
		1	2	3	4	5	6
Self-Efficacy	SE3	**.888**	-.001	-.019	-.011	.041	-.106
	SE5	**.838**	-.031	-.006	.006	.004	-.064
	SE1	**.796**	.065	-.038	-.033	-.021	-.007
	SE6	**.746**	.005	.103	-.071	.003	.047
	SE4	**.609**	-.003	-.055	.028	-.065	.161
	SE7	**.428**	-.043	.054	.106	-.014	.255
System Satisfaction	SS9	.019	**.874**	-.030	.035	.039	-.022
	SS7	-.041	**.806**	.092	-.044	-.178	.126
	SS5	.080	**.771**	.018	-.059	.021	-.048
	SS1	-.019	**.765**	-.013	.037	-.021	.021
	SS3	-.023	**.748**	-.050	.052	.162	-.074
Social Capital	QNSC3	-.078	-.047	**.852**	.024	-.050	.037
	QLSC4	.090	-.026	**.758**	-.040	.047	-.108
	QLSC3	.035	.056	**.744**	.001	-.009	-.029
	QNSC2	-.051	.063	**.548**	.032	.194	.074
Learning Goal Orientation	LGO4	-.109	.063	-.038	**.829**	-.068	.033
	LGO1	.266	.066	-.032	**.706**	-.054	-.071
	LGO3	.122	-.100	.059	**.644**	.089	-.035
	LGO2	.015	-.052	.051	**.641**	.031	.051
Perceived Learning	PL7	.014	.000	-.033	-.084	**.872**	.074
	PL5	-.061	.022	.078	.134	**.599**	-.018
	PL3	.004	-.011	.192	-.060	**.597**	.010
Topic Familiarity	TPF2	.023	.009	.131	-.008	-.084	**.731**
	TPF1	.048	-.001	-.193	.019	.193	**.638**

The correlations for these items are shown in Table 9.4, with the square root of the average variance extracted (AVE) shown in bold on the diagonal. These results suggest that the factor solution is valid and exhibits no validity concerns.

Table 9.4 Factor Correlations and Square Root of AVE

	Self-Efficacy	Social Capital	System Satisfaction	Learning Goal Orientation	Perceived Learning	Topic Familiarity
Self_Eff	**0.837**					
Soc_Cap	0.299	**0.785**				
Sys_Satis	-0.001	0.157	**0.781**			
Lrn_Goal	0.706	0.437	0.113	**0.857**		
Perc_Learn	0.334	0.763	0.192	0.425	**0.801**	
Topic_Fam	0.441	0.305	-0.096	0.359	0.285	**0.746**

9.8 Confirmatory Factor Analysis

The factor pattern matrix shown in Table 9.3 was imported into IBM SPSS Amos Version 22.0.0.0 to conduct confirmatory factory analysis. After addressing several issues by covarying individual error terms within certain factors, a satisfactory model fit was attained. Common method bias was addressed by creating a common latent factor in IBM SPSS Amos and testing the model to detect any significance for this factor. The fact that the common latent factor had no significant effect on the model indicates that the model did not suffer from common method bias. The common latent factor was therefore removed from the model prior to hypothesis testing.

At this point, the final factors were imputed to create the constructs to be tested in the structural model. The factors were imputed using the data imputation capability provided in IBM SPSS Amos.

9.9 Model and Hypothesis Testing

Research question seven (RQ7) asks what theoretical model best explains individual and group learning by sharing and managing Internet knowledge resources. Prior to restating the hypotheses to be tested in the theoretical model, it is important to first summarize the revisions to the model based on univariate analysis, bivariate analysis, and results from the data collection.

First, all hypotheses regarding knowledge exchange form were dropped from the model because students did not communicate using their assigned systems. The learner-learner interactions construct was removed due to a lack of bivariate relationship with the dependent variable and most other research variables. During factor analysis, the task value construct was removed due to severe cross loadings of all items. Finally, during factor analysis, the quality of social capital and quantity of social capital constructs merged into a new factor labeled social capital. The revised research model is shown in Figure 9.1.

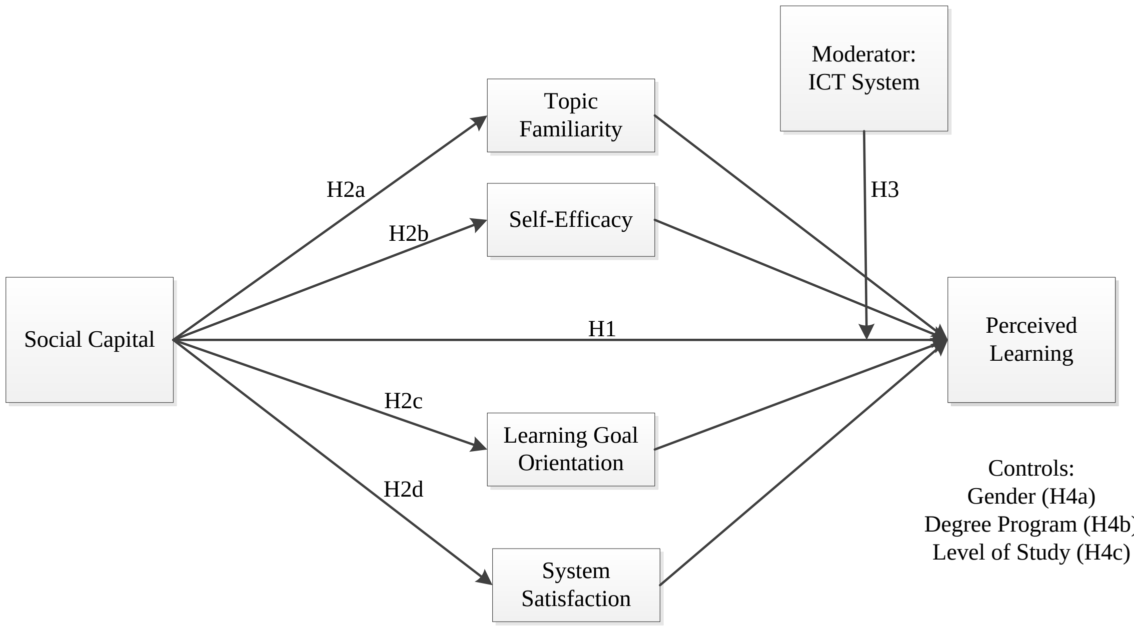


Figure 9.1 The revised theoretical model to be tested reflects the removal of the Task Value and Learner-Learner Interactions variables and the new factor, Social Capital, comprised of items from the Quality and Quantity of Social Capital constructs.

These revisions created a more parsimonious model suggesting the following hypotheses:

H1 *Social capital will have a positive relationship with perceived learning.*

H2a *Topic familiarity will mediate the relationship between social capital and perceived learning.*

H2b *Self-efficacy will mediate the relationship between social capital and perceived learning.*

H2c *Learning goal orientation will mediate the relationship between social capital and perceived learning.*

H2d *System satisfaction will mediate the relationship between social capital and perceived learning.*

H3 *The ICT system students used will moderate the mediated relationship between social capital and perceived learning.*

H4a *Female students will report lower perceived learning than male students.*

H4b *Students for whom the course is in their degree program will report higher perceived learning.*

H4c *Graduate students will report higher perceived learning than undergraduate students.*

Hypothesis testing began with the structural model based on the results of the confirmatory factor analysis. Direct effects were tested first, followed by mediation, moderation, and control variables.

9.9.1 Direct Effect

The model was first tested without mediation to assess the direct relationship between the independent variable and the dependent variable. This model is shown in Figure 9.2.

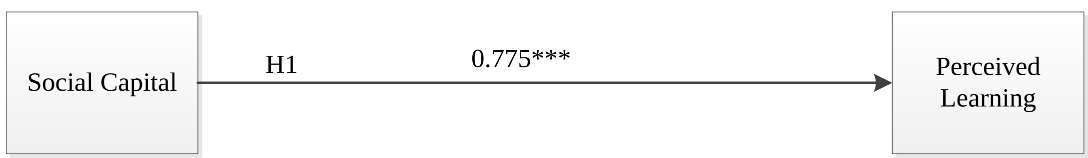


Figure 9.2 The model without mediation shows a strong direct effect between social capital and perceived learning.

Hypothesis 1 proposes a positive relationship between social capital and perceived learning. This hypothesis is supported; the direct relationship between social capital and perceived learning is very strong (0.775, $p < 0.001$). This result suggests that, in learning activities requiring the management and sharing of Internet resources, both quality and quantity of social capital play an important role in students' resulting perceptions of learning.

9.9.2 Mediation

The model was subsequently tested with the four mediators proposed by hypotheses H2a through H2d. These mediators are topic familiarity (H2a), self-efficacy (H2b), learning goal orientation (H2c), and system satisfaction (H2d). The fully mediated model is shown in Figure 9.3 below.

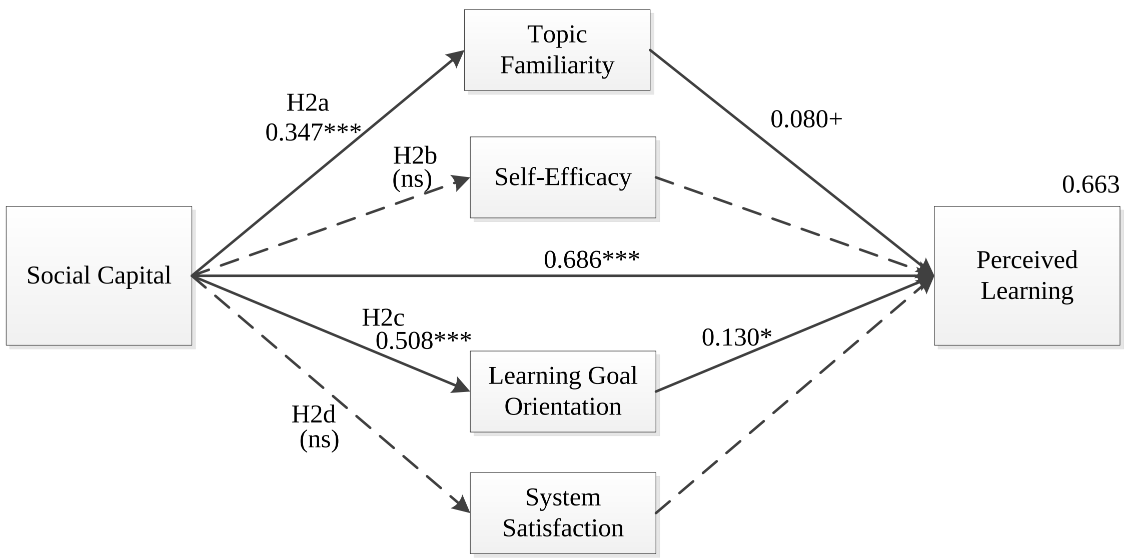


Figure 9.3 The model with mediation shows that topic familiarity and learning goal orientation mediate the relationship between social capital and perceived learning (indicated by solid lines), while system satisfaction and self-efficacy do not act as mediators for this relationship (indicated by dotted lines). + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hypothesis 2a proposed that topic familiarity would mediate the relationship between social capital and perceived learning. Analysis of the mediated model reveals that topic familiarity partially mediates the relationship between social capital and perceived learning, meaning that hypothesis H2a is supported. This result suggests that, while students can learn through Internet resources, their familiarity with the topic being researched will also have a positive effect on their perceived learning.

Hypothesis H2b proposed that system satisfaction would also mediate the relationship between social capital and perceived learning. In this case, hypothesis H2b is not supported because there was no evidence that system satisfaction mediated the relationship between social capital and perceived learning.

Hypothesis H2c proposed that student learning goal orientation would mediate the relationship between social capital and perceived learning. This hypothesis is supported; learning goal orientation partially mediates the relationship between social capital and perceived learning. This result suggests that, in autonomous learning activities in which students are expected to independently research a topic and then share their knowledge with their group, intrinsic motivation for learning will positively influence the effect of social capital formation on the perceived learning resulting from such activities.

Finally, H2d proposed that student self-efficacy would mediate the relationship between social capital and perceived learning. Again, results of the analysis suggest that student self-efficacy had no mediating effect on this relationship; therefore, H2d is not supported.

Table 9.5 lists the direct effects without mediation, direct effects with mediation, and indirect effects for all the mediated paths tested in Figure 9.2. Variables explored include social capital (SC), topic familiarity (TPF), perceived learning (PL), system satisfaction (SS), self-efficacy (SE), and learning goal orientation (LGO).

Table 9.5 Results of Mediation Testing

Path	Direct without mediator	Direct with mediator	Indirect effect	Conclusion
H2a: SC -> TPF -> PL	0.731**	0.715**	0.023*	Partial mediation
H2b: SC -> SE -> PL	0.722**	0.722***	0.006 (ns)	No mediation
H2c: SC -> LGO -> PL	0.709**	0.703***	0.045*	Partial mediation
H2d: SC -> SS -> PL	0.717**	0.716***	0.017 (ns)	No mediation
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, (ns) = not significant				

9.9.3 Controls and Moderation

Three control variables were tested in the model: gender, level of education (Undergraduate/Graduate), and whether the course was in the student's degree program or not. Although these three variables were already tested using univariate analysis to address research question two (RQ2), they were also considered as possible control variables for the structural model and were therefore tested as such. Gender was tested as a control variable (H4a) because prior research has suggested that female students report lower self-efficacy than their male counterparts and also have lower perceptions of learning outcomes. In this research model, gender exhibited no statistically significant effect; thus, hypothesis H4a was not supported. Students for whom the course was in their degree program were expected to be more engaged in the assignment than students for whom the course was an elective (H4b). This variable also had no statistically significant effect on the model, suggesting that H4b was also not supported. Finally, level of education (H4c) was tested as a control variable because graduate students were expected to be more engaged in their learning activities. Hypothesis H4c was also not supported; level of education had no statistically significant effect on the model.

One moderator was tested for the mediated model shown in Figure 9.2: ICT system (H3). ICT system was tested as a moderator on the structural model (including control variables) using the multi-group moderation approach in IBM SPSS Amos V22.0.0.0. Table 9.6 lists the significant moderation effects.

Table 9.6 Results of ICT System Multi-Group Moderation Testing

Path	Moodle Estimate	Pearltrees Estimate	Difference z-score
Social Capital to Topic Familiarity	0.194 p = 0.078	0.647 p = 0.000	3.099**
Topic Familiarity to Perceived Learning	0.004 p = 0.951	0.259 p = 0.010	2.145*
Learning Goal Orientation to Perceived Learning	0.299 p = 0.000	0.007 p = 0.965	-1.709†
† $p < 0.1$, * $p < 0.05$, ** $p < 0.01$			

From the results shown in Table 9.6, it is evident that the ICT system students used does moderate the mediated relationship between social capital and perceived learning, indicating that hypothesis H3 is supported. For topic familiarity, students using Pearltrees reported a stronger relationship between social capital and topic familiarity, and between topic familiarity and perceived learning, than students using Moodle. However, students who used Moodle for the assignment reported a stronger relationship between learning goal orientation and perceived learning. The metrics for the model fit of the final structural model are shown in Table 9.7.

Table 9.2 Model Fit Metrics of Final Structural Model

Metric	Observed Value	Recommended Value
CMIN/DF	1.221	1 to 3
CFI	0.993	> 0.950
RMSEA	0.023	< 0.060
PCLOSE	0.963	> 0.050
Standardized RMR	0.010	< 0.090

9.10 Summary

This chapter evaluates bivariate relationships between variables to further evaluate Research questions two (RQ2) and six (RQ6), aspects of which were already tested using univariate analysis. Research Question 2 explores the relationship between student characteristics and the research variables of interest in this study. Bivariate analysis suggests that students' familiarity with the assignment topic is positively associated with their perceptions of self-efficacy. At the same time, although students' semester GPA was not correlated with perceived learning, it was correlated with self-efficacy and learning goal orientation, and was also correlated with students' individual system use, suggesting that students with higher GPAs may be more actively engaged in their learning.

Bivariate analysis was also used to further explore Research Question 6 to identify differences resulting from the use of the two ICT systems when completing the assignment. Interestingly, students who were more familiar with the technology did not use it more, suggesting that introducing new systems may not impact students' engagement and participation in a learning activity. Students' familiarity with the topic also did not affect their system use, suggesting that students are no less engaged when they are familiar with a topic than when the topic is unfamiliar to them. Finally, there was no relationship between system usage and perceived learning. This could be the result of the large amount of non-use of either assigned system; despite the fact that many students did not store any resources in their assigned systems, they nevertheless included citations to resources in their submitted assignments, suggesting that Internet resources can be used for learning, even if those resources are not saved as instructed.

After bivariate analysis of the relationship between research variables, this chapter reports the results of multivariate analysis, exploratory factor analysis, and confirmatory factor analysis. The results of these analyses are used to explore research question seven (RQ7) and its related hypotheses that ask what theoretical model best explains individual and group learning by managing and sharing Internet knowledge resources. A summary of the hypotheses and their results are shown in Table 9.8.

Table 9.8 Summary of Revised Hypothesis Results for Structural Model

	Revised Hypothesis	Results
H1	Social capital will have a positive relationship with perceived learning.	Supported
H2a	Topic familiarity will mediate the positive relationship between social capital and perceived learning.	Partially supported[a]
H2b	Self-efficacy will mediate the positive relationship between social capital and perceived learning.	Not supported
H2c	Learning goal orientation will mediate the positive relationship between social capital and perceived learning.	Supported
H2d	System satisfaction will mediate the positive relationship between social capital and perceived learning.	Not supported
H3	The ICT system students use will moderate the mediated relationship between social capital and perceived learning.	Supported
H4a	Female students will report lower perceived learning than male students.	Not supported
H4b	Students for whom the course is part of their degree program will report higher perceived learning.	Partially supported[b]
H4c	Graduate students will report higher perceived learning than undergraduate students.	Partially supported[b]
RQ2a	Does topic familiarity have a positive relationship with self-efficacy?	Supported
RQ2e	Do students with higher GPAs report higher levels of perceived learning than students with lower GPAs?	Not supported
RQ2f	Do students with higher GPAs report higher self-efficacy?	Supported
RQ2g	Do students with higher GPAs report higher learning goal orientation?	Supported
RQ6a	Does students’ familiarity with the technology affect their use of their assigned system?	Not supported
RQ6b	Does students’ familiarity with the topic positively affect their use of their assigned system?	Not supported
RQ6c	Do students who store more resources in their assigned system report higher perceived learning?	Not supported

The following footnotes further explain the three hypotheses in Table 9.8 that were only partially supported.

a. In the initial theoretical model, H2a and H2b proposed that topic familiarity would positively mediate the relationship between quality of social capital and learning and would negatively mediate the relationship between quantity of social capital and learning. Because quality and quantity of social capital merged in the final theoretical model, the differences between quality and quantity could not be differentiated, but topic familiarity does positively mediate the relationship between social capital and perceived learning.

b. This hypothesis was supported in a direct comparison of the two groups using an independent samples t-test; however, this variable was not significant when tested as a control in the structural model.

CHAPTER 10

REPEATED MEASURES STUDY: PEARLTREES VS. MOODLE, AND THE EFFECT OF REPEATING SHARING ASSIGNMENTS IN COURSES

10.1 Overview

In three graduate-level courses, a repeated measures quasi-experimental design (Campbell & Stanley, 1963) was used to better understand students' perceptions regarding assignments requiring the use of Internet resources and the capabilities of the two ICT systems. The repeated measures portion of the study enables the exploration of the following four research questions:

RM RQ1 *What are the advantages and disadvantages of Pearltrees and Moodle?*

RM RQ2 *Are perceptions of the two systems affected by whether students used them first or second?*

RM RQ3 *Are there any significant differences in outcomes when this type of assignment is repeated a second time in a course? That is, for instance, do students change their perceptions of how much they learned in the assignment and, if so, for the better or for the worse?*

RM RQ4 *For students who experience both systems and compare and comment on them, design strengths and weaknesses of the two systems are investigated. What are the design implications of the students' comparative evaluations for the design of Learning Management Systems (LMSs) such as Moodle to better support the sharing of Internet resources?*

10.2 Method

A subset of students who participated in the larger, quasi-experimental control group study completed a second assignment using the ICT system they did not use for their first assignment. The study followed the experimental design shown below.

$$O_1 \quad X \quad O_2 \quad O_3 \quad Y \quad O_4$$

$$O_1 \quad Y \quad O_2 \quad O_3 \quad X \quad O_4$$

Students were randomly assigned to groups at the beginning of the semester. Students in odd numbered groups used Moodle (X) for the first assignment; students in even numbered groups used Pearltrees (Y) for the first assignment. Students willing to participate in the research portion of the assignment for extra credit also completed a pre-assignment survey (O_1) and a post-assignment survey (O_2) for the first assignment. Several weeks later, these same groups were instructed to use the system they did not already use for a second, similar assignment. Slightly modified pre-assignment (O_3) and post-assignment (O_4) surveys were administered before and after the second assignment. This can be diagrammed as a 2 x 2 repeated measures crossover design as shown in Figure 10.1.

	Moodle	Pearltrees	Both Systems
Task 1			
Task 2			
Both Tasks			

Figure 10.1 The setup of the 2 x 2 repeated measures design is shown, with students who used Moodle for the first assignment switching to Pearltrees for the second and vice versa.

10.3 Participant Demographics

The students participating in the repeated measures study are a subset of those already described in the pre-post study discussed in Chapter 8. Demographics for this subset of students (N=90) are shown in Table 10.1 below. Other than educational level, the demographics of participants are similar to those of the full (N = 210) cohort.

Table 10.1 Demographics of Repeated Measures Cohort

Demographic Data		
Gender	61 Male (67.8%)	29 Female (32.2%)
Assigned System	47 Moodle (52.2%)	43 Pearltrees (47.8%)
Educational Level	2 Undergraduate (2.2%)	80 Graduate (97.8%)
English is 1st Language	26 Yes (28.9%)	64 No (71.1%)
Had shared Internet learning resources before	70 Yes (77.8%)	20 No (22.2%)
Degree Program		
Information Systems		43 (47.8%)
Computer Science		0 (0.0%)
MBA		11 (12.2%)
Other (Information Technology, Business Information Systems, Computer Engineering)		36 (40.0%)

The three courses included in the repeated measures study were all graduate level courses, although the demographic data reveals that exceptions were made for two undergraduate students to enroll in these courses.

10.4 Univariate Analysis

The students included in the repeated measures study represent a subset of the larger (N=210) group of students. In this case, students who did not complete all four surveys were removed prior to analysis, resulting in a final group of 90 students participating in the repeated measures design study.

Two variables from the first pre-assignment survey were repeated in the survey administered prior to the beginning of the second assignment. These variables are task value and topic familiarity. The other two variables were expected to remain consistent across assignments (self-efficacy and learning goal orientation were not expected to change based on assignment).

All of the variables from the first post-assignment survey were repeated in the final post-assignment survey administered after submission of the second assignment. These variables include learner-learner interactions, perceived learning, system satisfaction, quality of social capital, and quantity of social capital. Additionally, two measures were included in the post-assignment surveys of students who had used Pearltrees for that assignment. These measures capture perceptions regarding the complexity of using Pearltrees for the assignment and the perceived compatibility of Pearltrees with students' learning activities. The means and distributions of these two new measures are reported in the following sections.

Eight additional questions were added to the final post-assignment survey. Three of these asked students to rate their perceptions regarding the second assignment: did they learn more or less, did they like the second system they used more or less, and did their group members work more or less during the second assignment. The means and distributions for these questions are shown later in this chapter. Additionally, five open-ended questions were included in the final post-assignment survey, asking what students liked least and most about each system, and finally which system they felt was better for assignments requiring the use and sharing of Internet resources for learning. The results of these open-ended questions are discussed at the end of this chapter.

10.4.1 Complexity of Using Pearltrees

Because the students in the repeated measures design study were exposed to both Moodle and Pearltrees, the post-assignment survey during the Pearltrees condition included five statements capturing students' perceptions about the extent to which having to use Pearltrees complicated the learning task (complexity). Of the 90 students in the repeated measures design study, 43 used Pearltrees for the first assignment and 47 used Pearltrees for the second assignment.

A t-test was conducted to address repeated measures research question two (RM RQ2): are perceptions of the ICT systems affected by whether students used them first or second? An independent samples t-test of the complexity construct suggests that the order in which students were exposed to Pearltrees did have an effect on their perceptions of the complexity of using Pearltrees, with students using it second reporting that they perceived Pearltrees as more complex and not fitting as well with their learning activities ($t = -2.135$, $p = 0.036$). An exploration of the individual scale items (which were reverse coded to adjust for the negative wording of the items) reveals that one item differed at the 95% confidence level, while two other items differed at the 90% confidence level. The distributions and significant differences are shown in Table 10.2.

Table 10.2 Univariate Analysis of Complexity of Pearltrees Use

Label	Choice (SD to SA)	1	2	3	4	5
CMPX1	Using Pearltrees takes too much time from my other learning activities. Mean = 3.416, SD = 0.986 (Reverse coded)					
	Assignment 1 Mean = 3.605, SD = 0.821	1	2	14	22	4
	Assignment 2 Mean = 3.277, SD = 1.117	4	6	16	15	6
CMPX2	Working with Pearltrees is so complicated, it is difficult to understand what is going on. Mean = 3.494, SD = 1.046 (Reverse coded)					
	Assignment 1 Mean = 3.277, SD = 1.155*	1	3	7	26	6
	Assignment 2 Mean = 3.767, SD = 0.868*	4	8	12	17	6
	t = -2.290, p = 0.024					
CMPX3	Using Pearltrees involves too much time storing and managing my Internet resources. Mean = 3.449, SD = 1.108 (Reverse coded)					
	Assignment 1 Mean = 3.674, SD = 0.919†	1	5	6	26	5
	Assignment 2 Mean = 3.255, SD = 1.224†	3	12	11	12	9
	t = -1.847, p = 0.068					
CMPX4	It takes too long to learn how to use Pearltrees to make it worth the effort. Mean = 3.539, SD = 1.244 (Reverse coded)					
	Assignment 1 Mean = 3.791, SD = 1.059†	2	5	2	25	9
	Assignment 2 Mean = 3.340, SD = 1.372†	6	8	9	12	12
	t = -1.751, p = 0.084					
CMPX5	Using Pearltrees in addition to Moodle requires too much extra effort. Mean = 3.146, SD = 1.093 (Reverse coded)					
	Assignment 1 Mean = 2.979, SD = 1.132	2	8	9	21	3
	Assignment 2 Mean = 3.021, SD = 1.105	5	11	15	12	4

† $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These results suggest that students who were exposed to Pearltrees during the first assignment found that it was less complex to integrate Pearltrees into their learning activity than students who used Pearltrees for the second assignment. One explanation for this difference is the impact of the timing of the second assignment which came late in the semester when students typically feel pressured to complete assignments for all of their courses and begin to prepare for final examinations. Another possible explanation is that more time had elapsed between the second assignment and the time when the researcher had introduced the students to the system at the initiation of the first research assignment. In anticipation of this effect, a Pearltrees video tutorial was created and provided to students at the beginning of the research assignment. Responses suggest that approximately 65 percent of students watched the tutorial video (65.1% of students who used Pearltrees for the first assignment and 63.3% of students who used Pearltrees for the second assignment). Therefore, the first explanation (that students felt more pressured with other demands around the time of the second assignment and therefore learning a new system was an additional burden) is more plausible.

10.4.2 Univariate Results for Compatibility

The compatibility scale measures the extent to which students believe that Pearltrees is compatible with their learning style and activities. As with the complexity variable, the compatibility items were captured only when students were assigned to use the Pearltrees system.

Analysis of the compatibility construct revealed that the order in which students were exposed to Pearltrees again was related to their perceptions, although at the variable level, this difference was significant only at the 90% confidence level ($t = -1.878$, $p =$

0.064). To further explore this difference, each item in the compatibility scale was analyzed individually; two of the three items resulted in statistically significant differences. Results are shown in Table 10.3.

Table 10.3 Univariate Analysis of Compatibility of Pearltrees Use

Label	Choice (SD to SA)	1	2	3	4	5
CMPB1	Using Pearltrees is compatible with all aspects of my learning. Mean = 3.449, SD = 0.965					
	Assignment 1 Mean = 3.674, SD = 0.892	1	4	8	25	5
	Assignment 2 Mean = 3.255, SD = 0.988	4	3	20	17	3
	t = -2.104, *p* = 0.038					
CMPB2	I think that using Pearltrees fits well with the way I like to manage my learning resources. Mean = 3.528, SD = 0.990*					
	Assignment 1 Mean = 3.767, SD = 0.868*	1	3	7	26	6
	Assignment 2 Mean = 3.319, SD = 1.045*	3	6	16	17	5
	t = -2.202, *p* = 0.030					
CMPB3	Using Pearltrees fits into my learning style. Mean = 3.517, SD = 0.967					
	Assignment 1 Mean = 3.605, SD = 0.877	1	2	16	18	6
	Assignment 2 Mean = 3.447, SD = 1.039	3	4	15	19	6
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$						

As with the complexity construct, univariate analysis of the compatibility construct also reveals that students reported lower perceptions of the compatibility of Pearltrees with their learning activities when they used Pearltrees for the second assignment. In response to repeated measures question two, these results suggest that perceptions about the system used for the assignment are affected by the order of system use, particularly when the system used second is unfamiliar to the students. This result also addresses research question four (RQ4) which explores pedagogical best practices for assignments requiring the use, management and sharing of Internet resources. It suggests that, if new systems are to be introduced as part of the assignment, instructors should organize these assignments early in the semester when students have more time to dedicate to learning the new system as part of the assignment. Instructors may even consider providing additional time at the beginning of the assignment to allow students to explore and become familiar with the system prior to beginning the actual assignment.

10.5 Analysis of Questions Comparing Assignments

The survey administered after students had submitted the second assignment included three questions asking students to compare their experiences with the second assignment to the first. In particular, these questions asked about their perceptions of learning during the second assignment, to what extent they liked the second system better, and how hard their group worked on the second assignment. These questions address repeated measures research question three (RM RQ3) which explores whether there are any significant differences in outcomes when this type of assignment is repeated a second time in a course. Responses for these three questions were scored on a five point Likert-type scale with the following responses:

1. A great deal less
2. Somewhat less
3. About the same
4. Somewhat more

5. A great deal more

Results are discussed in the following sections.

10.5.1 Univariate Analysis of Learning Comparison

The final post-assignment survey included a question capturing students' perceptions of how much they learned during the second assignment compared to the first assignment. The question asked, "During the second assignment, I learned …" A one sample t-test comparing the neutral response (3) to the means of the question revealed that students' perceptions were generally positive about the second assignment. To determine if there were any differences in perceptions based on the system students used for the second assignment, an independent samples t-test was used to compare the means for students using Pearltrees for the second assignment and students using Moodle. There were no significant differences based on ICT system used. Results for the one sample t-test are shown in Table 10.4.

Table 10.4 Learning During Second Assignment Univariate Analysis

LRN	During the second assignment, I learned…				
		Mean	SD	t statistic	Sig.
	Both systems	4.067	0.818	t = 12.366	0.000
1=A great deal less, 2=Slightly less, 3=About the same, 4=Slightly more, 5=A great deal more					

In response to repeated measures research question three, the positive mean and the significance of its difference from the neutral response (3) suggest that students felt more positively about the learning outcomes of the second assignment than the first assignment. One explanation for this result is that, having received feedback and a grade on the first assignment of this type, students felt that they had a clearer understanding of the expectations of this type of assignment when it was repeated for the second time in the course.

10.5.2 Univariate Analysis of ICT System Preference

The final post-assignment survey included a question prompting students to compare the system they used for the second assignment with the system they used first, asking if they liked the second system less or more. A one sample t-test was used to compare the mean of all responses to the neutral (three). Because this result was significant, an independent samples t-test was conducted to uncover which system students preferred. Responses are shown in Table 10.5.

Table 10.5 Liking Second System Univariate Analysis

LIKE	I liked this second system …				
		Mean	SD	t statistic	Sig.
	Both systems	3.300	1.240	2.295	0.024
	Second System Used Was…				
	Moodle	3.698	1.145	-3.041	0.003
	Pearltrees	2.936	1.223		
1=A great deal less, 2=Slightly less, 3=About the same, 4=Slightly more, 5=A great deal more					

Results reveal a statistically significant difference, with Pearltrees having a significantly lower mean than Moodle as the preferred system. To understand if this difference was equally distributed across the three courses included in the repeated measures study or if there were responses in any particular course that caused this difference, an independent Mann-Whitney U test was used to evaluate differences by course. This test revealed that there were no significant differences in system preferences except in the Information Systems Strategy course (IS_679_SPR14). In this course, students using Moodle as their second system reported liking it much more than Pearltrees. Results are shown in Table 10.6.

Table 10.6 Between Course Differences for System Liked Better

Between Course Differences	Moodle 2nd System (n=43)	Pearltrees 2nd System (n=47)
IS_679_SPR14	Mean rank = 11.38 (n=8)	Mean rank = 5.62 (n=8)
	Mann-Whitney U = 55.00, p = 0.015	

The only difference between this course (IS_679_SPR14) and the other two courses included in the repeated measures study is that this course was an elective course. Although an exploration of course differences based on required versus elective for the repeated measures courses did not reveal any statistically significant differences, this could be the explanation for the difference in preference for ICT system.

10.5.3 Univariate Analysis of Work During Second Assignment

A third question in the final post-assignment survey captured students' perceptions of how much effort their group members contributed to the second assignment. A one sample t-test was used to determine if the responses of all participants differed from the neutral response (three). Results for the one sample t-test were strongly significant. To further evaluate this result, an independent sample t-test was conducted to explore differences between students using Pearltrees and students using Moodle for the second assignment. No significant difference by ICT system was found. Results of the independent sample t-test are shown in Table 10.7.

Table 10.7 Working During Second Assignment Univariate Analysis

WORK	During the second assignment, my group members worked…				
		Mean	SD	t statistic	Sig.
	Both systems	4.200	0.782	14.561	0.000
1=A great deal less, 2=Slightly less, 3=About the same, 4=Slightly more, 5=A great deal more					

Relating to repeated measures research question three (RM RQ3), these results suggest that students felt their group members worked more during the second assignment. One explanation for this could be that, having already completed one assignment of this type and having received instructor feedback and grades for that assignment, students were more engaged and contributed more during the second assignment.

The results of the three comparison measures (learning more, liking the system more, and working harder) all suggest that there is a benefit to repeating this type of assignment in a course as students' perceptions were generally more positive after the second assignment.

10.6 Bivariate Analysis

To explore whether there were any changes between the correlations of the repeated variables and the variables that were captured only during the first pre-assignment survey

(Sefl-efficacy and learning goal orientation), a Pearson's correlation was calculated for these sets of variables. Results are shown in Table 10.8.

Table 10.8 Bivariate Analysis Repeated Measures with Non-Repeated

	Self-efficacy x Assignment 1	Self-efficacy x Assignment 2	Learning Goal Orientation x Assignment 1	Learning Goal Orientation x Assignment 2
Task value	0.647***	0.312**	0.705**	0.307**
Topic Familiarity	0.353**	0.114 (ns)	0.357**	0.172 (ns)
Learner-learner Interactions	-0.100 (ns)	0.081 (ns)	-0.045 (ns)	-0.031 (ns)
Social Capital	0.279**	0.211*	0.403**	0.210*
System Satisfaction	0.082 (ns)	0.088 (ns)	0.114 (ns)	0.052 (ns)
Perceived Learning	0.369**	0.236*	0.382**	0.174 (ns)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, (ns) = not significant				

These results suggest that, for many of the retested variables, their correlations with self-efficacy and learning goal orientation decreased during the second assignment. These differences will be further explored using a paired samples t-test. To explore the relationships between the retested variables themselves, a paired samples correlation was calculated for each repeated pair. These results are shown in Table 10.9.

Table 10.9 Correlations of Repeated Measures

Variable	Assignment 1 x Assignment 2 Correlation
Task value	0.482***
Topic Familiarity	0.402***
Learner-learner Interactions	0.664***
Social Capital	0.431***
System Satisfaction	0.404***
Perceived Learning	0.370***

A paired samples t-test was subsequently computed for each variable that was repeated between Assignment 1 (A1) and Assignment 2 (A2). Results are shown in Table 10.10.

Table 10.10 Paired Samples T-test for Repeated Measures

Paired Samples	Mean	SD	t (df = 89)	Sig.
Task Value A1 – A2	0.044	3.151	.134	(ns)
Topic Familiarity A1 – A2	-0.389	1.497	-2.465	0.016
Interactions A1 – A2	0.022	2.440	0.086	(ns)
Social Capital A1 – A2	0.100	2.327	0.408	(ns)
System Satisfaction A1 – A2	0.522	4.241	1.168	(ns)
Perceived Learning A1 – A2	0.089	1.987	0.424	(ns)

Topic familiarity was the only variable that was significantly different between assignment 1 and assignment 2. To better understand this difference, topic familiarity was evaluated in more detail using a related samples Wilcoxon Signed Rank non-parametric test. This test compared the responses for topic familiarity between the first (A1) and second (A2) assignments by course. Results are shown in Table 10.11.

Table 10.11 Topic Familiarity Differences By Course

Course	Mean and SD Assignment 1	Mean and SD Assignment 2	Wilcoxon Signed Rank Results
IS_677_SPR14 (n = 30)	6.600, SD = 1.476	6.600, SD = 1.522	(ns)
IS_679_SPR14 (n = 16)	5.812, SD = 1.601	6.250, SD = 1.438	(ns)
IS_677_FL14 (n = 44)	6.136, SD = 1.231	6.773, SD = 1.159	Z = 333.50 $p = 0.002$

These results suggest that there were no differences between students' familiarity with the topics of the assignment except in the Information Systems Principles (IS_677_FL14) course. The second assignment in this course required students to explore the ethical concerns of the Facebook emotional contagion manipulation study. Because this study had been publicly discussed and debated, students reported being more familiar with this topic. However, a two-way ANOVA showed that there were no interactions between topic familiarity and perceived learning for any of the courses.

10.7 Two-Way Repeated Measures ANOVA

To investigate whether there were any interactions between students' experiences during the two assignments and their assigned systems, a two-way repeated measures ANOVA was conducted for each repeated variable. Task value, system satisfaction, and learner-learner interactions revealed no interaction effects between the conditions of assigned system and assignment. Perceived learning exhibited an interaction effect with the students' assigned system at the 90% confidence level, and social capital exhibited an interaction effect significant at the 95% confidence level. Each of these results is examined in more detail in the following sections.

10.7.1 Interaction of Perceived Learning and ICT System

A two-way repeated measures ANOVA was conducted to explore the interaction of students' perceptions of learning from assignment 1 and assignment 2 and the system to which they were assigned. Box's test of equality of covariance matrices was not significant, suggesting that the observed covariance matrices of the dependent variables are equal across groups. The main within-subjects effect of perceived learning was not significant. However, the interaction of perceived learning and ICT system was significant at the 90% confidence level, with F (1) = 3.692, p = 0.058. A further exploration of the means of the four conditions is shown in Table 10.12.

Table 10.12 Means of Perceived Learning Repeated Measures

Perceived Learning	Moodle	Pearltrees	Both Systems
Assignment 1	11.766 SD = 1.577	11.349 SD = 1.798	11.567 SD = 1.690
Assignment 2	11.674 SD = 1.508	11.298 SD = 2.105	11.478 SD = 1.844
Both Assignments	11.722 SD = 1.536	11.322 SD = 1.954	

As shown in Table 10.12, the means of the perceived learning variable for students using Pearltrees was lower (regardless of assignment) than the mean for students using Moodle. To evaluate if any individual items had a greater effect on the interaction between perceived learning for each assignment and the ICT system used, a paired samples t-test was conducted for the three items used to capture perceived learning in the final measurement model. Significant results are shown in Table 10.13.

Table 10.13 Paired Samples T-test for Perceived Learning Scale Items

System	Variable	Mean/SD A1	Mean/SD A2
Moodle A1	PL5 – I learned to see relationships between ideas during this assignment.	4.000 SD = 0.626	3.702 SD = 0.778
	t (46) = 2.625, p = 0.012		
Pearltrees A1	PL3 – The quality of this assignment compared favorably with other activities in this course.	3.674 SD = 0.644	3.388 SD = 0.586
	t (46) = -1.850, p = 0.071		

These results suggest that there was an interaction between the system used and the assignment in terms of perceived learning. Students who used Moodle for the first assignment responded more positively to the statement about learning to see relationships between ideas than students who used Pearltrees for that assignment. At the same time, students who used Pearltrees for the first assignment responded more favorably regarding the quality of the assignment than students who used Moodle. The meaning of this interaction is not immediately obvious and should be explored in more depth in future research. In general, however, there does appear to be an interaction between ICT system used and perceived learning.

10.7.2 Interaction of Social Capital and ICT System

A two-way repeated measures ANOVA was used to explore the interaction of students' perceptions about the social capital that resulted from assignment 1 and assignment 2 and the system to which they were assigned. Box's test of equality of covariance matrices was not significant, suggesting that the observed covariance matrices of the dependent variables are equal across groups. The main within-subjects effect of social capital was not significant. However, the interaction of social capital and ICT system was significant, with F (1) = 6.006, $p = 0.016$. A further exploration of the means of the four conditions is shown in Table 10.14.

Table 10.14 Means of Social Capital Repeated Measures

	Moodle	Pearltrees	Both Systems
Assignment 1	16.809 SD = 2.133	15.744 SD = 2.150	16.300 SD = 2.195
Assignment 2	16.256 SD = 1.840	16.149 SD = 2.449	16.200 SD = 2.168
Both Assignments	16.544 SD = 2.007	15.956 SD = 2.307	

As shown in Table 10.14, the means of the social capital variable for students using Pearltrees was lower (regardless of assignment) than the mean for students using Moodle. To evaluate if any individual items had a greater effect on the interaction between social capital for each assignment and the ICT system used, a paired samples t-test was conducted for the four items used to capture social capital in the final measurement model. Results are shown in Table 10.15.

Table 10.15 Paired Samples T-test for Social Capital Scale Items

System	Variable	Mean/SD A1	Mean/SD A2
Pearltrees A1	QNSC3 – Group members provided meaningful comments to the shared information.	3.861 SD = 0.676	4.047 SD = 0.575
	t (46) = -2.075, p = 0.044		
	QLSC4 – The knowledge shared by members of my group was reliable.	3.907 SD = 0.610	4.140 SD = 0.560
	t (46) = -2.496, p = 0.017		

The results shown in Table 10.15 suggest that students assigned to use Pearltrees for the first assignment did not respond as positively about the comments shared by their group or the reliability of the resources shared by their group for the first assignment compared to the second assignment. The lower perceptions regarding comments shared when using Pearltrees could be the result of Moodle's more robust discussion features. The lower perceptions about the reliability of knowledge are more difficult to interpret, although they could be the result of non-use of the assigned ICT system to share resources with group members. Further research will be required to better understand this result.

10.8 Qualitative Data Analysis

To explore repeated measures research question four, the final post-assignment survey included five open-ended questions about the ICT systems students used for the two assignments. For Moodle and Pearltrees, two questions prompted students to explain what they liked best and least about using that system for this type of assignment. The final open-ended question asked students to explain which system they felt provided better affordances for completing this type of assignment. Thematic analysis was used to evaluate the qualitative data. Results are discussed below.

10.8.1 What Students Liked Best About Moodle

When asked what they liked best about using Moodle for an assignment requiring the use and sharing of Internet resources, students focused on several key areas. First, because assignments had to be submitted through Moodle (regardless of whether the students used Pearltrees or Moodle to manage and share resources), several students felt that this simplified their activities. One student stated, "*Submission of the assignment was easy*" when using Moodle.

Other students focused on the fact that they were already experienced and comfortable using Moodle. Said one student, "*Since we were used to Moodle from [the] beginning we didn't want to learn anything new*." Another student said, "*It makes it easier to go to one place*." A third student commented, "*Moodle is just convenient because all contents we need are there…*"

A few students noted specific affordances provided by Moodle which are not available or are more difficult in Pearltrees. One student liked the fact that Moodle provides *"… e-mail notifications when other members post."* Although Pearltrees provides Comment and Note capabilities, they are not as intuitive and user-friendly as Moodle's discussion forums, leading another student to state that Moodle was "*easy for discussion.*" Because Pearltrees data is public by default, and can only be made private through a paid account, one student commented that he preferred Moodle because it supported "*privacy of data*."

10.8.2 What Students Liked Least About Moodle

In response to what they liked least about using Moodle for this type of assignment, a number of students mentioned Moodle's inability to easily share Internet resources. Several students mentioned that Moodle's sharing capabilities are "*very basic*" and that it is "*hard to share*" in Moodle. Said one student, "*[Moodle] does not provide instant access to information as soon as the team members posted them, plus the website were just links unlike Pearltrees*." Another student said, "*Storing the references [in Moodle] was just seeing the links as an output, but no graphics or interactive data could be seen…*"

10.8.3 What Students Liked Best About Pearltrees

When asked what they liked most about using Pearltrees for this type of assignment, students focused on the visual interface of Pearltrees, the ease of storing resources, and the ease of sharing those resources with their teammates. One student called Pearltrees' user interface "*awesome*"; in general, students commented that Pearltrees had a "*very good design and has a lot of features*." Another student said about Pearltrees, "*I like everything from its interface, its bookmarking system to its sharing and folders system*."

Responses about sharing Internet resources on Pearltrees focused on the ease of sharing. Said one student, "*Pearltrees is graphically very appealing and [I] just have to add [the URL] to share web content [with] group members [who] can see thumbnail of the shared content.*" Another student said that "*sharing of resources with your group is very easy…*" in Pearltrees.

10.8.4 What Students Liked Least About Pearltrees

In response to what they liked least about using Pearltrees for this type of assignment, students felt that the demands of learning a new system impeded their normal interactions. One student stated, "*People are kind of new to it so the interaction didn't go to the normal level*." However, another student pointed out, "*There is a bit of a learning curve involved while using this system but once you get used to it, it is pretty easy to use*." Another student said that Pearltrees created "*one more extra account to maintain*." One student also complained that "*it is hard to communicate within the team using the system*."

10.8.5 Which System Is Better For Assignments Using Internet Resources

Of the 49 students who provided responses to the final question about which system they felt had better tools for completing this type of assignment, opinions were split, with 25 students stating that they preferred Pearltrees and 24 stating that they preferred Moodle or an improved version of Moodle. Students who preferred Moodle generally mentioned having all the information in one place as a principle benefit of Moodle. One student stated that she preferred "*Moodle because the course content and assignment are at the* *same place.*" Another student stated that he preferred Moodle because "*it is more convenient for students as they are more used to the Moodle system and how it works*."

Several students stated that they preferred Moodle because it had better affordances for communication between students. One student said that she definitely preferred Moodle for this type of assignment because it required "… *strong communication with group members*." Similarly, another student stated, "*Moodle is better, since it [provides] a mature way for us to interact with each other.*"

Students who preferred Pearltrees for this type of assignment focused on Pearltrees' appealing interface and better sharing capabilities. One student stated that Pearltrees made it "*easier to manage and store resources*." Another commented that Pearltrees "*has [a] drag and drop option. It can be used to invite people…*" to share.

Several students felt that Pearltrees was generally more suited to assignments requiring the management and sharing of resources. "*You don't want to download things and store them to your computer. That's a major downside to Moodle. Be it PDF docs or word (sic) docs, you have to upload them and then download them to read. Pearltrees on the other hand doesn't require you to download them. Another plus point is the bookmarking system, whereas on Moodle you'd be expected to copy paste the link into a forum.*" Another student stated, "*I think that Pearltrees definitely wins over Moodle. The reason being that as I got used to Pearltrees, the more easier (sic) it was to store and share data with teammates*." Similarly, one student said Pearltrees was "*better since this assignment required us to use Internet resources extensively. Pearltrees help[ed] gather the website information and organized them for easy access.*"

Some students expressed ambivalence, stating that the ideal system for this type of assignment would include certain affordances from each system. One student stated that both systems are "*good at their respective level: Moodle to share all the information; Pearltrees to share all the resources*." Another student pointed out that Pearltrees is "*more attractive to use and [is] more user-friendly. In Moodle, one has to look for [a] particular section, open it and then search for the desired post. In Pearltrees the home menu makes it more convenient to share resources as the posts are available at one click. So I think Pearltrees is better. The only negative point is that since everyone is used to using Moodle, Pearltrees requires a bit of learning curve*."

10.9 Design Implications

Students' responses to what they liked most and least about each system, and which system they felt was better for an assignment requiring the use and sharing of Internet resources, provide important implications for the design of new or improved systems. A system built to support these types of activities should provide advanced discussion capabilities; students frequently mentioned Moodle's discussion capabilities as a positive aspect of using Moodle for this type of assignment. Although not specifically a design implication, students also mentioned preferring to have all of their learning activities and resources in one place, suggesting that whatever learning management system students use should provide capabilities for sharing Internet resources in addition to managing course content and assignment submissions.

Many students preferred Pearltrees' graphical interface which supports and simplifies the creation of visual, hierarchical organizations of students' resources. At the same time, students felt that Pearltrees' affordances for sharing resources were superior to those of Moodle. Rather than copying and pasting a link into a discussion forum, Pearltrees provides a shared bookmarking system in which each “pearl” directly links to the relevant web content. Design implications therefore suggest that a new or improved system should provide a method for sharing bookmarks to facilitate the exploration of the linked content, directed communication tools to facilitate the exchange of tacit knowledge with other students, broadcasting communication tools to simplify wider sharing of knowledge resources with some form of notification of new content, and an interface that enables the creation and visualization of hierarchically organized resources.

Finally, at least one student mentioned that data stored in Pearltrees was public, while data stored in Moodle was private to the student or at least to the course. Pearltrees intentionally makes user accounts public by default (Pearltrees can be made private only through paid accounts). The public nature of Pearltrees accounts enables exploration of other individual’s curated resources; in fact, Pearltrees suggests curated collections with similar topics and notifies users when someone has picked the same pearl that they have stored. This capability to explore and find like-minded others is considered a benefit of Pearltrees’ capabilities. However, the fact that some students were uncomfortable with the public nature of Pearltrees’ accounts suggests that designers must allow students to control the visibility of their curated resources.

10.10 Summary

This chapter analyzes the repeated measures data from three graduate level courses that included two assignments requiring the use, management and sharing of Internet resources for learning, with students switching ICT systems between assignments. This crossover enabled a comparison of the two systems to understand what students perceived as the advantages and disadvantages of each for this type of assignment. The results of this analysis provide design guidelines for new or improved systems supporting learning by using and sharing Internet resources. In general, students reported that Moodle provided better affordances for communication between students, while Pearltrees made it easier to organize and share Internet resources.

To understand whether the order of use of the ICT system had any effect on students' perceptions, the complexity and compatibility measures were analyzed for students who used Pearltrees for the first versus for the second assignment. In both cases, students using Pearltrees second reported lower perceptions for these variables, suggesting that there is an interaction between the order of ICT use and students' perceptions regarding the system, particularly for new systems that are unfamiliar to the students.

Repeated measures research question three asks whether there is any difference when this type of learning assignment is repeated in a course. Students responded positively to questions about learning more and working more during the second assignment, suggesting that repeating this type of assignment does result in improved outcomes.

Finally, this chapter summarizes the qualitative data students provided in response to questions asking what they liked least and most about each ICT system (Pearltrees and Moodle) and which system they thought was best suited for this type of assignment, suggesting important design implications from students' comments.

CHAPTER 11

NETWORK MEASURES, INTERNET RESOURCES, AND LEARNING

11.1 Overview

Social network analysis is a methodology used to explore the networks that result from interactions between actors, uncovering the patterns that are otherwise difficult to identify in these often complex networks. In these networks, the actors (nodes) can represent not only individuals but also organizations, resources, and even knowledge or opinions. Depending on the types of actors in a network, the relationships connecting them can signify friendship, animosity, flow of information, or simply access, such as an individual's access to specific knowledge or expertise (Wasserman & Faust, 1994).

Social network analysis enables the exploration of these relationships through different levels of analysis. At the network level (i.e. evaluating the connections of all nodes in the network), measures such as density provide researchers with information about the connectedness of the actors in the network as a whole. At the node or actor level, centrality measures reveal an actor's position in its local network and suggest what benefits that position may provide to the actor or what role that actor may play in the network (Borgatti, Everett, & Johnson, 2013).

Although frequently used to explore interactions between individuals such as being friends on Facebook or building communities on Twitter (Gruzd, Wellman, & Takhteyev, 2011), social network analysis has also been applied to investigating political polarization (Gruzd & Roy, 2014) as well as identifying the effects of co-authorship networks on the performance of scholars (Abbasi, Altmann, & Hossain, 2011) and the inclusion of underrepresented minorities (Osatuyi, Steffen-Fluhr, Gruzd, & Collins, 2010).

In this research, social network analysis is applied to networks of students and the resources they cite in their individual assignments. Exploring an innovative approach to learning analytics, this research suggests a framework that defines relationships between network structures and assignment characteristics and between node-level network measures and learning outcomes. This framework can be applied to the development of learning activities seeking to produce particular network structures while simultaneously informing evaluation of student performance based on their network positions. The development of this framework is therefore guided by the following three research questions:

SN RQ1 *How do the characteristics of learning activities influence the structures of their resulting student citation networks?*

SN RQ2 *What network measures (betweenness, closeness, and total degree centrality as well as clique count) might be indicators of learning outcomes in these different network structures?*

SN RQ3 *Can centrality measures be used to identify cited Internet resources having potential value as instructional resources or as indicators of student learning?*

11.2 Methodology

The development of the proposed framework requires the integration of several critical components. First, details about the assignments are required to understand their impact on the resulting network structures. At the same time, evaluations of learning outcomes must be reliable to investigate the relationships between learning performance and network positions. These components are discussed in detail in the following sections.

11.2.1 Included Courses and Assignments

Because reliable learning metrics are necessary to explore the relationships between student performance and network measures, this analysis is limited to three graduate-level courses, all of which were taught by the same instructor. The exclusion of other courses was necessary to address the instructor grading inconsistencies discussed in Chapter 8.

The three courses included, IS_677_SPR14, IS_679_SPR14, and IS_677_FL14, were not only taught by the same instructor, but they were also the three courses in which two assignments of this type were included. (See the Repeated Measures study described in Chapter 10 for more information.) Because only six assignments could be used in the development of the framework, and because not all students allowed the researcher to capture their assignment grades, the findings presented in this chapter are preliminary, suggesting guidelines for future framework refinement and evaluation.

11.2.2 Network Definitions

Prior to beginning a discussion about the networks resulting from the six assignments, it is necessary to define some basic concepts about networks. First, social networks can be one-mode or two-mode (Borgatti et al., 2013). In a one-mode network, there is only one type of actor. For example, a social network exploring an individual's educational connections is considered to be one-mode because all of the actors are people. Actors may have attributes that distinguish them as different (for example, fellow students, teachers, and administrators), but nevertheless all of the actors are individuals.

In a two-mode network, the network consists of different types of actors. For example, in this research, the networks connecting students and their cited Internet resources are two-mode. That is, there are two types of actors in these networks: students and Internet resources.

A bipartite network is a special type of two-mode network. In bipartite networks, relationships can exist only between the two types of actors and not between the same types of actors. The student citation networks explored in this research are bipartite; students are connected only to the resources they cite and not to other students, except through a shared resource. An example of a student by resource bipartite network is shown in Figure 11.1.

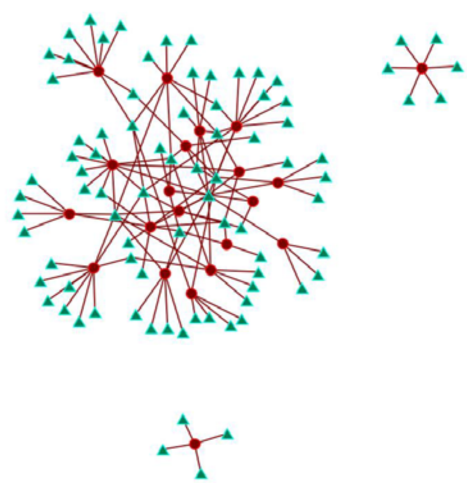


Figure 11.1 This image shows the bipartite student citation network that emerged from the individual assignment in one course included in this research. The red dots represent students and the green triangles represent their cited resources.

For the purposes of network analysis, there can be a benefit to converting bipartite networks into one-mode networks. In this case, two related one-mode networks can be created from a single bipartite network: one connecting students who cited the same resources, and one connecting Internet resources having students in common. The one-mode networks resulting from the bipartite network shown in Figure 11.1 are shown in Figure 11.2 below.

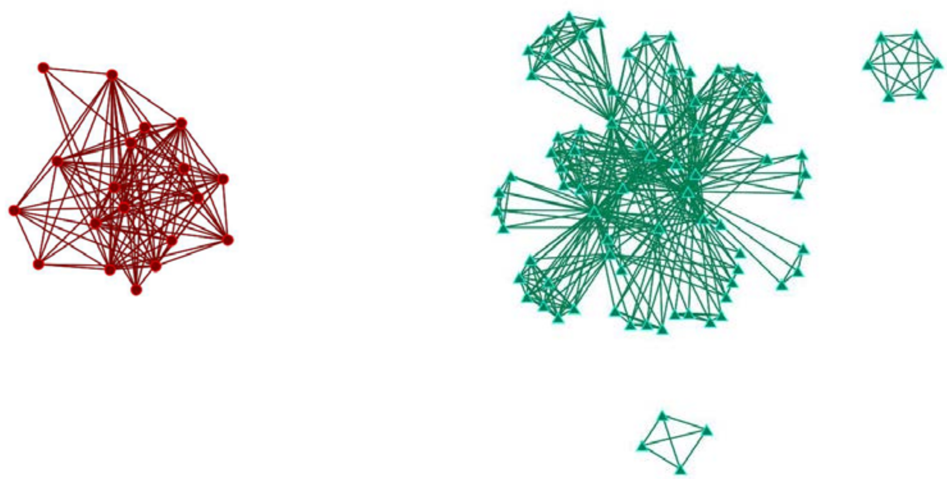


Figure 11.2 The network on the left represents the dot product matrix of students who are connected through commonly cited resources. The network on the right represents the dot product matrix of resources connected through common citations by students.

11.2.3 Constructing Bipartite Networks

For all students who submitted individual assignments, the resources they cited in their assignments and stored in their assigned systems (Moodle or Pearltrees) were captured for analysis. To build the bipartite student citation networks, a spreadsheet was created in Microsoft Excel containing a list of the student's cited Internet resources along with the student's identifier. For each student-resource relationship, a link weight of 1 was specified to indicate that the resource was cited once by that student in that particular assignment. A sample of the spreadsheet is shown below in Figure 11.3.

	A	B	C	D	E	F
1	NodeType	ID	NodeType2	Resource	Weight	Network
2	Agent	ID1	Resource	http://www.informationbuilde	1	Individual
3	Agent	ID1	Resource	http://docs.oracle.com/cd/B10	1	Individual
4	Agent	ID1	Resource	http://en.wikipedia.org/wiki/I	1	Individual

Figure 11.3 These lines from a Microsoft Excel spreadsheet show the input format used to build the student by resource networks for each assignment.

This spreadsheet was subsequently imported into Carnegie Mellon's CASOS Organizational Risk Analyzer (ORA) software Version 2.2.9. This application facilitates the creation, exploration, manipulation, and visualization of social networks. To create the one-mode networks of students and of resources, ORA's Matrix Algebra Dot Fold capability was used. Finally, ORA's Measures attribute capability was used to calculate the centrality measures of interest for each node. These centrality measures were subsequently exported from ORA and imported into the repeated measures data (described in detail in Chapter 10) for analysis in IBM SPSS V22.0.0.1.

11.3 Assignments and Resulting Networks

Social network research question 1 (SN RQ1) explores how characteristics of the assignments affect the structures of the resulting student citation networks. The primary characteristic that drives students in their selections of Internet resources is the definition of the research topic itself. While some assignments allowed students to select topics, such as case studies for analysis or information systems failures for exploration, other assignments clearly defined the topic to be researched. Table 11.1 provides a summary of the courses and assignments included in this analysis. Complete instructions for all the assignments are provided in Appendix E.

Table 11.1 Course Assignments Generating Student Citation Networks

Course	Assignment
IS_677_SPR14	A1 – Research the components of an information system as defined in the textbook, analyze a mini-case about these components (also in the textbook), and then research three information system failures from the list provided in the text, applying the four components to their analysis
	A2 – Select a case study from several provided by the instructor and prepare an analysis including a summary of the case study, a description of the problems and relevance, possible alternative solutions, an analysis of how the case integrates with the course material, a critical analysis, and a summary of what lessons were learned from the case
IS_679_SPR14	A1 – Research Hofstede's national cultural dimensions, find information about India's measures for the cultural dimensions, explore the organizational structures of two very different Indian consulting firms and apply the cultural dimensions to the organization structures of those two companies
	A2 – Use the university's library to select a relevant case study for analysis from an industry journal, subsequently providing a summary of the case study, a description of the problems and relevance, possible alternative solutions, an analysis of how the case integrates with the course material, a critical analysis, and a summary of what lessons were learned from the case
IS_677_FL14	A1 – Define the four types of organizational structures discussed in the textbook, apply those definitions to the organizational structure of the Federal Bureau of Investigation (FBI), find at least one other company or organization that has a similar structure, and compare the cultures and information systems strategies of the two organizations in light of an information systems failure at the FBI (also discussed in the textbook)
	A2 – Conduct an analysis of the ethical considerations and issues resulting from the Facebook emotional contagion study, subsequently providing a summary, a description of the problems and relevance, some alternative solutions to how the study was conducted, an evaluation of how the study integrated with the course materials, a critical analysis, and a discussion of lessons learned

A review of the assignments described in Table 11.1 suggests that four of the six assignments were open in the sense that students could select details regarding the research topic, from a case study for analysis to a company with an organizational structure similar to that of the FBI. The remaining two assignments (IS_679_SPR14 A1 and IS_677_FL14 A2) were more focused, clearly defining the topic as a whole. These two types of assignments (open versus focused) resulted in very different network structures, discussed in more detail in the following sections.

11.3.1 Open Topic Research Assignments

Assignments with open topics guided students in a general research direction (for example, applying the four components of an information system to information system failures) but allowed students to select the specific companies or cases to be analyzed. Because students selected different cases or companies to research, this type of assignment resulted in networks with distinct components. These components are indications of several students researching the same case; because students had to complete a group assignment after their individual assignments were submitted, they had to coordinate with their group members in advance to research the same cases.

One of the assignments allowing students to select from a list of topics was the first assignment in IS_677_SPR14. The network resulting from this assignment had the lowest density of all the student citation networks. This assignment instructed students to read about the four components of an information system described in the textbook, review a mini-case (also in the textbook), and subsequently research three notable information system failures from a list provided in the textbook. An analysis of the resulting bipartite network suggests that students did not conduct much research about the mini-case in the book but focused on researching the system failures of various companies. Because students could select any three companies from the list provided in the textbook, the resulting network was fragmented, as shown in Figure 11.4.

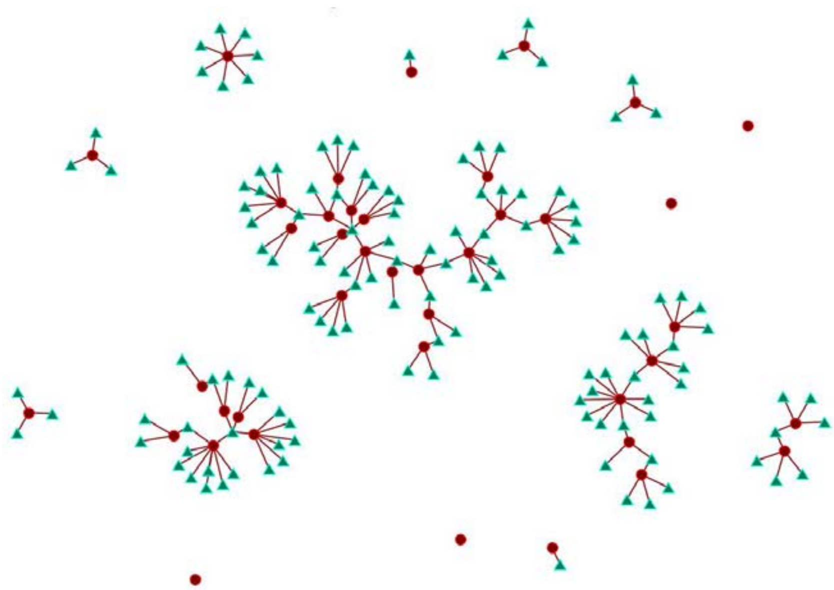


Figure 11.4 The fragmentation of the bipartite network resulting from assignment 1 in IS_677_SPR14 is a reflection of the assignment that allowed students to select companies having suffered information system failures rather than all students researching the same company.

A visualization of the related one-mode student network, shown in Figure 11.5, highlights the disconnectedness of this network. The mean of students' clique counts for this network is 0.3, with a median of 0 and a range of 0 to 2, suggesting that most students in this network are not members of any cliques. (Clique count is described in more detail in Section 11.4.2.) The network shown in Figure 11.5 has a very low density of 0.08736.

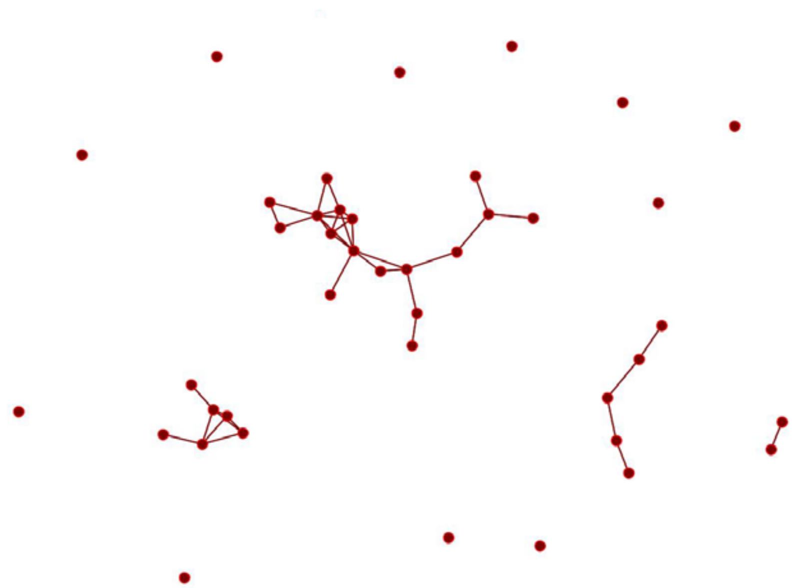


Figure 11.5 The one-mode student network generated from the bipartite network shown in Figure 11.4 shows the low density resulting from students rarely citing the same Internet resources.

Another example of an open topic assignment is the second assignment in IS_679_SPR14 that allowed students to select any case study from an information systems industry journal. Because students were given little guidance in selecting a specific case for analysis, the resulting network is once again fragmented. However, the network resulting from this assignment is much more dense than the network resulting from the first assignment in IS_677_SPR14. This could be the result of students' increased engagement during the second assignment. In general, students stored more resources during the second assignments in courses where the assignment was repeated and also felt that they learned more and that their teammates worked harder (as reported in Chapter 10).

The bipartite network for IS_679_SPR14 Assignment 2 is shown in Figure 11.6.

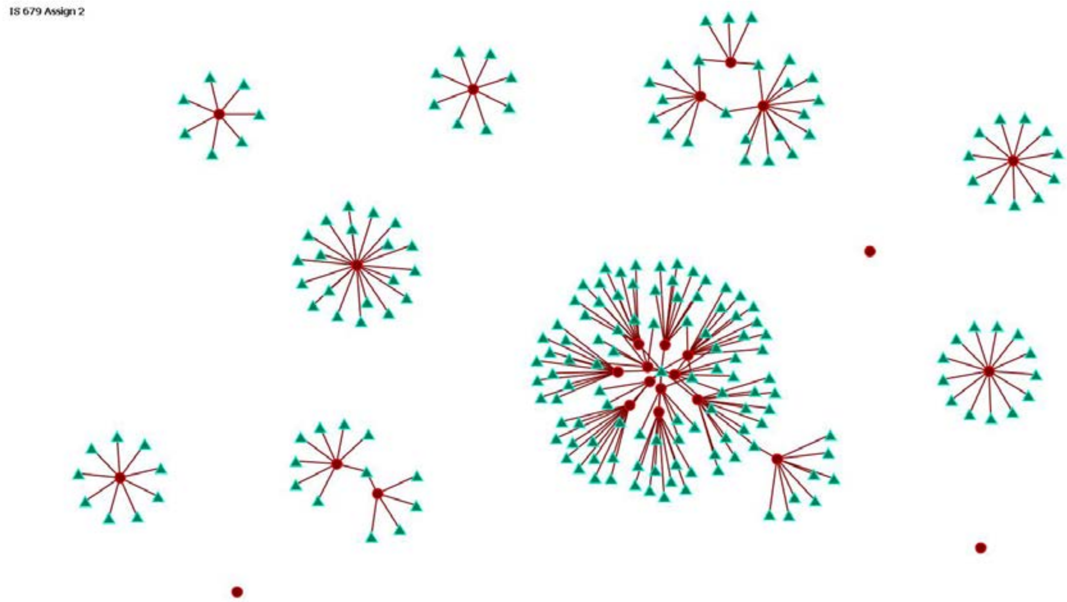


Figure 11.6 This bipartite network has a single large cluster and several smaller clusters. These clusters are a visual cue of an open topic assignment that allows students to select the details of their Internet research.

The visualization of the one-mode student network resulting from this bipartite network reveals that this network has one large, dense cluster in the center and several small clusters in the periphery, as well as isolated students who did not cite any resources also cited by others. The mean of nodal clique counts in this network is low (0.625) with a median of 1.0 and a range of 0 to 1, suggesting that students are still not well connected in the network. However, this network has the highest density of the four open topic research assignment networks (0.4412). This higher density measure is the result of the many connections between the students in the large, central cluster. These connections are easily visible in the one-mode student network shown in Figure 11.7.

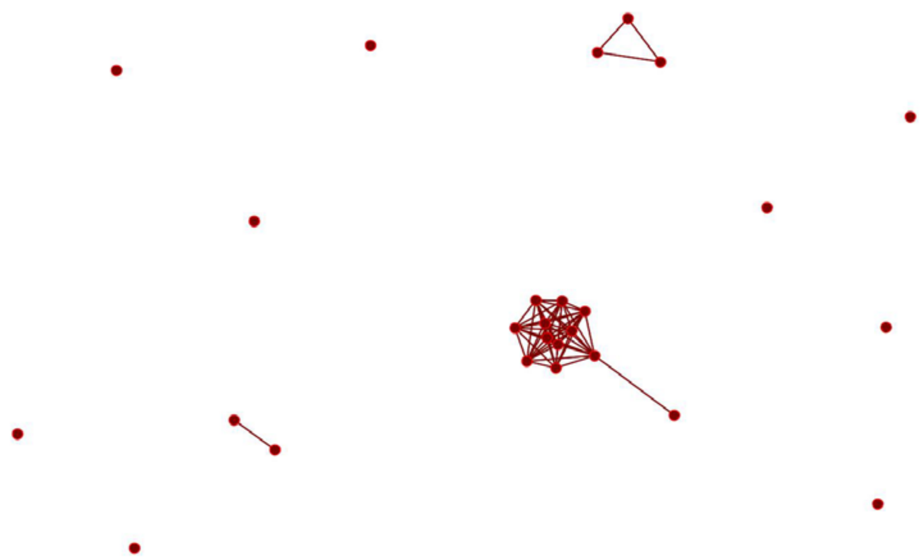


Figure 11.7 The one-mode student network makes more apparent the central, well-connected cluster, a dyad, a triad, and the many isolates in this network.

In general, the characteristics of the networks resulting from all of the open topic assignments are similar. The networks are generally fragmented, they have lower density, and the nodes in the network have low mean and median clique counts.

11.3.2 Focused Topic Research Assignments

Two of the six assignments included in this analysis provided very specific instructions to students regarding the topics to be researched. While students still found many unique resources about these topics, an exploration of the network structures resulting from focused assignments revealed very different structures than those of the open topic assignments.

The first assignment in IS_679_SPR14 instructed students to research Hofstede's cultural dimensions, particularly Hofstede's dimensions for India, and to apply those dimensions to two Indian consulting firms (TCS and Cognizant), each having very different organizational structures. The bipartite network resulting from this assignment is shown in Figure 11.8.

Almost all students cited the same one or two resources that explained Hofstede's cultural dimensions and gave the measures for India. These resources are very central in the resulting bipartite network which has a dense network structure. However, as can be seen in Figure 11.8, after finding the common resources describing the cultural dimensions, students found many other relevant yet unique resources.

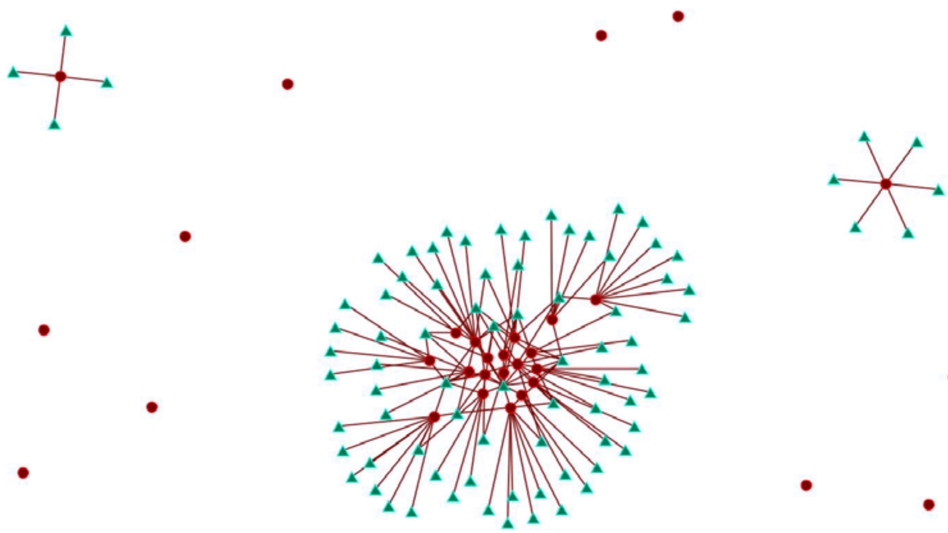


Figure 11.8 This bipartite network shows one large central cluster of students, two students who cited resources unique to themselves, and many isolates signifying students who did not cite any resources in their assignments.

An exploration of the one-mode student network shown in Figure 11.9 reveals a tightly connected central cluster while all other students are isolates. The density of the one-mode network is the highest of all six networks in this analysis at 0.6842. The mean of the clique count for the nodes in this network is 4.0, with a median of 5 and a range of

0 to 7. These values are much higher than the means and medians for any of the open topic assignment networks, all of which had clique counts with medians of either 0 or 1. The one-mode student network resulting from the assignment researching Hofstede's cultural dimensions (IS_679_SPR14 A1) is shown in Figure 11.9.

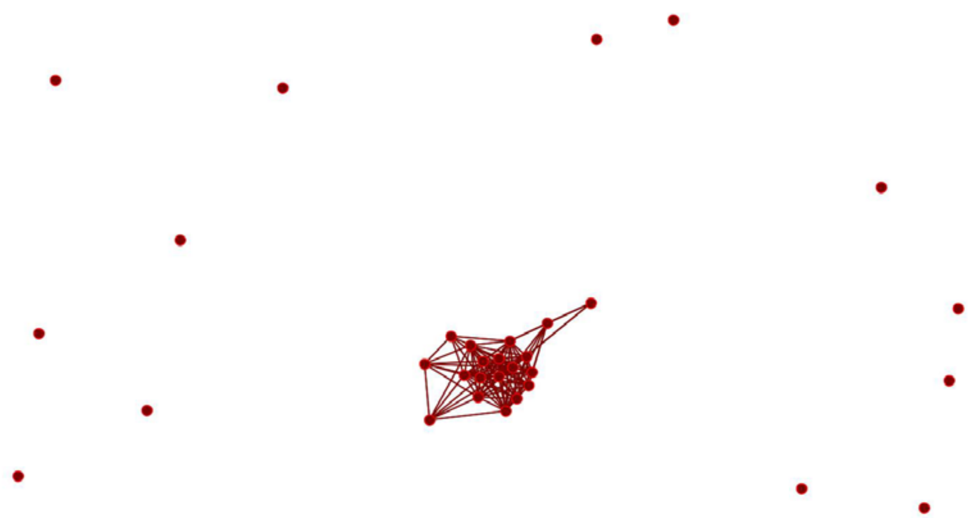


Figure 11.9 This one-mode student network has the highest density of all the networks included in this analysis. This density is the result of research about a topic that can only be discovered easily through one or two Internet websites.

The other focused topic assignment included in this analysis is the second assignment of IS_677_FL14. This assignment asked students to research the ethical considerations of the Facebook emotional contagion study (Kramer, 2012). The students were asked to first read the study paper and subsequently to find resources discussing the ethical debate surrounding the study. The resulting network is shown in Figure 11.10.

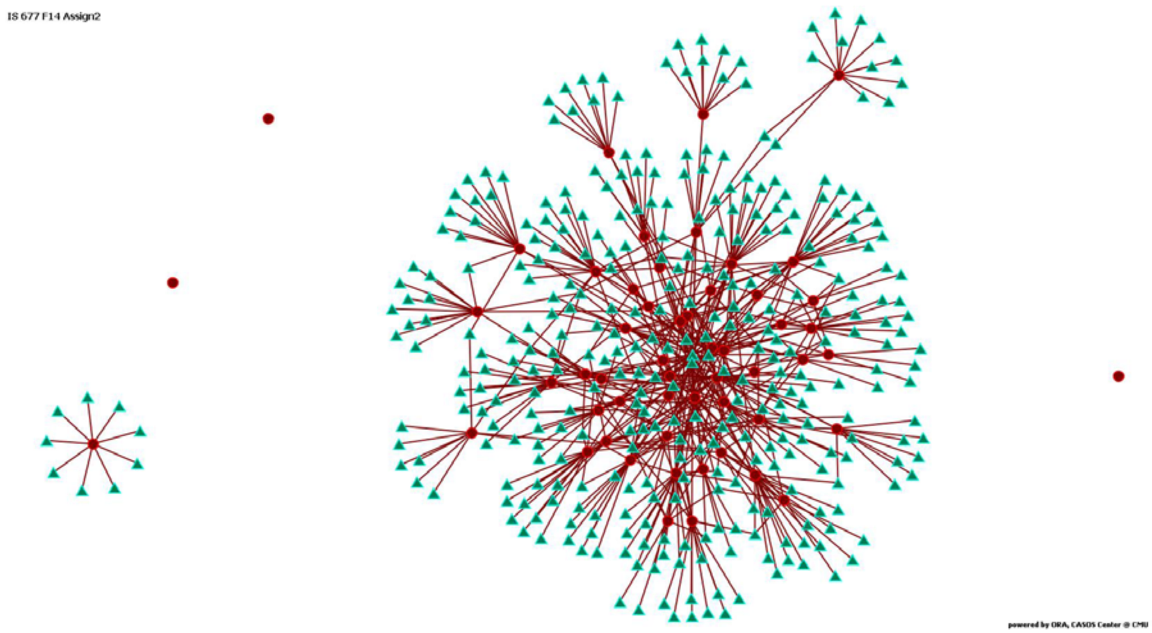


Figure 11.10 All but one of the students who submitted assignments for this learning activity found at least one resource in common with another student, leading to the large central cluster. The student who cited other resources but is not connected to the cluster misunderstood the research topic and found unrelated Internet resources, causing them to be disconnected.

As shown in the bipartite network visualization, almost all students who cited resources cited at least one resource in common with other students. Only one student did not share any resources with other students; in fact, this student (an international student) misunderstood the assignment topic and found resources unrelated to the Facebook emotional contagion study. This suggests that, when a narrowly defined topic is used for assignments of this nature, the network structure should generally not be fragmented; isolated nodes can serve as a visual cue indicating students who may not be researching the intended topic.

The one-mode student network structure (shown in Figure 11.11) makes apparent the interconnectedness of students based on citations of the same resources. This network has the second highest density of all six networks in this analysis (0.5867) and the highest clique count, with a mean of 98.568, a median of 91.0, and a range of 0 to 327.

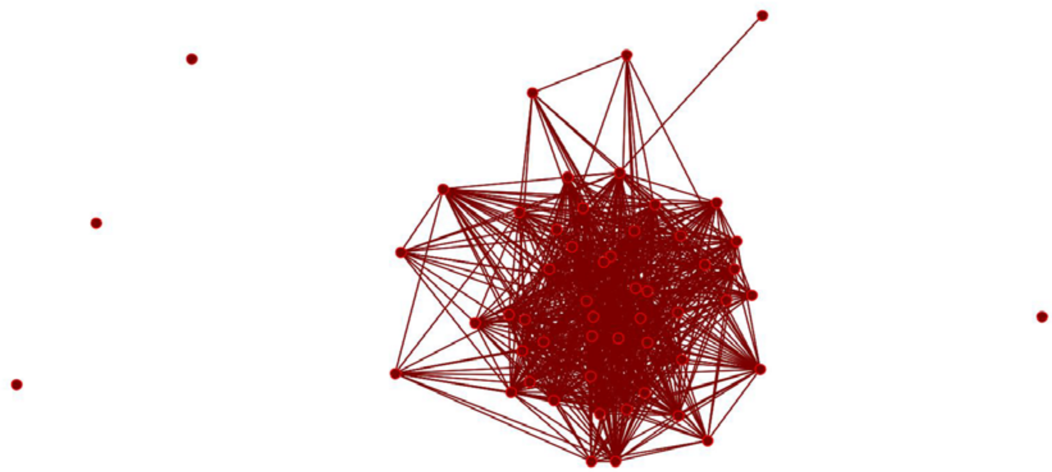


Figure 11.11 The density of this network suggests that, because the assignment topic was very focused, almost all students found at least one resource that was shared by another student in the course, leading to a well-connected central cluster.

11.3.3 Summary of SN RQ1

In response to SN RQ1 which explores the impact of assignment characteristics on network structure, the findings suggest that the extent to which the research topic is defined and constrained has a significant impact on the structure of the resulting student citation network. In general, open topics result in fragmented networks having lower densities, with nodes belonging to few cliques within the network as evidenced by low clique counts. Narrowly defined, bounded research topics result in more well-connected networks with higher densities. The nodes in these networks typically have higher clique membership as evidenced by higher clique counts. Network densities and clique count measures for all six assignments are shown in Table 11.2.

Table 11.2 Network Densities and Clique Counts by Assignment

		Clique Count		
Assignment	Network Density	Mean	Median	Range
Open Topic Assignments				
IS_677_SPR14 A1	0.08736	0.300	0	0 - 2
IS_677_FL14 A1	0.2016	2.864	1	0 - 17
IS_677_SPR14 A2	0.2905	0.633	0	0 - 4
IS_679_SPR14 A2	0.4412	0.625	1	0 - 1
Focused Topic Assignments				
IS_677_FL14 A2	0.5867	98.568	91	0 – 327
IS_679_SPR14 A1	0.6842	4	5	0 - 7

The assignments in Table 11.2 are arranged in ascending order of network density. This makes apparent the higher network densities resulting from assignments with focused research topics. Instructors seeking to encourage dense networks of shared Internet resources can apply this knowledge in the creation of appropriate learning activities that are carefully focused to guide students to deeper research on a single topic rather than broader research encompassing more loosely defined topics. At the same time, visualizing the networks resulting from focused assignments can identify students whose research efforts were misaligned with the assignment topic.

11.4 Social Network Centrality Measures

Network structure is one component of the learning analytics framework proposed in this research. Another is assessment of student performance based on network measures. In this research, node-level network measures are explored as indicators of learning performance, including betweenness centrality, clique count, closeness centrality, and total degree centrality. Each of these measures is explained in more detail in the following sections. This is followed by a discussion of centrality measures and learning outcomes for each of the assignments listed in Table 11.1.

11.4.1 Betweenness Centrality

Betweenness centrality measures the percentage of shortest paths that pass through a node compared to all node pairs that have a shortest path containing that node. In practical terms, a node having higher betweenness centrality is considered a broker or gatekeeper between groups because that node connects those groups. Typically, if nodes with high betweenness centrality are removed from a network, the network will break into clusters.

An example of a node with high betweenness centrality is shown in Figure 11.12. This example is based on the kite network developed by Krackhardt (1990). In this network, if node H is removed, nodes I and J become disconnected from the network. Node H therefore has high betweenness centrality and is the only node maintaining a connection between I and J and the rest of the network.

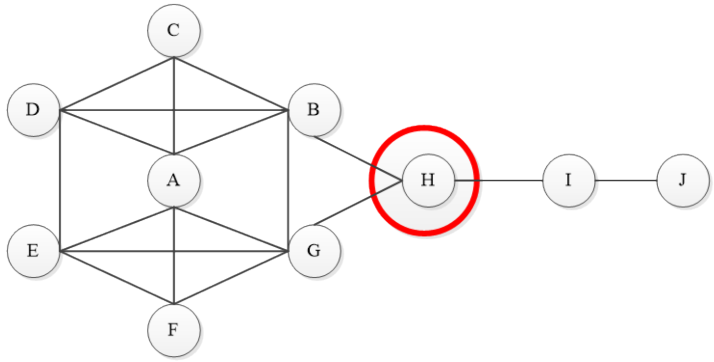


Figure 11.12 In this kite network (adapted from Krackhardt, 1990), the circled node has high betweenness centrality. If this node is removed from the network, nodes I and J will become disconnected from the main network.

11.4.2 Clique Count

In social network analysis, a clique is defined as "a subset of actors in which every actor is adjacent to every other actor in the subset and it is impossible to add any more actors to the clique without violating this condition" (Borgatti et al., 2013). In this research, clique count suggests groups of students who cited several similar resources. (Clique count is calculated based on the one-mode student network, not on the bipartite network.) Figure 11.13 illustrates the cliques that exist in the illustrated network.

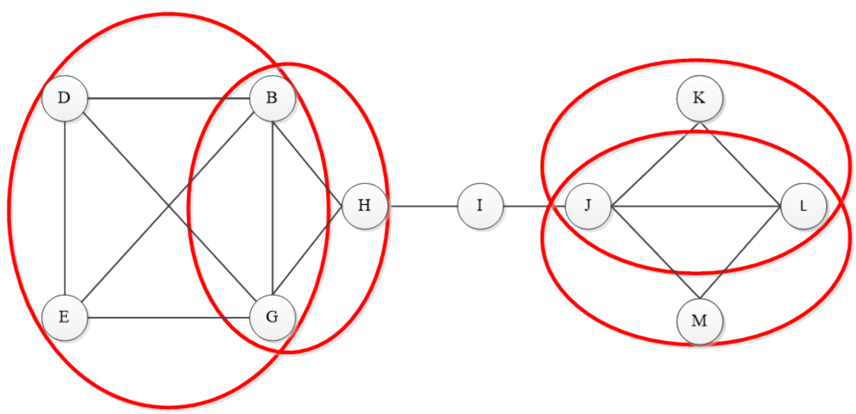


Figure 11.13 In this network (adapted from Borgatti et al., 2013), the circled nodes are all members of cliques. Nodes contained within the overlapped areas belong to both cliques, giving them a clique count of two. Nodes within only one oval have a clique count of one, and node I has a clique count of zero.

As illustrated in Figure 11.13, a clique is composed of three or more nodes that all have direct connections to each other and to which no other nodes can be added without violating that requirement. After identifying all of the cliques in a network, the clique count for each node is calculated by determining the number of cliques to which a given node belongs. As such, higher clique counts suggest that nodes are members of many directly connected subgroups.

11.4.3 Closeness Centrality

Closeness centrality indicates the average "closeness" of a node to the other nodes in a network as measured by the average distance in the network between any given node and all other nodes. High closeness centrality suggests nodes that are "in the middle of things" but do not necessarily have many connections themselves. Node A in Figure 11.14 has high closeness centrality.

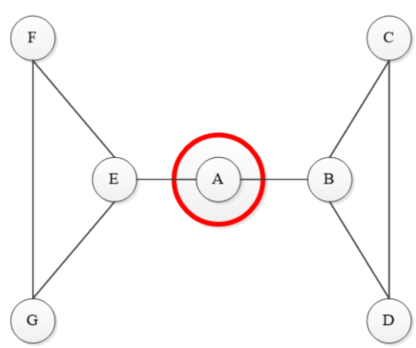


Figure 11.14 Node A in the network above has high closeness centrality because it is central in the network even though it does not have many connections itself.

11.4.4 Total Degree Centrality

The total degree centrality of a node is the normalized sum of its row and column degrees. In other words, nodes having high total degree centrality have more connections to others in the same network. An example of a node with high total degree centrality is shown in Figure 11.15. In this network, node A has the highest total degree centrality because it has the most direct connections to other nodes. In this case, node A is directly connected to six other nodes (B, C, D, E, F, and G) while nodes B and G are directly connected to five other nodes.

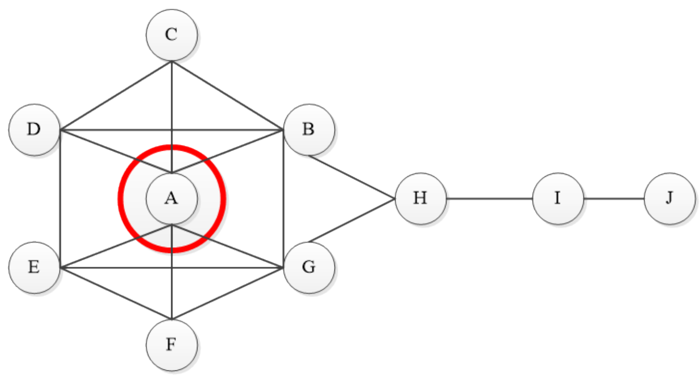


Figure 11.15 In this kite network (adapted from Krackhardt, 1990), the circled node has the highest total degree centrality because it is connected to the most other nodes in the network.

11.4.5 Centrality Measures and Learning Outcomes By Assignment

Social network research question two (SN RQ2) seeks to complement the exploration of the relationship between assignment characteristics and network structure (SN RQ1) with an evaluation of possible relationships between network position and learning performance. To detect these relationships, a Spearman's rank correlation (ρ) correlation was calculated for the previously described network centrality measures and student assignment grade and semester GPA. Spearman's rank correlation was used because the data violated the assumption of normality; additionally, Spearman's rank correlation has been used in other social network analysis research exploring performance and network measures (Abbasi et al., 2011).

Table 11.3 lists the course assignments and any significant results of the Spearman's rank correlation for betweenness centrality, clique count, closeness centrality, and total degree centrality with semester GPA or individual grade for the assignment. Correlations were also explored with three variables related to the Internet resources cited by students: perceived learning, quality of social capital, and quantity of social capital. Because this is exploratory research, relationships significant at the 90% confidence level are reported.

The results shown in Table 11.3 suggest that, for each assignment, at least some of the network measures were correlated with other variables of interest. However, there was no discernable pattern in the network measures that achieved significant correlations. Several factors could be confounding this exploratory research. First, a number of students did not participate in the research surveys and, of those who did, not all gave the researcher permission to obtain their grades for the assignments. This type of missing data could impact the results through exclusion of high or low performing students from the analysis.

Additionally, a larger dataset would provide more opportunities to detect patterns in the relationships between network measures and learning outcomes. Although this research includes data from other courses, the inconsistencies of instructor grades precludes their use for any sort of meaningful analysis in which individual grades and not means of grades are required. The results of SN RQ2 are therefore inconclusive.

Table 11.3 Correlations of Learning Outcomes and Centrality Measures

Correlation	Spearman's rho (ρ)	Sig.
IS_677_SPR14 Assignment 1 (information system failures)		
Closeness centrality and quality of social capital	0.487	0.016
Total degree centrality and quality of social capital	0.355	0.089
IS_679_SPR14 Assignment 1 (Hofstede's cultural dimensions)		
Exclusivity and grade	0.568	0.054
Closeness centrality and quality of social capital	-0.659	0.020
Closeness centrality and assignment grade	-0.519	0.084
IS_677_FL14 Assignment 1 (FBI organizational structure)		
Exclusivity and quality of social capital	-0.319	0.076
IS_677_SPR14 Assignment 2 (industry case study)		
Betweenness centrality and assignment grade	-0.381	0.066
Total degree centrality and assignment grade	-0.394	0.057
Clique count and assignment grade	-0.354	0.089
IS_679_SPR14 Assignment 2 (industry case study)		
Betweenness centrality and assignment grade	0.796	0.002
Closeness centrality and assignment grade	0.847	0.001
Total degree centrality and assignment grade	0.600	0.039
Total degree centrality and quantity of social capital	-0.587	0.045
IS_677_FL14 Assignment 2 (ethics of Facebook emotional contagion study)		
Clique count and quantity of social capital	0.369	0.038
Total degree centrality and quantity of social capital	0.375	0.034
Clique count and perceived learning	0.363	0.041
Total degree centrality and perceived learning	0.349	0.050

11.5 An Exploration of Resources Based on Network Measures

Social network research question three (SN RQ3) asks, "Can centrality measures be used to identify cited Internet resources having potential value as instructional resources or as indicators of student learning?" This research question is guided by two objectives. First, as the educational community places an ever increasing emphasis on open educational resources (OERs), the identification of free, publicly available resources that can be used to supplement instructional materials becomes a critical task. The resources that students felt were important to their understanding of the research topic can provide instructors with supplementary teaching materials that have already been vetted by students. At the same time, these resources may be in a variety of formats (blogs, news reports and even videos) that can give students options to select the formats most suited to their personal learning preferences.

The other objective of SN RQ3 is to understand how the types of resources cited by students can provide clues as to their understanding of the research topic and their engagement in the learning activity. For example, as briefly mentioned in Section 11.3.2, the network of resources about the ethics of the Facebook emotional contagion study shows a large central cluster and one student who cited a number of resources not shared by any other students. An examination of this singular student revealed that the student did not understand the assignment topic, causing him to find unrelated resources.

To explore social network research question three (SN RQ3), a qualitative analysis of the resources having the highest total degree centrality and exclusivity values was conducted. These lists were generated using ORA's reporting capability to identify the 10 resources with the highest total degree centrality and the 10 resources with the highest exclusivity. By exploring the cited Internet resources with high total degree centrality, instructors can identify the sources students found most informative, while Internet resources with high exclusivity provide clues about more unique resources that are nevertheless relevant to the topic.

The following section defines the exclusivity measure; total degree centrality was defined in Section 11.4.3. Subsequent sections describe the results of the qualitative analysis of the top total degree centrality and exclusivity resources for each assignment.

11.5.1 Exclusivity

Exclusivity measures entities that have ties no other entity has, or that few other entities have. In this research, exclusivity indicates a student who cited resources that none or few other students cited. Figure 11.20 illustrates a student having high exclusivity. Only one of the student's cited resources was cited by other students; all the other Internet resources that the student cited are unique to him.

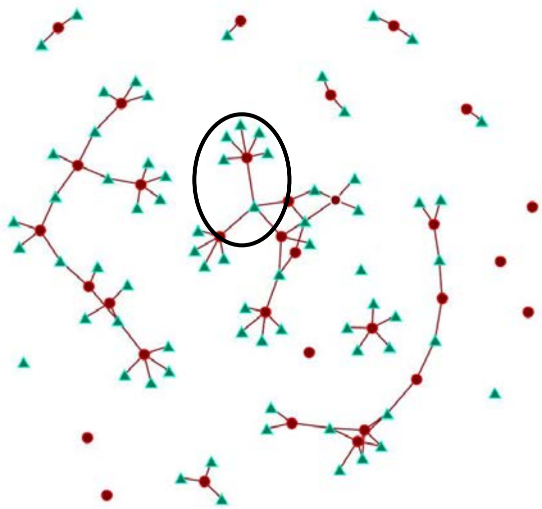


Figure 11.16 In the student citation network shown above, the student with the highest exclusivity is highlighted. This student cited five resources that were unique (exclusive) to him and only one resource that was also cited by other students.

11.5.2 IS_677_SPR14 Assignment 1 Resources

The first assignment in IS_677_SPR14 asked students to explore information system failures discussed in the textbook. Because several high-profile system failures were mentioned, students were instructed to choose three they found most interesting. This diversity is evident in an exploration of the resources with the highest total degree centrality, which range from a publication produced by Supply Chain Digest detailing "The 11 Greatest Supply Chain Disasters" to a transcript of testimony given by the FBI director to the Appropriations Subcommittee on Commerce, Justice, State, and the Judiciary about the failure of their virtual case files system. Some students chose to explore a supply chain management system failure at Nike, citing a student paper on Scribd as one of the principle resources.

Interestingly, while most students focused on the failures, an exploration of resources having high exclusivity suggested that at least one student went beyond the failure of Nike's system, citing an article from CIO magazine entitled, "Nike Rebounds: How (and Why) Nike Recovered from its Supply Chain Disaster." This provides evidence of a deeper approach to learning, as this resource moves beyond the immediate question of system failure to provide information about how companies can recover from such failures. Instructors could integrate both of these papers into future learning activities as a case study not only in system failure but in recovery as well.

11.5.3 IS_677_SPR14 Assignment 2 Resources

In this assignment, students were asked to select a case study from several provided by the instructor for analysis. One of the case study topics was Starbucks' entry into the mobile application domain. One of the most frequently cited resources (as indicated by total degree centrality) was published by Mobile Commerce Daily ("Starbucks generates 10pc of US revenue from mobile").

However, an analysis of the resources with high exclusivity revealed that at least one student again went beyond the immediate topic, citing an Information Week article entitled "How Starbucks Taps 7 Tech Trends." This article discussed Starbuck's e-commerce push but also discussed their improvements to their point of sale and customer relationship management systems. The fact that this resource was cited suggests that some students sought a more complete understanding of Starbucks' information systems improvements, and that this could be achieved by exploring all of their investments in technology rather than focusing on only one area.

11.5.4 IS_679_SPR14 Assignment 1 Resources

The first assignment in this course required students to explore Hofstede's cultural dimensions for India and to relate the cultural dimensions to two very different Indian software consulting firms. Because this assignment was very specific, there was not much variety in the most frequently cited resources, which mostly came from websites created by the Hofstede Centre and Geert Hofstede. An evaluation of the Internet resources with high exclusivity show that, for this assignment, students sought supplementary materials to better understand Hofstede's cultural dimensions. Two of these supplementary resources were YouTube videos of lectures discussing Hofstede's cultural dimensions. In the future, instructors could provide links to these videos as supplementary learning materials for students who might have difficulty understanding this topic.

11.5.5 IS_679_SPR14 Assignment 2 Resources

The second assignment in this course required students to find an interesting case study from a research journal (MIS Quarterly) and conduct an analysis. Because the topics in this assignment were at the students' discretion, no patterns emerged from an analysis of the cited Internet resources having either high total degree centrality or high exclusivity.

11.5.6 IS_677_FL14 Assignment 1 Resources

In this assignment, students were asked to explore the organizational structure of the Federal Bureau of Investigation (FBI), find an organization with a similar structure, and compare the cultures of the two. Interestingly, three of the most frequently cited Internet resources (highest total degree centrality) for this assignment were Wikipedia definitions of the following terms: virtual case file, flat organization, hierarchical organization. This suggests that many students required supplemental materials to understand these terms. Citation of these kinds of resources that address Bloom's lower levels of cognitive learning outcomes (Knowledge and Comprehension) can be an indicator to instructors of deficiencies in students' understandings that could be addressed with additional classroom instruction or supplementary materials.

11.5.7 IS_677_FL14 Assignment 2 Resources

This assignment instructed students to explore the ethics of the Facebook emotional contagion study which had recently been heatedly debated in the news and in various research communities. Internet resources with the highest total degree centrality included articles published by The Atlantic, The Guardian, and PsychCentral, as well as Forbes-sponsored blog postings. All of these resources directly addressed the ethics of how Facebook and Cornell researchers conducted such a study without users' knowledge or approval.

In exploring the Internet resources with high exclusivity, it is apparent that some students also explored the broader concept of ethics in technology through a citation to a webpage discussing "Ethical Issues in Electronic Information Systems" published by the University of Colorado. Once again, student-identified webpages such as this one could be added to course materials to enhance and supplement learning activities.

11.6 Summary

The application of social network analysis to different types of networks has increased our understanding of how people communicate, how communities develop, and even how networks can be used to identify the marginalization of under-represented minorities in academic environments. This research applies social network analysis to networks connecting students and the Internet resources they cite during learning activities to develop an analytical framework that can inform the development of similar learning activities and the evaluation of resulting learning outcomes.

SN RQ1 asks, “How do the characteristics of learning activities influence the structures of their resulting student citation networks?” This research identifies the principle assignment characteristic influencing network structure: whether the research topic is open or focused. Open research topics in which students were allowed to select the details of the research assignment resulted in fragmented networks with low density and nodes with low clique counts. Focused research assignments that constrained and clearly defined the topic to be explored resulted in denser networks in which nodes had high clique counts. Despite the focus of such assignments, however, it is important to note that students still found a variety of interesting Internet resources, suggesting that narrowing the research topic does not mean all students will find the same information.

SN RQ2 explores network measures as indicators of individual student learning outcomes. The results of this research question were inconclusive. Although each assignment resulted in some network measures being correlated with research variables of interest (such as individual grade or perceived quality of social capital), there was no observable pattern to the relationships. This suggests that the exploratory framework developed in this research can identify key assignment characteristics influencing the resulting network structures but cannot yet identify network measures linked to educational performance.

An exploration of the cited Internet resources having high total degree centrality and high exclusivity suggest that these network measures can be used to identify Internet resources that have value as supplementary learning content. At the same time, the types of resources cited may indicate knowledge deficiencies; for example, if a Wikipedia definition has high total degree centrality, this may suggest that a number of students do not understand that concept and are using Wikipedia to address this knowledge gap prior to continuing with the assignment.

CHAPTER 12

DISCUSSION OF RESULTS

12.1 Overview

The Internet abounds with information, and research has shown that millennial students turn to Google as their first resource when confronted with some information need (Connaway et al., 2008). This claim is supported by the interviews conducted as part of this research in which students stated that they frequently searched for information resources online in response to either instructor assignments or their own individual information needs. This use of Internet resources for learning, however, is largely ignored in research due to its informal nature and concerns about the varying quality of the content students may find and use. The research presented here addresses this gap by exploring the learning outcomes of assignments specifically instructing students to conduct research using Internet resources they feel are reliable but not necessarily peer-reviewed scholarship.

Recognizing that learning is influenced by a variety of factors, this research explores the effects of learners' intrapersonal, interpersonal, and cognitive characteristics on learning outcomes resulting from this type of assignment. At the same time, an assignment requiring the use, management and sharing of Internet resources by default includes specific activities that may not be properly supported in students' current information and communication technologies (ICTs). Therefore, this research also evaluates the use of two different ICT systems, each of which provides support for some of these activities.

This research began with semi-structured interviews to understand students' Internet foraging practices and the drivers for such foraging. Based on those interviews and a comprehensive literature review, a theoretical model was then proposed with eight research questions, three of which informed hypotheses that were tested in the theoretical model. The other five research questions were more exploratory in nature. To test the measurement instruments, the assignment itself, and the ICT systems, a pilot study was conducted in one course. After minor revisions to the measurement instruments and the assignment, the study was conducted over two semesters. In all eight courses in which the full scale study was conducted, students completed a survey prior to beginning the research assignment. This was followed by an individual assignment, a related group assignment, and then a post-assignment survey. The individual assignment and group assignment each lasted for approximately one week. The data from these courses was analyzed using univariate, bivariate, and multivariate analysis. Model testing was conducted using structural equation modeling (SEM).

Univariate analysis identified issues with some of the measurement variables and observed data originally included in the theoretical model. Knowledge exchange form (the method students used when sharing Internet resources with group members) was dropped because of a lack of data. Students were using their assigned system to share the links to the resources but there was little to no discussion about the resources, meaning that there was insufficient data to create knowledge exchange form classifications. This lack of discussion was also reflected in the self-reported learner-learner interactions scale, which was not correlated with the other research variables and was subsequently also removed from the theoretical model.

Although not dropped from multivariate analysis, actual learning as measured through grades on the assignment was problematic due to systematic differences between courses and instructors. While individual grades showed more variance in all courses, group grades were more tightly clustered; in fact, one instructor gave all groups a score of 100. Therefore, actual learning is analyzed and reported with the understanding that assignments grades should be viewed as indicators and not necessarily true measures of learning.

Because the measurement scales used in this research came from a number of earlier sources, exploratory factor analysis was conducted prior to confirmatory factor analysis. Due to cross loadings or insufficient loadings, certain modifications to the measurement model had to be made to ensure an acceptable solution. Task value was removed because its items loaded on multiple measures, and quality and quantity of social capital loaded together, becoming one factor relabeled social capital. Social capital and the other remaining measurement items (self-efficacy, learning goal orientation, topic familiarity, system satisfaction, and perceived learning) were tested using structural equation modeling. The initial SEM model had paths that reflected the proposed hypotheses; pruning of the model was done until a valid and reliable model was derived in which all paths were significant. Results are summarized and their implications are discussed in Section 12.3.

In three of the eight courses, students completed a second research assignment with matching pre- and post-assignment surveys. In these three courses, students switched systems between the first and second assignment, allowing a repeated measures analysis of the repeated research variables and a direct comparison of the two systems

(Moodle and Pearltrees). The repeated measures analysis was guided by four research questions; results are discussed in Section 12.4 of this chapter.

The remainder of this chapter summarizes the findings summarizes the findings from all of the studies and then discusses their implications in greater detail. Limitations of the study are described, along with areas for future research. The chapter concludes with a summary of the contributions and theoretical and practical implications.

12.2 Summary of Findings from Semi-Structured Interview Study

To understand students' existing practices in using and sharing Internet knowledge resources, semi-structured interviews were conducted with 54 students. While all interviews were summarized, 16 were determined to be most informative and were therefore fully transcribed and coded using thematic analysis. Results of the interviews informed the theoretical model and the design of the nonequivalent control group study.

12.2.1 Summary of Results for INT Research Question 1 – Information Drivers

Interview Research Question 1 asks, "What drives students to search for external information resources?" ***There are two main categories of drivers of information foraging for learning: instructor-driven and student-driven.***

Students' responses suggested two major drivers for information foraging on the Internet: instructor assignments and student information needs. Instructor assignments frequently required the citation of scholarly resources; in this case, students typically searched the university's online library to find papers published in academic journals. However, in cases where instructors asked students to participate in asynchronous online discussions (AODs) and to "add value," students were able to identify and cite other, less vetted Internet resources. Students reported learning from these resources, the added value being that instructors could ask students to research emerging topics for which scholarly works may not yet exist.

For student-driven knowledge needs, students sought Internet resources that they felt were reliable, while also searching for formats that they preferred. For example, one student found videos about supply chain management that explained details the student had not understood from class. While these videos were freely available on YouTube, they were nevertheless reliable as the student noted that they had been created by a professor at another university. In general, the reasons for student-driven foraging centered around a personal knowledge need such as obtaining additional information about a topic that was unclear or ambiguous, defining or understanding unfamiliar terms (or terms that had been forgotten), or assisting in the application of new skills such as how to solve a complex Calculus problem.

Although this research focuses on instructor-driven knowledge needs, instructors who create environments in which sharing is encouraged and acknowledged can also facilitate the creation of student-driven knowledge repositories that can improve the learning experiences of the entire class.

12.2.2 Summary of Results for INT Research Question 2 – Sharing Factors

Interview Research Question 2 asks, "What factors influence the sharing, summarizing, and consolidation of these information resources?" ***The answer is that, in the case of instructor-driven information foraging, students were told to consolidate and summarize the knowledge and share links to their resources in the form of citations,***

while for student-driven information foraging, the decision to summarize and to share was up to the student.

When information foraging was related to an assignment, students were almost always required to consolidate the Internet resources they found into some formal summary, either in the form of a research paper or a posting in an asynchronous online discussion (AODs). In the case of AODs, sharing was an inherent part of the activity as the forum postings were typically visible to all students in the class, and in many courses students were required to cite their resources as part of their summaries.

In the case of student-driven information foraging, students' decisions to share depended largely on their personalities and their intrinsic motivations. However, several students stated during the interviews that, if the instructor acknowledged the information they shared or encouraged sharing, they were more likely to share resources with their classmates. This finding stresses the importance of careful integration of such activities into the classroom environment and the necessity of instructor encouragement and acknowledgement.

12.2.3 Summary of Results for INT Research Question 3 – Support for Learning

Interview Research Question 3 asks, "How do these activities support learning?" ***The answer is that asking students to share multiple viewpoints or supplemental materials, as well as asking them to summarize the information from those materials, was reported to generally improve learning outcomes.***

During interviews, participants reported that, when properly integrated into learning activities, the sharing of resources and multiple viewpoints added to their learning experiences. However, if the activity (such as a contribution to an asynchronous online discussion) was not well-integrated into the course, it was perceived as a chore and students saw little value from the postings of others. This reinforces pedagogical best practices that clearly explain the value of such activities as well as set clear expectations of the contributions to such discussions.

12.2.4 Summary of Results for INT Research Question 4 – Technologies Used

Interview Research Question 4 asks, "What technologies do students use to support these activities?" ***For instructor-driven information resources, Moodle was the primary technology used to share and summarize resources. For student-driven information resources, no single system emerged as the preferred method to organize and manage resources. For sharing, some students shared the information gained from Internet resources using rich media formats while others broadcast helpful resources widely using social media.***

Students reported using Moodle to share and summarize information resources that were found as part of instructor-driven information foraging activities. Typically, these resources were summarized and shared through postings to asynchronous online discussions that were conducted in Moodle. Despite using Moodle, however, to contribute to such formal discussions, very few students reported sharing student-driven information resources in Moodle. In fact, there was no single system that emerged as the preferred technology for sharing informal Internet knowledge resources. Some students did not share the actual resources but instead shared the knowledge gained from them. This type of sharing was typically conducted through face to face discussions or e-mails that allowed a directed discussion with one or a few individuals rather than everyone in the class (reflecting Nonaka and Takeuchi's (1995) socialization exchange form).

However, a number of students also reported sending links to helpful resources to all of their friends using systems such as Facebook and Dropbox (reflecting the externalization exchange form (Nonaka & Takeuchi, 1995)). These results suggest that there are opportunities for the enhancement of existing systems or the development of new systems to facilitate these types of activities.

At the same time, the combined interview findings suggest that an assignment requiring students to find reliable, rather than scholarly, Internet resources for an individual assignment, and then share those resources with group members to complete a group assignment, would lead to positive learning outcomes. Following this general design, assignments were created with instructor guidance for each of the eight courses included in the nonequivalent control group study.

12.3 Summary of Findings for the Nonequivalent Control Group Study

In total, 210 students participated in the nonequivalent control group study which included a pre-assignment survey, an individual assignment, a related group assignment, and a post-assignment survey. Eight research questions guided the design and implementation of this study. Results of each research question are discussed in the following sections.

12.3.1 Summary of Results for Research Question 1 – Learning Outcomes

Research Question 1 asks, "Do assignments requiring the use, management, sharing, and consolidation of Internet information resources lead to positive learning outcomes at the individual and group level?" ***The answer is yes.***

Instructors frequently assign research projects to individual students or groups of students with the caveat that the resources they cite must be scholarly (for example, a paper published in an academic journal). This requirement, however, neglects the wealth of reliable content available on the Internet, from corporate websites and major news publishers to research blogs and instructional YouTube videos. It also overlooks the fact that students take advantage of these free and publicly available knowledge resources to aid in their learning, even if those resources are not cited in their final assignments. This research therefore explores learning outcomes resulting from assignments that encourage students to conduct research using Internet resources they feel are reliable, even if those resources do not meet the requirements of being scholarly.

Allaying instructors' fears that students would find unreliable or inaccurate information on the Internet, the univariate results of the perceived learning measure were very positive, suggesting that students felt they had learned from the assignment. Actual grades were also generally high, with the mean of individual grades being 81.358 and the mean of group grades being 87.716. In fact, all of the items capturing perceived learning, quality of social capital, and quantity of social capital had strongly positive results, suggesting that learning activities requiring students to find, use, and share Internet knowledge resources resulted not only in positive perceptions of learning but also in positive perceptions of the social capital that developed as a result of sharing and consolidating the resources with group members. This result is further supported by a comparison of the individual and group grades of students, with group grades being higher than individual grades.

Perceptions of learner-learner interactions that occurred during the group assignment were not as consistent, with two of the four items resulting in neutral perceptions, one having positive perceptions, and one having negative perceptions. The items capturing the extent to which students answered each other's questions or stated their opinions to each other resulted in neutral (neither positive nor negative) perceptions. Results for the item capturing the extent to which students asked each other questions during the group assignment were negative. The only learner-learner interaction item resulting in positive perceptions was the one capturing the amount of interaction that occurred during the group assignment.

Although these results seem contradictory at first, an exploration of the actual exchanges that occurred in the students' resource sharing areas explains these findings. Students actively shared their resources by posting the links (URLs) they thought were most relevant for the assignment. Some students additionally posted brief descriptions of each resource (for example, which question in the assignment that particular resource addressed). However, there was little evidence of actual discussion between group members in their respective sharing areas. This suggests that simply sharing the links to the resources was sufficient to give students positive perceptions about the interactions occurring during the group part of the assignment, despite the fact that there were few meaningful interactions. This also suggests that it is sufficient for students to share links to helpful resources (without much annotation) to develop positive perceptions about the quality and quantity of shared social capital.

12.3.2 Summary of Results for Research Question 2 – Student Characteristics

Research Question 2 asks, "Are characteristics of the student (gender, level of study, and degree program) related to the variables of interest in the study? ***The findings suggest that level of study and degree program have an effect on some of the research variables, but gender does not.***

Prior research has frequently reported that student characteristics (for example, gender) have an effect on learning outcomes or students' perceptions of their self-efficacy as learners. This research therefore explores the effects of student characteristics including gender, level of study (undergraduate versus graduate), and whether the course was in the student's degree program or not, to address research question two (RQ2). Results are summarized in Table 12.1 and are discussed in more detail below.

Table 12.1 Results of Hypotheses Based on Student Characteristics

	Hypothesis	Result
H4a	Female students will report lower perceived learning than male students.	Not supported
H4b	Graduate students will report higher perceived learning than undergraduate students.	Supported
H4c	Students for whom the course is part of their degree program will report higher perceived learning.	Supported

Gender has been found to influence learners' self-efficacy and perceived learning performance, suggesting hypothesis H4a. However, for the participants included in this research, there were no differences between male and female students' self-reported data (including self-efficacy and perceived learning), ICT system usage data, or grades. This lack of difference may be the result of the challenging environment female students face at New Jersey Institute of Technology. These women students may view themselves as highly capable because they must compete in a setting with a challenging curriculum in which males significantly outnumber females. This research should be conducted at other universities to determine if the lack of gender differences is unique to New Jersey Institute of Technology.

This research proposes that graduate students will generally be more positive in their responses to self-reported data than undergraduate students (H4b). Not only are graduate students typically older than undergraduate students (and therefore possibly more mature), but at New Jersey Institute of Technology, most graduate students are either working or have previous work experience that may cause them to feel more confident in their abilities.

This hypothesis was supported. Graduate students not only reported higher perceived learning than undergraduates, but they also reported higher perceptions of system satisfaction, quality of social capital, and quantity of social capital. These positive perceptions could be the result of graduate students' increased confidence in their abilities; this explanation is supported by the higher perceptions of self-efficacy and learning goal orientation reported by graduate students. Graduate students may also have increased perceptions of learning and social capital development because they are more engaged in their learning; this is supported by univariate analysis of the task value measure, which indicates that graduate students felt the learning task had a higher educational value than was reported by undergraduate students. Finally, graduate students had higher semester GPAs than undergraduates, used their assigned ICT systems more (both individually and in their respective groups), and also received higher group grades on the assignments than undergraduate students, again suggesting that graduate students may be more engaged in their learning than undergraduates.

Another characteristic that was hypothesized to affect the engagement level of students in a learning assignment is whether or not the course is part of the student's degree program. Typically, students are more interested, and therefore more engaged, in coursework that is directly related to their major (H4c).

Students did in fact report higher perceived learning when the course in which the research assignment occurred was part of their degree program, supporting hypothesis H4c. Additionally, students reported increased perceptions of the value of the learning task when the course was part of their degree program, suggesting that students are more engaged in learning activities when those activities apply directly to their educational program. This is reinforced by the number of resources students stored as part of the individual assignments; students for whom the course was part of their degree program stored significantly more resources than students for whom the course was outside of their degree program.

When the course in which the research assignment occurred was part of their degree program, students also reported higher perceptions of the quantity (but not the quality) of the social capital, as well as increased satisfaction with their assigned ICT system. This increased system satisfaction could be the result of the increased student engagement already discussed. One possible explanation for the improved perceptions of quantity of social capital could be that students for whom the course was part of their degree program were more familiar with the general domain and therefore felt that the number of resources shared was sufficient to understand the topic, while students for whom the course was outside of their degree program may have felt they needed more information to fully understand the topic. This finding should be explored in more detail in future research to better understand this difference.

Three hypotheses explored the relationship between students' semester GPA and their perceived learning, self-efficacy, and learning goal orientation to understand if students having higher GPAs also have more positive perceptions of their capabilities as learners.

Table 12.2 Hypotheses and Results for GPA and Student Characteristics

	Hypothesis	Result
H6a	Students having a higher GPA will report higher perceived learning.	Not supported
H6b	Students having a higher GPA will report higher levels of self-efficacy.	Supported
H6c	Students having a higher GPA will report higher levels of learning goal orientation.	Supported

Although perceived learning was not correlated with GPA, self-efficacy and learning goal orientation were positively correlated with GPA. Correlation does not suggest causality but simply a relationship between two variables, suggesting that students who tend to perform well in their education (as measured by GPA) have higher perceptions of their ability to do well and also are more intrinsically motivated to learn. Interestingly, GPA was also correlated with students' individual use of their assigned ICT systems, suggesting that students with higher GPAs may generally be more engaged in their learning activities.

12.3.3 Summary of Results for Research Question 3 – Course Characteristics

Research Question 3 asks, "Are characteristics of the course related to the variables of interest in the study?" ***The answer is yes.***

Because the sharing of Internet resources, and the formation of social capital, is an important part of this research, the course characteristic evaluated is the method of group formation. In some courses, students had already self-selected into groups and were already working together on a semester-long project prior to the introduction of the research assignment. In other courses, the instructor assigned students to groups either randomly (using a capability provided in Moodle) or purposefully. In all of the courses in which students were assigned to groups, the students' first interaction with their team members occurred as a result of the research assignment.

Because self-selected groups represent students who have chosen to work together and, in the case of this research, were already familiar with one another, the expectation was that these students would share more resources and would report higher perceptions of learning that students who were assigned to groups. However, results suggest that the opposite is true, with students in assigned groups storing more resources in their assigned ICT system (during the individual assignment) and reporting higher perceptions of learning and of the quantity of social capital.

One possible explanation for students in assigned groups storing more resources individually is that students who do not know each other may feel more responsible for their own success because they are unsure of whether they can count on the others in their group. Another explanation may be that students feel a greater need to contribute to the group to earn the respect of their group members. In general, this finding suggests that students may be more engaged in learning activities when they are assigned to groups in which they may not know the other students. This increased engagement is reflected in students' higher perceptions of the quantity of shared knowledge.

The fact that students in assigned groups also reported higher perceptions of learning suggests that the act of sharing and consolidating Internet resources to complete a group assignment may be more challenging when students do not know each other. In this case, the students must first develop a shared language to discuss their findings, and this negotiation of shared meaning may improve perceptions of learning from the assignment.

12.3.4 Summary of Results for Research Question 4 – Pedagogical Guidelines

Research Question 4 asks, "What pedagogical guidelines/practices best support sharing and managing Internet resources for learning?" ***Findings suggest that the type of assignment, the amount of detail provided by the assignment instructions, and encouragement from the instructor all play key roles in the success of this type of learning activity.***

Student interviews conducted as part of this research suggested that students do share Internet knowledge resources with friends or classmates, even when not required as part of an assignment. However, several students stated that a lack of response from the instructor or other students about the shared resource made the students less inclined to share in the future. Instructor encouragement and recognition of sharing is therefore critical to ensure that students are willing to make the effort to share knowledge resources found on the Internet. At the same time, the instructor must ensure that the learning goal and the value of the task are thoroughly explained to students. Because differences were found between courses having experienced instructors and courses taught by Doctoral students, a lack of experience in conveying the learning goals and expectations of an assignment may affect students' level of engagement and effort.

At the same time, an evaluation of differences based on courses/assignments showed that students reported increased perceptions of learning when the assignments were more focused. For example, in cases of pre-learning (where students were tasked with researching an upcoming topic before its introduction in the class) or supplemental learning (where students were tasked with researching a topic not specifically covered in class but relevant to the class topic), students reported lower perceptions of learning as well as quantity and quality of social capital, and students used their assigned systems less than students participating in assignments in which the research topic was more narrowly defined. This suggests that assignments instructing students to research broad topics (such as data warehouses or non-relational databases) may provide insufficient guidance, resulting in a wider variety of perspectives about the topic. Although multiple perspectives may be beneficial in providing a broader understanding of a topic, it may also lead to a more superficial understanding that may be problematic when individual resources must be shared to develop a cohesive group response.

12.3.5 Summary of Results for Research Question 5 – Knowledge Exchange Form

Research Question 5 asks, "Do students have a preference for type of knowledge exchange form (socialization versus externalization) when sharing Internet resources for learning?" ***Results suggest that socialization is preferred, but that many students also report using externalization, suggesting that neither form can be ignored.***

During interviews with students, a number of respondents stated that they preferred to share knowledge gained from Internet resources rather than the resources themselves. Similarly, for survey respondents who replied that they had shared before, the two most commonly reported methods used to share knowledge were email and face to face discussion. These methods represent the socialization knowledge exchange form in that they support the exchange of tacit knowledge which includes personal experiences and judgments and allow for an ongoing dialogue.

At the same time, however, several students reported during interviews that they preferred to broadcast Internet knowledge resources to their friends, posting them on Facebook, tweeting about them through Twitter, and even sharing them in Dropbox. This type of knowledge sharing reflects the externalization knowledge exchange form because it enables the public sharing of codified knowledge. This broadcasting method was also reported by students participating in the survey, with students stating a preference for sharing via Facebook, Moodle and Dropbox. (Twitter is not widely used by most of the students at New Jersey Institute of Technology.) These results suggest that, although socialization is preferred because it allows an exchange of knowledge, broadcasting resources via externalization is also considered a meaningful way to share.

12.3.6 Summary of Results for Research Question 6 – ICT System

Research Question 6 asks, "Do learning outcomes differ depending on the ICT system students use for the assignment?" ***The answer is no; learning outcomes did not differ although students' use of their ICT systems differed, suggesting increased engagement based on system***.

The two systems compared in this research are Moodle (the university's learning management system) and Pearltrees (a web-based digital curation system). Students were generally familiar with Moodle, while most students reported never having used Pearltrees before. Despite this unfamiliarity, results suggest that students who were assigned to use Pearltrees stored significantly more resources than students who used Moodle for the individual assignment, although resulting learning outcomes did not differ. One explanation for this increased engagement of Pearltrees' users is that the affordances of Pearltrees are more closely aligned with this type of activity. In fact, Pearltrees provides a visual, drag and drop interface for managing resources, simplifies the sharing of resources, and also provides an Internet browser plug-in to facilitate the storage of Internet URLs.

12.3.7 Summary of Results for Research Question 7 – Theoretical Model

Research Question 7 asks, "What theoretical model best explains individual and group learning through the use, management, sharing, and consolidation of Internet resources?" ***The findings show that social capital (a combination of items from the quality and quantity of social capital measures) has a very strong relationship with perceived learning and that this relationship is mediated by students' familiarity with the topic and students' learning goal orientation.***

To evaluate the theoretical model, the direct relationship between social capital and perceived learning was first tested; results suggest a strong, positive relationship between these two variables. Four mediators were then tested: topic familiarity, system satisfaction, self-efficacy, and learning goal orientation. Finally, the ICT system was tested as a moderator for the mediated model. The results are summarized in Table 12.3.

Table 12.3 Hypotheses and Results for Theoretical Model

	Hypothesis	Result
H1	Social capital will have a positive relationship with perceived learning.	Supported
H2a	Topic familiarity will mediate the relationship between social capital and perceived learning.	Supported
H2b	System satisfaction will mediate the relationship between social capital and perceived learning.	Not supported
H2c	Self-efficacy will mediate the relationship between social capital and perceived learning.	Not supported
H2d	Learning goal orientation will mediate the relationship between social capital and perceived learning.	Supported
H3	The ICT system students used will moderate the mediated relationship between social capital and perceived learning.	Partially supported

The final theoretical model is shown in Figure 12.1.

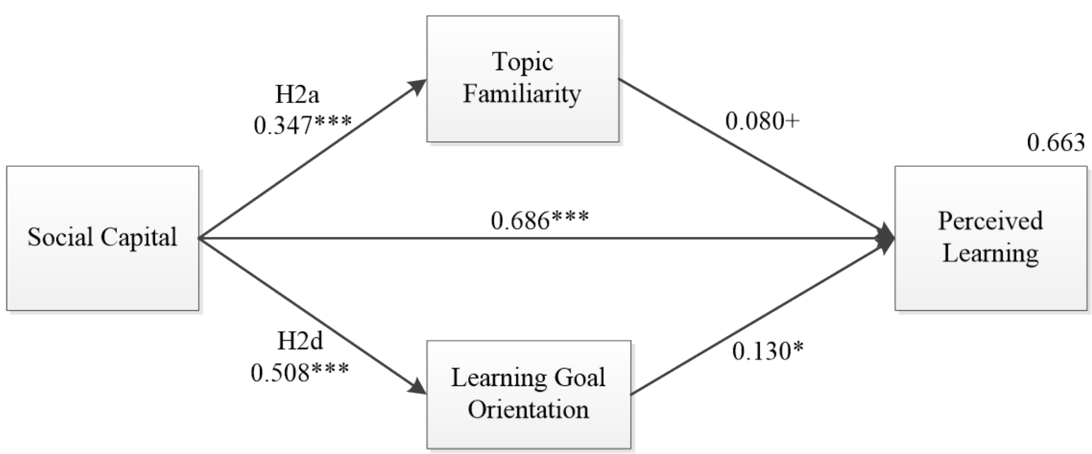


Figure 12.1 The final theoretical model shows a strong direct relationship between social capital and perceived learning as well as two mediators, topic familiarity and learning goal orientation. The + indicates significance at the 0.1 level, * indicates significance at the 0.05 level, and *** indicates significance at the 0.001 level.

The direct effect in the final theoretical model suggests the importance of both the quality and quantity of social capital shared during this type of learning assignment to the perceptions of learning resulting from the assignment. The strength of this relationship indicates that students can learn from assignments that require them to use, manage, and share Internet resources, but that the quality and quantity of those resources are critical in order for the learning experience to be positive.

The final theoretical model includes topic familiarity and student learning goal orientation as partial mediators of the direct relationship between social capital and perceived learning. The fact that topic familiarity mediates the relationship suggests that, while students can learn by using and sharing Internet knowledge resources, their familiarity with the topic may positively influence their perceptions of learning through this type of assignment. Learning goal orientation also positively mediates the relationship between social capital and perceived learning. This suggests that, in autonomous learning activities in which students are expected to independently research a topic and then share their knowledge with their group, students' intrinsic motivation for learning will positively influence the effect of social capital formation on the perceived learning resulting from such activities.

12.3.8 Summary of Results for Research Question 8 – Design Guidelines

Research Question 8 asks, "What design guidelines characterize a system that best supports sharing and managing Internet resources for learning?" ***Findings suggest that key characteristics include the ability to directly link to Internet resources as well as socialization and externalization communication capabilities.***

During the repeated measures study, students were asked what they liked least and most about each system and which system they felt was better suited to this type of assignment. Students generally felt that Moodle's discussion forums were superior to Pearltrees' note and comment capabilities, but that Pearltrees' direct links to Internet resources (rather than downloaded files and copied links) and graphical interface provided critical capabilities not supported in Moodle. These responses suggest that a new or improved system designed to better support learning through the use and sharing of Internet resources should provide the following capabilities:

- A method to share actual bookmarks (rather than simply pasted links) so that students can select a shared resource to easily view its content
- A graphical interface that supports the organization and visual representation of a hierarchical classification of resources
- Directed communication tools to facilitate discussions with other individuals or a group of individuals to share tacit knowledge
- Broadcasting communication tools to simplify externalization of knowledge by sending it to a large group with some form of notification of new content

Such a system would ideally be integrated with the students' learning management system to remove the burden of students having to use multiple systems to access other course content and submit course assignments.

12.4 Summary of Findings for the Repeated Measures Study

In three graduate level courses, a repeated measures study was implemented to allow students to directly compare the use of both ICT systems for the same type of assignment.

The repeated measures study provided the opportunity to test four additional research questions. The results of these research questions are summarized and discussed in greater detail in the following sections.

12.4.1 Summary of RM Research Question 1 – Comparison of ICT Systems

Repeated Measures Research Question 1 asks, "What are the advantages and disadvantages of Pearltrees and Moodle for this type of assignment?" ***The findings generally suggest that Moodle excelled in its affordances for discussion but lacked support for sharing activities, while Pearltrees provided an engaging user experience and the ability to easily share and organize Internet resources but lacked communication capabilities.***

Analysis of the qualitative data provided by students about the two systems used in this research yielded interesting insights regarding what students liked most and least about each system. For example, students were generally satisfied with Moodle's advanced discussion capabilities; they also noted the convenience of having all of the course content and activities in one system. However, students stated that Moodle's sharing capabilities were "very basic." In order to store Internet resources in Moodle, students had to copy the links of URLs and paste them into discussion forums. For other students to then view these resources, they had to locate the necessary forum posting, copy the link from Moodle, and open the resource themselves.

Pearltrees, on the other hand, was reported to be lacking in discussion tools, but made it easy to share Internet resources with others. The fact that the resources stored in Pearltrees actually linked directly to the content of those resources was frequently cited as an important capability for this type of assignment. Finally, organizing resources in

Pearltrees was simple through a visually appealing, drag and drop interface, while Moodle has no such capability.

12.4.2 Summary of RM Research Question 2 – Order of System Use

Repeated Measures Research Question 2 asks, "Are perceptions of the two systems affected by whether students used them first or second?" ***The answer is yes.***

Two research variables were included in the repeated measures study to explore Repeated Measures Research Question 2. One captures students' perceptions of the compatibility of Pearltrees with their learning activities, while the second captures the amount of complexity introduced into students' learning activities through the use of Pearltrees. These variables were captured only for the assignment during which students used Pearltrees. This enabled a direct comparison of the perceptions of students who used Pearltrees for the first versus the second assignment.

Results suggest that the order in which students used Pearltrees did have an effect on perceptions of complexity and compatibility, with students using Pearltrees for the second assignment reporting higher perceptions of complexity (at the 95% confidence level or above) and lower perceptions of compatibility (at the 90% confidence level). One possible explanation for this change is the timing of the second assignment. A significant amount of time had elapsed between the introduction of the research assignment and the second assignment (over one month), suggesting that students using Pearltrees second may have forgotten the brief Pearltrees tutorial provided by the research. However, to address this fact, a video tutorial of Pearltrees was made accessible to students. A more plausible reason that students perceived Pearltrees as more complex and less compatible during the second assignment is that this assignment occurred late in the semester when students may have felt more pressured because of final assignments and preparation for examinations in their other classes.

12.4.3 Summary of RM Research Question 3 – Outcomes Based on Repetition

Repeated Measures Research Question 3 asks, "Are there any significant differences in outcomes when this type of assignment is repeated a second time in a course? That is, for instance, do students change their perceptions of how much they learned in the assignment and, if so, for the better or for the worse?" ***The findings suggest that students' perceptions of their own learning and of the effort expended by their group members improved for the second assignment, and that students who used Moodle second generally preferred that system, while students who used Pearltrees second were more neutral.***

The final post-assignment survey asked students to respond to the following three statements:

- During the second assignment, I learned…
- I liked the second system…
- During the second assignment, my group members worked…

Responses to these statements were based on a five point Likert-type scale with the following responses:

1. A great deal less
2. Somewhat less
3. About the same
4. Somewhat more
5. A great deal more

Responses to the question about learning during the second assignment suggest that students felt more positively about the learning outcomes of the second assignment than they did about the first assignment. This suggests that repeating this type of assignment in a course improves learning, possibly because students felt they had a better understanding of the assignment expectations the second time.

In response to the question about whether they liked the second system more, less, or about the same, students generally responded that they preferred the second system they used, regardless of which system it was. However, when this result was evaluated by system, students using Moodle for the second assignment reported liking it much more than students who used Pearltrees for the second assignment. One possible explanation for this could be that using Pearltrees for the second assignment required students to take time to learn an unfamiliar system at a time when they were already feeling pressed for time. However, a further evaluation of differences by course suggests that this difference was reported primarily in one course (IS_679_SPR14); this course is an elective course and this fact, combined with the timing of the second assignment, could result in this more negative perception of Pearltrees.

Finally, students responded that they felt their group members worked more during the second assignment, regardless of ICT system used. This result suggests that, having completed one assignment of this type and having received feedback and grades for the first assignment, students felt they better understood the instructor's expectations for the second assignment and therefore worked harder to ensure a more positive learning outcome.

12.4.4 Summary of RM Research Question 4 – Design Implications

Repeated Measures Research Question 4 asks, "For students who experience both systems and compare and comment on them, design strengths and weaknesses of the two systems are investigated. What are the design implications of the students' comparative evaluations for the design of Learning Management Systems (LMSs) such as Moodle to better support the sharing of Internet resources?" ***Student responses suggest that advanced discussion capabilities, an engaging interface, the ability to hierarchically organize resources, and the ability to link directly to the Internet resources were critical affordances of systems supporting this type of activity***.

An evaluation of what students liked most and least about each ICT system (Moodle and Pearltrees) suggested several important design implications for improvements to Moodle and other learning management systems in order to better support learning by using and sharing Internet resources.

One of the key affordances provided by Pearltrees that is not currently available in Moodle is support for shared digital curation (bookmarking) of Internet content. The ability to store links that immediately open the content of the URL is critical to this type of learning activity and should be supported in any system intended to allow the use, management, and sharing of Internet resources for learning. Without this ability, students wishing to share Internet information resources must first find the location where the link was shared and subsequently copy the link into their browser to view the content.

Storing links in discussion forums also precludes any ability for students to organize the links into related topics. Another key design implication is therefore a method to create hierarchical organizations of related links so that students can make sense of the shared resources. Finally, future systems should provide sharing capabilities that allow students to invite others to contribute to the development of a knowledge repository of Internet information resources.

12.5 Summary of Findings for the Social Network Analysis

Social network analysis was applied to networks of students and their cited resources in the development of a framework defining the network structures resulting from different types of assignments and exploring the relationships between learning outcomes and learner positions in the resulting networks. Network measures were also applied to students' cited resources as an evaluative tool to identify resources that may be of value as supplemental learning materials as indicators of students' approaches to learning. These findings are discussed in the following sections.

12.5.1 Summary of SN Research Question 1 – Network Structure and Assignment Characteristics

Social Network Research Question 1 asks, "How do the characteristics of learning activities influence the structures of their resulting student citation networks?" ***The answer is that the extent to which the topic of the learning activity is constrained results in very different network structures.***

Visualization of citation networks of open topic versus focused topic assignments revealed very different network structures. Because open topics allowed students to select details (for example, a particular case study or company to research), the resulting networks were typically fragmented, having low network density and nodes with low clique counts. Focused research assignments resulted in denser networks in which nodes had higher clique counts. This suggests that instructors and researchers wishing to apply student citation networks as evaluative tools can design learning activities resulting in more dense or more sparse networks.

12.5.2 Summary of SN Research Question 2 – Network Measures and Student Performance

Social Network Research Question 2 asks, "What network measures (betweenness, closeness, and total degree centrality as well as clique count) might be indicators of learning outcomes in these different network structures?" ***Although there were relationships between network measures and some measure of learning outcome for each assignment, there was no observable pattern, meaning that results were inconclusive.***

For each assignment, some network measures were correlated with research variables of interest (such as individual grade or perceived quality of social capital). However, there was no discernable pattern to the relationships. This suggests that the exploratory framework developed in this research can identify key assignment characteristics and can suggest variables of interest to researchers and educators, but that there are no clear guidelines for assessing learning through network position.

12.5.3 Summary of SN Research Question 3 – Network Measures and Internet Resources

Social Network Research Question 3 asks, "Can centrality measures be used to identify cited Internet resources having potential value as instructional resources or as indicators of student learning?" ***The answer is yes.***

In the one-mode networks of cited resources, exploring the resources with the highest total degree centralities enables instructors to identify the resources cited most often by students. The fact that these resources were the most frequently cited suggests that they may contain relevant information or present it in an understandable way that students found helpful for their research assignments. Instructors may review these resources and subsequently include them as supplementary instructional materials in the course. At the same time, if the most frequently cited resources are foundational (e.g. Wikipedia definitions of terms), this suggests to instructors that students may not have understood the topic of the assignment and had to seek supplemental information to address their gap in understanding.

For certain assignments, an exploration of resources with the highest exclusivity (those that were cited by few students) was also meaningful because some of these resources went beyond the immediate topic assignment, providing a more contextual, “big picture” understanding. Identifying these resources through their network positions can be a useful tool for instructors seeking to augment course materials using resources already filtered by students. An added benefit is that, depending on students’ learning preferences, the resources they find may be of different types (white papers, blog postings, and even videos), enabling instructors to build a library of helpful resources presented in a variety of formats.

12.6 Limitations and Future Work

This study has several limitations that affect its generalizability. First, the findings of this study are based on a limited number of courses, all offered at New Jersey Institute of Technology, most of which were in the Information Systems discipline (one course was from the Science, Technology and Society department). Although there were no immediate differences between the Information Systems courses and the Science, Technology and Society course, courses from other disciplines may result in different perceptions of the efficacy of this type of learning assignment. Future research should integrate these types of learning activities into courses in other disciplines.

Another limitation of this study is that no online/distance learning courses were included; the courses in this research all met face to face on campus. Future research should extend this research to online courses to see whether the remote nature of the participants would affect the results. At the least, it would be expected that more learner-learner interactions may occur in the students' assigned systems as distance learners do not often meet face to face. The fact that students did not communicate through their assigned systems for the group assignment is both a finding and a limitation. This result is a limitation in that one of the variables of interest had to be dropped from the theoretical model. However, this suggests an interesting finding: students prefer to use other communication methods to discuss group assignments. Future research should explore the methods students use to communicate outside of their assigned systems in order to understand how they are communicating and why they chose to use an alternate communication method.

Because all of the courses in this research were offered at New Jersey Institute of Technology, students in all of the courses were already familiar with the university's learning management system (Moodle) and had used it for other activities, including other activities in that course. The application of this research at other universities with different learning management systems may yield different results.

Additionally, the assignment utilized in this research required students to share Internet resources with group members rather than capturing informal learning through resource sharing. Although requiring students to share may negate the preference of some students to keep their knowledge resources private, interviews with students that were conducted as part of this research, and a complementary research survey with over 300 respondents (Xiong, Alelyani, Collins, & Hiltz, 2015), both suggest that students generally share resources voluntarily outside of required course assignments, suggesting informal learning communities that exist yet remain largely unexplored. In the future, research should explore the effects of resource sharing on informal learning outcomes, such as when students share resources not directly related to an assignment or when not required as part of an assignment.

The findings from this research and the complementary study cited above (Xiong et al., 2015) can also inform future research on informal learning using social media. Interviews and survey responses suggest that many students use social media to broadcast knowledge resources they feel are helpful. These results can be extended through future studies capturing knowledge sharing through social media using qualitative and quantitative methods. While prior research has explored informal learning focusing only on learner interactions (Dabbah & Kitsantas, 2012; Li, Gray, Chang, Elliott, & Barnett, 2014), this research suggests that informal learning can be observed through individual resource management as well as knowledge sharing interactions.

At the same time, the results of this research can inform further studies in learning analytics. A great deal of interest has been directed at learning dashboards that can provide feedback to students and insights to instructors regarding learning processes rather than simply outcomes. Addressing the concerns of researchers and instructors (Gasevic, Dawson, & Siemens, 2015), the methodologies explored in this research lay the foundation for learning analytics that explore student learning processes and identify gaps in student comprehension, enabling future design-based research of systems providing immediate feedback to students on how the Internet resources they use for learning reflect the completeness or accuracy of the topic (Corrin & de Barba, 2015; Ravenscroft, Schmidt, Cook, & Bradley, 2012).

12.7 Summary of Contributions

This research contributes to the existing literature by adding to the current understanding of how students learn through research conducted using Internet information resources. It adds to current knowledge about social learning and the formation of social capital through the sharing of knowledge resources in the educational domain. It also proposes a framework that identifies assignment characteristics influencing the resulting citation network structures and investigates the relationships between network measures and learning outcomes, while at the same time exploring the identification of new, student-vetted open educational resources. Finally, this research provides practical recommendations for the integration of this type of learning assignment into existing pedagogy as well as design considerations for improvements to learning management systems to better support these types of activities. These contributions are discussed in more detail in the following sections.

12.7.1 Summary of Theoretical Contributions

This research proposes and tests a theoretical model describing the impact of social capital formation on learning. Building on the exploration of social capital development in virtual communities (Chiu et al., 2006), this research found that quantity and quality of social capital combined into a single social capital construct that had a strong, positive relationship to the perceived learning resulting from the research assignment. This social capital developed with only limited interactions (Benbunan-Fich & Arbaugh, 2005; Chang & Chuang, 2011; Wasko et al., 2009), suggesting that simply sharing Internet resources can result in social capital formation between students.

Learning goal orientation was found to partially mediate the relationship between social capital and perceived learning, supporting the findings of Yi and Hwang (2003). At the same time, a new construct, topic familiarity, was also found to partially mediate this relationship. Together, the theoretical model resulting from this research suggests that students can learn from activities that require them to use Internet resources for knowledge acquisition and share those resources for collaborative knowledge building, and that the social capital that develops during collaborative knowledge building has a strong positive relationship with students' perceptions of learning from the activity.

12.7.2 Summary of Methodological Contributions

Through the application of social network analysis to networks constructed of students and the resources they cite in their assignments, this research suggests a framework exploring learning outcomes and network structures resulting from assignments requiring students to use and cite Internet resources for learning. Although no pattern of relationships between students' positions in their networks and their performance on the assignment emerged based on the six assignments explored, the framework can be successfully applied to the design of learning activities for educators and researchers wishing to guide the development of either dense or sparse learning networks. Exploring the most frequently cited and most rarely cited Internet resources suggests a novel method of identifying new open educational resources to be used in the classroom while at the same time providing insights into students' knowledge needs.

12.7.3 Summary of Applied Contributions

This research makes important contributions to instructors and system designers alike. For instructors wishing to introduce this type of activity into their coursework, it is important to carefully define the scope of the assignment, as allowing students to independently research broad topics can lead to frustration when multiple individual perspectives must be combined into a single group assignment. At the same time, instructors must explain the expected learning outcomes and benefits of such an activity to students to encourage their engagement.

Additionally, although students often prefer to self-select into groups with other students they know for group assignments, the findings of this research suggest that instructors should assign students to groups in order to improve learning outcomes and engagement in the learning activity. Repeating this type of assignment in a course also improves learning outcomes, suggesting that instructors may wish to introduce this type of assignment early in the course to familiarize students with the tasks and expectations and then implement a second assignment a short time later.

The identification of reliable Internet knowledge resources based on students' citations gives instructors the opportunity to expand their instructional content by integrating relevant materials that are freely available on the Internet and that have been pre-screened by students. At the same time, the use of Internet resources for research means that instructors can create assignments exploring current topics. For example, the instructor in IS_677_FL14 was able to create an assignment shortly after the Facebook emotional contagion study had been discussed in the public forum. This assignment asked students to evaluate the ethical concerns of the study. Similarly, the instructor in IS_390_SPR14 revised an assignment exploring a past security breach to include one that was unfolding at the time, making the material much more relevant to the students.

This research also makes contributions to learning management system designers. By identifying the strengths and shortcomings of the university's learning management system to support this type of assignment, this research has provided design implications identifying the key affordances a system should provide to enable students to individually and collaboratively create knowledge repositories of Internet resources that can increase engagement and improve learning outcomes.

APPENDIX A

CONSENT FORMS AND FERPA WAIVER

Students in participating courses were invited to participate in this research in return for extra credit. Students not wishing to participate could earn the equivalent amount of extra credit by completing an alternate assignment of the instructor's choice – typically a review of a relevant industry or research journal article.

To indicate their agreement to participate in the research, students were asked to complete and sign the consent form shown in this appendix. An optional Family Educational Rights and Privacy Act (FERPA) waiver was included in the consent form. Students who signed the FERPA waiver were giving the researcher permission to obtain their semester's GPA and grade for the assignment.

TITLE OF STUDY: Learning by Sharing Digital Resources

RESEARCH STUDY:
I,____, have been asked to participate in a research study under the direction of Regina Collins and Dr. S. Roxanne Hiltz. Other professional persons who work with them as study staff may assist to act for them.

PURPOSE:

This research explores how students organize and use digital/online resources for their educational activities, as well as when and how they share these resources with friends, group members or classmates. This research evaluates two different technologies to assess the affordances provided by each, assessing how these affordances affect online resource management and sharing activities. Finally, this research incorporates the sharing of digital resources into course assignments to understand how these types of activities would contribute to both individual and group learning.

DURATION:
My participation in this study will last for _____1-2 weeks_________.

PROCEDURES:
I have been told that, during the course of this study, the following will occur:

I will complete a course assignment using either Moodle or Pearltrees, first submitting an individual summary and then combining my resources with those of my group members to complete a group summary. I will be asked to complete a brief (<40 question) online survey prior to beginning the assignment and another brief (<40 question) online survey upon completion of the activity. During the assignment/study period, the researcher will be monitoring the resources I manage for my own use, the resources I share with my group members, and any comments/discussions exchanged for the purposes of completing the activity.

I understand that if, as a result of the study, the researchers become aware of any academic misconduct, it will not be reported to the instructor or to NJIT academic affairs.

In addition to this written consent form, I will be asked to sign a Family Education Rights and Privacy Act (FERPA) waiver indicating that the researcher may obtain my current GPA (as of this semester) and the grade I receive on the completed assignment described above for research purposes.

PARTICIPANTS:
I will be one of about ___200_______participants in this study.

EXCLUSIONS:

I will inform the researcher if any of the following apply to me:

- I am under the age of 18.
- I do not have internet access outside of campus.
- I have any other issues which preclude me from participating in this study.

RISKS/DISCOMFORTS:
I have been told that the study described above may involve the following risks and/or discomforts:

N/A

There also may be risks and discomforts that are not yet known.

I fully recognize that there are risks that I may be exposed to by volunteering in this study which are inherent in participating in any study; I understand that I am not covered by NJIT's insurance policy for any injury or loss I might sustain in the course of participating in the study.

CONFIDENTIALITY:
I understand confidential is not the same as anonymous. Confidential means that my name will not be disclosed if there exists a documented linkage between my identity and my responses as recorded in the research records. Every effort will be made to maintain the confidentiality of my study records. If the findings from the study are published, I will not be identified by name. My identity will remain confidential unless disclosure is required by law.

PAYMENT FOR PARTICIPATION:
I have been told that I will receive extra credit for my participation in this study.

RIGHT TO REFUSE OR WITHDRAW:
I understand that my participation is voluntary and I may refuse to participate, or may discontinue my participation at any time with no adverse consequence. I also understand that the investigator has the right to withdraw me from the study at any time.

INDIVIDUAL TO CONTACT:
If I have any questions about my treatment or research procedures, I understand that I should contact the principal investigator at:

Regina Collins

rsb24@njit.edu

If I have any addition questions about my rights as a research subject, I may contact:

Judith Sheft, IRB Chair
New Jersey Institute of Technology
323 Martin Luther King Boulevard
Newark, NJ 07102
(973) 596-5825
sheft@njit.edu / irb@njit.edu

SIGNATURE OF PARTICIPANT

I have read this entire form, or it has been read to me, and I understand it completely. All of my questions regarding this form or this study have been answered to my complete satisfaction. I agree to participate in this research study.

Participant Name	X
Signature	X
Date	X

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT WAIVER

NEW JERSEY INSTITUTE OF TECHNOLOGY
323 MARTIN LUTHER KING BLVD.
NEWARK, NJ 07102

AUTHORIZATION TO RELEASE INFORMATION

Student Consent for Educational Records to be Released to Researcher for Purposes of Analysis Only

Student's Name (please print): NJIT UCID (e.g. rsb24)

_____________________________________ _______________________

PLEASE READ:
In accordance with the Family Educational Rights and Privacy Act of 1974 (FERPA), the undersigned student hereby permits New Jersey Institute of Technology to disclose the information specified below to the researcher, Regina Collins, for the purposes of research only. This information will be kept strictly confidential and will not be disclosed to any third parties, nor will any identifiable information about the student be released.

This consent shall be valid only for the semester during which the student participates in the research study.

INFORMATION TO BE RELEASED:
The information to be obtained shall be limited to:

- The student's grade for the course assignment designated as part of this research
- The student's overall GPA at the time of his or her participation in this research

I have read and understand the contents of this consent form pertaining to the Family Educational Rights and Privacy Act of 1974.

Student's Signature: Date:

____ ___________________

APPENDIX B

INTERVIEW GUIDES

This research began with semi-structured interviews seeking to understand why students searched for resources on the Internet, how they managed those resources, and whether or not they shared them with others. As the interviews progressed, the interview guide was refined to focus on topics that emerged in earlier interviews. This appendix shows the first interview guide in Section B.1 and the final interview guide in Section B.2.

B.1 First Interview Guide

The first interview guide was informed by the research questions discussed in Chapter 4. The interview sheets guiding these first interviews are shown below.

Interviewer:	Note taker:	Day & Time :
Location:	Observed Activity:	
Subject name/ID:	Gender: F / M	Age:
Major:	Undergrad / Grad	[e-mail:]

Introduce yourself; explain the reason for the interview, that it will be brief. Get to know the person a little bit. The following questions are not to be read from the paper but instead adjusted and maybe reworded to fit the situation and to guide the conversation. If you feel the interview provided interesting data, at the end of the interview ask the person if they would be willing to provide their e-mail to be contacted for a follow-up interview.
"May I ask you a few questions?" - "I'm a grad student here and as part of a class project I'm interested in how students share knowledge and ideas with each other individually and in group projects."

1. **What courses are you taking this semester?**

2. **What is the delivery mode for each of these courses?** [Are they all face to face? Are they hybrid (partially face to face and partially online) or completely online?]

3. **How do you get course-related information like the syllabus or homework assignments for your courses?** [If they are taking a mix of face to face and hybrid or online courses, ask if there are differences in how the instructors communicate with the students.]

4. **Have any of your courses required you to reference multiple resources like published articles, books, wikis, blogs, and so on? Was there ever a situation in which you felt there was too much information or it was hard to locate relevant information? Can you tell me about it?**

5. **Thinking about that situation, what did you do to find the relevant information? [Did you go through all the materials gathered from each resource and find what was relevant? Or did you decide to review only certain information resources? Were there any resources you chose to go through completely? How did you pick those resources?]**

Students are willing to share discovered knowledge resources with others with the expectation that others will reciprocate and provide information that may help them at some other point. Students will share these resources through…
… private communication (e-mail, text msg, in-person discussion) when there is a perception of zero-sum game
…public methods (posting to Moodle, emailing all participants) when the coursework is collaborative

6. **In thinking about the resources instructors have given you or ones you've found on your own, have you ever come across some that you found particularly helpful?**

If yes:

6a. Did you find the resource on your own or did the instructor provide it?

6b. Did you share it with anyone? If so, with one person, a few people, or everyone in the class? Why?

6c. How did you share the information? (Depending on answer to previous question, if needed prompt for appropriate methods such as posting it to Moodle, sending an e-mail, or just telling someone about it.)

6d. Did you provide any information that explained how that resource helped you solve the problem? Why or why not? [If they did provide information, did any of their classmates comment on it?]

If no:
Why not?

Students are motivated to explore external knowledge resources when …
…they trust the person recommending the resource
…they perceive a value (e.g. higher grades, more opportunities to participate) can be gained from the resource

Now I'd like to ask you a little more about your interactions with other students in the class.

7. **Has a student in any of your classes ever shared something they thought was helpful like a link to a website or youtube video? Did you look at it? Why or why not?**

8. **How did that person share the information?** [e.g through Moodle to the whole class, in a private e-mail to you and maybe a few others? Did they send it to the professor who then distributed it?]

9. **Did your perception of the student who shared the information influence your decision to look at it?**

Students will have to use multiple methods to manage knowledge resources

10. **Do you keep track of the external resources that you find helpful?** [e.g. how do you store links to web-based resources? What about helpful documents and PDFs?]

11. **Do you think these resources are helpful in the context of a single course, or are there some that you might refer to on an ongoing basis?**

Knowledge acquisition evidenced by a group project will not match each individual's knowledge acquisition from the same project when
…the group work was segmented as opposed to each student contributing to each part of the project
…social loafing and free riding impacted contributions, forcing other students to cover additional parts of the project
…the group's final deliverable did not accurately reflect the knowledge acquired by all the individual members

12. **Have any of your recent courses involved a group project? Could you give me a brief description of what the project was about and what your group deliverable was (e.g. report, presentation…)?**

13. **Thinking about that group project, how did your group organize the tasks you had to perform to finish the project? (In other words, did you segment the learning tasks or the deliverable? Was each person expected to contribute to each part?)**

14. **How did the group project go? Did everyone contribute to the final product?**

15. **Did the professor in any way ensure that each member contributed to the project? (For example, was each person expected to be able to answer questions about the project on an exam?)**

16. **Do you feel that everyone in your group learned equally from their work on the group project?**

17. **How did you share information with your group when you worked on the project? What kind of information did you share?**

B.2 Final Interview Guide

The interview guide evolved through several iterations of feedback and refinement. The final interview guide shown below was used to conduct 25 interviews, or approximately 50% of the 54 interviews conducted.

Interviewer:	Note taker:	Day & Time :
Location:	Observed Activity:	
Subject name/ID:	Gender: F / M	[e-mail:]
Major:	Undergrad / Grad	Fresh/Soph/Jr/Sr

Introduce yourself; explain the reason for the interview, that it will be brief. Get to know the person a little bit. The following questions are not to be read from the paper but instead adjusted and maybe reworded to fit the situation and to guide the conversation. If you feel the interview provided interesting data, at the end of the interview ask the person if they would be willing to provide their e-mail to be contacted for a follow-up interview.
"May I ask you a few questions?" - "I'm a grad student here and as part of a class project I'm interested in how students share knowledge and ideas with each other individually and in group projects."

18. **What courses are you taking this semester? What is the delivery mode for each of these courses?**

Course Title	Delivery Mode	Discussion Forum	Group Project
	F2F/Hybrid/Online		
	F2F/Hybrid/Online		
	F2F/Hybrid/Online		
	F2F/Hybrid/Online		
	F2F/Hybrid/Online		

In courses that require rote learning of concepts and skills (e.g. Math, Physics), students will utilize external knowledge resources to support the Application level of Bloom's taxonomy by locating resources that help them apply their knowledge to solve problems.

19. **Have you ever used any practice quizzes or tutorials to help you learn something?**

20. **Have you ever used any online resources to get specific information that you don't feel is worth remembering (e.g. the specific properties of a material in Chem, or how to code a particular statement in a programming course?)**

21. **Have you ever looked online for explanations or definitions of something you didn't understand in class?**

22. **Have you ever looked online for a resource that could help you do your homework (like solving a math problem, for example)?**

Providing opportunities for Socialization through informal exchange of knowledge will enable students to share their viewpoints and compare them to the viewpoints of others.

23. **Did you find something that helped you?**

24. **How many things did you look at before you found something helpful?**

25. **Did you use more than one resource (e.g. a few different videos or websites)?**

Providing integrated opportunities for Socialization through informal exchange of knowledge will enable students to share their viewpoints and compare them to the viewpoints of others.

26. **Did you share the resource with anyone? Why or why not?**

27. **Did you share the resource itself or what you learned from it? If you shared the resource, did you tell the person why you thought it was helpful?**

28. **Has a student in any of your classes ever shared something they thought was helpful? Did you find it helpful? Why or why not?**

Providing integrated opportunities for Externalization through the sharing of student-created knowledge resources will reinforce the student's own learning and allow knowledge to be applied, analyzed, synthesized and evaluated.

29. Have you ever created any sort of knowledge resource that you shared with students in your class (e.g. study guide, video, Moodle posting, report)? Has anyone else in your class ever done something like that?

10a. What was the reason for creating such a resource? Did you [or that person] do it for yourself, was it part of an assignment, or some other reason?

30. What about when you were working on a group project and you shared your work with your group? Did you review each other's work? How do you think that affected your final deliverable?

31. Did you ever have differing opinions between group members? How did you resolve the different viewpoints?

32. Did you ever have a group member who wasn't contributing? How did you feel about sharing knowledge resources with that person?

Because there is no tool to conveniently store different types of information resources, students will have to use multiple methods to manage these resources

33. Did you or your group members share any external knowledge resources (e.g. articles to be cited or links to background information)? How did you share and manage those external resources between the group members?

34. What about your own knowledge resources? How do you store or manage them?

In courses that require the understanding of higher-level concepts (e.g. Humanities, Ethics), students will utilize external knowledge resources for Analysis of their viewpoints, Synthesis of viewpoints from other sources, and Evaluation of the resulting knowledge.

35. Have any of your courses required you to reference multiple knowledge resources, for example in the creation of a term paper?

36. Did you already have a point of view about the subject? [If YES: Did you look for resources that supported your point of view or that disagreed with it, or both? If NO: How did you use the resources you found to develop a coherent point of view?]

37. Did you look for resources that agreed with your point of view, disagreed, or both?

Providing opportunities for the Combination of students' knowledge will encourage the creation of new ideas and understandings.

38. Have any of your courses used Moodle for online discussions to share ideas or discuss assignments? Did the discussions in any way enhance or even change your own point of view about the topic?

APPENDIX C

INSTRUCTIONS FOR THINK ALOUD PROTOCOL

A think aloud protocol was conducted before the pilot test to ensure that both systems (Moodle and Pearltrees) were adequate for the types of activities necessary for the intended course assignments. Instructions were created for both Moodle and Pearltrees; however, because most students were familiar with Moodle and not with Pearltrees, the Pearltrees instructions were more detailed, covering use of the system and management of resources as well as study participant instructions. The instructions are shown in this appendix.

Instructions (Pearltrees)

Overview

You will be using sources found on the Internet to explore the topic of tea. If you're willing to participate in this research, you must first read and sign the consent form. After signing the consent form, you will first read some basic instructions about the use of the Pearltrees social media curation site. Then you will complete two tasks using information you find on the Internet.

When you find webpages that are helpful, you must store them in Pearltrees and cite at least three of them in your answers to the questions.

Part 1

1. You will find and save resources that explain the traditional Japanese tea ceremony.
2. You will answer one question about the Japanese tea ceremony using information from the resources you found and saved.

Part 2

1. You will look at provided resources and find and save your own to describe the differences between types of tea.
2. You will answer one question about types of tea using information from the resources that were provided and the ones that you found and saved.

Your resources don't have to be scholarly but you should feel comfortable using the information from them.

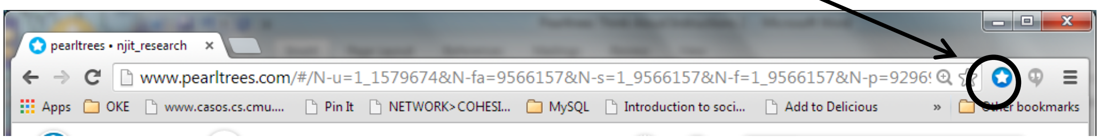
After you finish both tasks, the researcher will have a few follow-up questions. You'll be given $10 to thank you for your participation in this research.

Pearltrees Instructions

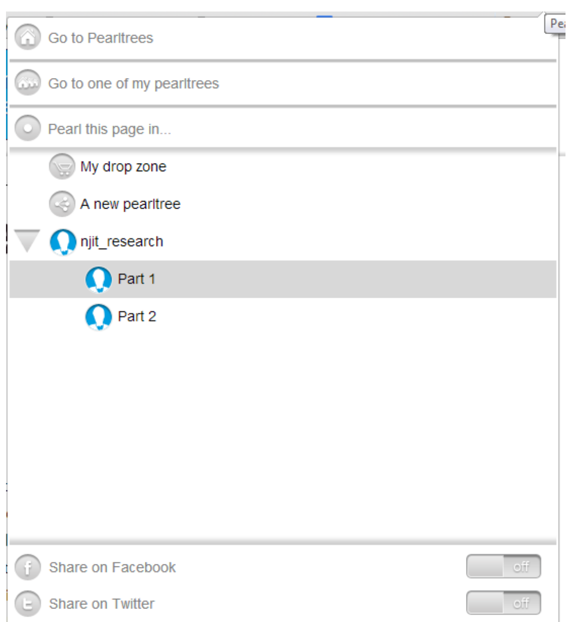
You'll be working on the researcher's computer for this study. The researcher will have a guest account open for you on Pearltrees. If, during the study, you accidentally log out of the Pearltrees system, ask the researcher for assistance.

Adding Webpages To Pearltrees

You can easily add webpages (URLs) to your Pearltrees guest account using the "Pearler" add-on to Google Chrome. Simply click on this symbol while viewing the URL you want to add.



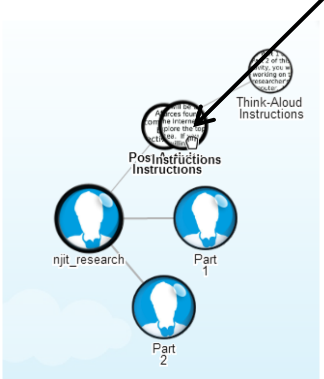
When you're viewing a webpage you want to add to Pearltrees, click on the Pearler on the browser bar. Pearltrees displays a drop-down menu that lets you select where you want to put the resource. Use Part 1 for the first activity and Part 2 for the second activity.

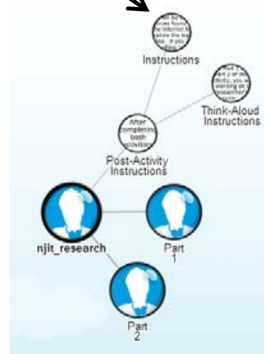


Working in Pearltrees

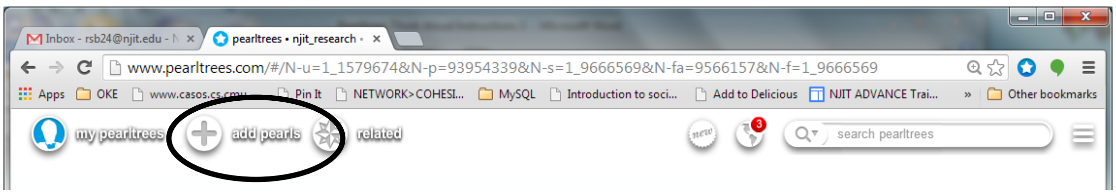
You can go to the Pearltrees site and manage your resources, called pearls.

You can move pearls around; drag a pearl onto another pearl to create a branch of a tree.





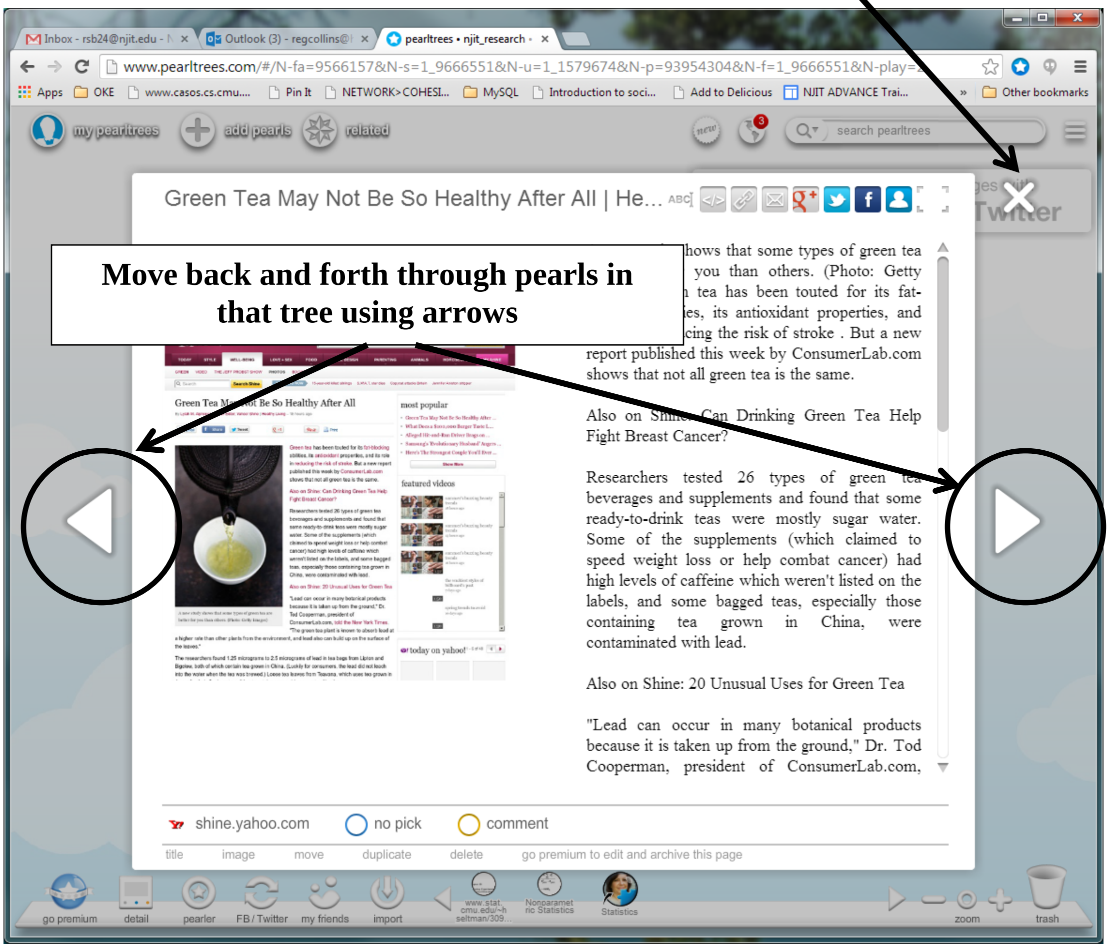
You can also create a note in Pearltrees.



1. Click on add pearl.

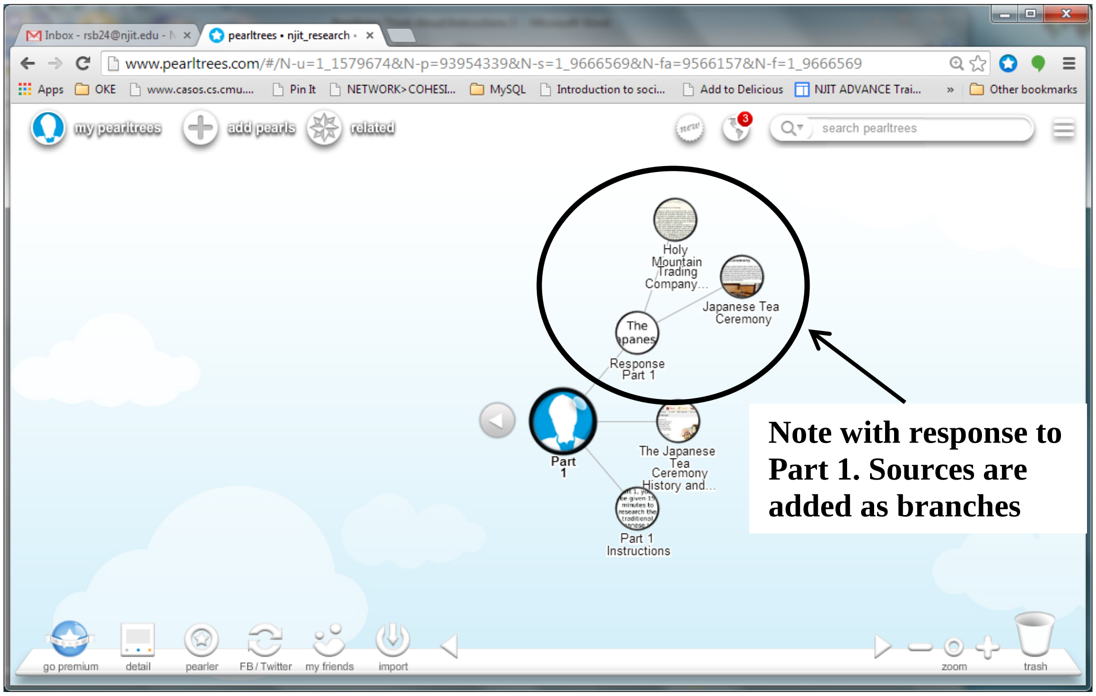
2. Select Note to create a note.

If you click on one of your pearls, Pearltrees displays it in a pop-up window. You can use the arrows to view all the pearls in that tree, or close the pop-up window by clicking on the "x".



For each part of this study:

1. Create a Note in the appropriate Pearltree (Part 1 and Part 2)
2. Write your response to the question in the Note you created.
3. Cite your sources in the body of the note or make the resources you used branches on your Note.



Getting Set Up

You'll be working on the researcher's computer. You will have access to a guest Pearltrees account in which you can work and you will have access to the Internet and to Google Chrome for web searching.

- Your on-screen activities and utterances will be recorded using Camtasia Relay.
- You will be asked to say aloud what you are thinking while performing the activities.
- If you forget to think aloud, the researcher may remind you to do so.

Otherwise, the researcher will try to interact with you as little as possible. However, if you have difficulty completing any task, you may ask the researcher for explanation.

Part 1

In Part I, you will be given 15 minutes to research the traditional Japanese tea ceremony and respond to the following question using at least three resources you find on the Internet.

> **When you find a resource that you feel is relevant, add it to the Part 1 pearltree using the Pearler on the browser menu bar.**

You can organize and use the Part 1 pearltree however you see fit for the purposes of this research. The question you must respond to is:

> *Describe the key elements of the traditional Japanese tea ceremony. Save and cite your sources. Write your response in a Note in Part 1.*

Remember to think out loud during this activity. If you forget or are silent for an extended period, the researcher may remind you to say what you are thinking.

Part 2

You will now be provided with resources other people have compiled about specific types of tea. You will be given 15 minutes to explore these resources and find some of your own.

When you find a resource that you feel is relevant, add it to the Part 2 pearltree using the Pearler on the browser menu bar.

You can organize and use the Part 2 pearltree however you see fit for the purposes of this research. The question you must respond to is:

Analyze the differences between these four types of tea: white, green, oolong, and black. Cite three sources, at least one of which was provided and at least one of which you found.

Remember to think out loud during this activity. If you forget or are silent for an extended period, the researcher may remind you to say what you are thinking.

Follow-Up Interview

Upon completion of both parts of this study, the researcher will have some follow-up questions about your experience in the study. After answering these questions, you will be given $10 to thank you for your time and effort.

APPENDIX D

INSTRUCTIONS AND RUBRIC FOR PILOT STUDY

The pilot study was conducted in the Fall of 2013. Students from one graduate-level Information Systems course were invited to participate. The primary purpose of the pilot study was to test the instructions, the use of the two systems (Moodle and Pearltrees), and the assignment design in a real classroom environment.

D.1 Instructions

The instructions for the pilot study assignment (individual and group) are shown in this section. The scoring rubric for the independent scoring of assignments is shown in Section D.2.

Overview

You will be using sources you find on the Internet to explore the topic of Object Oriented Modeling (OOM). The assignment is a two week graded assignment that is a required activity for this course.

- Week 1 (Part I) requires an individual submission
- Week 2 (Part II) requires a group submission.

All students in the course have been assigned to use one of two systems: Moodle or Pearltrees.

System	Group	Students
Moodle	1 – Alpha	ID1 through ID6
	3 – SGT	ID7 through ID11
	6 – Icebreaker	ID12 through ID17
Pearltrees	2 – Invicta	ID18 through ID23
	4 – Apollo	ID24 through ID29
	5 – Matrix	ID30 through ID33

The informational resources you find for this assignment and your submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed)
2. Completing a brief online survey before beginning the activity
3. Completing a second brief online survey after completing the activity

Assignment Part I

This assignment is broken into two parts. During the first week of the assignment, you will work **individually** to research the topic of Object Oriented Modeling (OOM) and create an individual summary to answer the five questions listed below.

Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.

1. Explain the concept of Object-Oriented Modeling. Copy and paste the links to at least three (3) internet sources used to inform your explanation at the end of your assignment.

2. Use this explanation to describe the impact of OOM on software development.

3. Find at least three (3) online resources that describe an essential characteristic of OOM (e.g. inheritance, aggregation). Analyze any similarities and differences between the resources you find. Provide links to the resources you used.

4. Provide your own description of this characteristic.

5. Defend the importance of this characteristic in OOM or argue why it is not applicable or helpful.

Each student will also be responsible for submitting a class model diagram based on a problem provided at the beginning of this assignment. The model must be included with your Part I individual summary.

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.

Assignment Part II

Once all individual assignments have been submitted, you will work with your group to create a group summary that responds to the same five (5) questions, listed below.

1. Explain the concept of Object-Oriented Modeling. Copy and paste the links to at least three (3) internet sources used to inform your explanation at the end of your assignment.

2. Use this explanation to describe the impact of OOM on software development.

3. Find at least three (3) online resources that describe an essential characteristic of OOM (e.g. inheritance, aggregation). Analyze any similarities and differences between the resources you find. Provide links to the resources you used.

4. Provide your own description of this characteristic.

5. Defend the importance of this characteristic in OOM or argue why it is not applicable or helpful.

To create your group assignment, share the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment Survey

Upon completion of the assignment, if you are willing to participate in the research portion of this assignment and you completed the pre-assignment survey, you must complete a brief **post-assignment survey** regarding your experience. The link is available on Moodle.

D.2 Scoring Rubric

The assignments submitted by students were graded by the instructor for the purposes of providing a course-related grade for the assignment. Two independent raters were also recruited to score the assignments based on a rubric evaluating levels of evidence of cognitive learning based on Bloom's taxonomy. The scoring rubric for the pilot study assignments is shown below.

Id: ____________ rater: ____________________

1. **Object Oriented Modeling**. The submission discusses the key elements of object oriented modeling including abstractions of entities, their relationships (associations/multiplicity), attributes and services/methods and messages.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

2. **Impact of OOM on Software Development**. The submission discusses the abstraction of entities in a system through OOM and the use of design patterns.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

3. **OOM Characteristics.** The submission discusses any one characteristic of OOM classes such as inheritance, aggregation, abstraction, encapsulation and polymorphism. The submission provides a description of the characteristic and mentions discrepancies between different descriptions.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

4. **OOM Characteristics 2**. The submission draws on the previous descriptions to create a single, coherent description that accounts for any differences from various sources.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

5. **Defend the use of OOM.** The submission provides relevant and supported arguments about the benefits of OOM and Class Models or provides relevant arguments as to why OOM is not useful.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

6. **Class Model.** The class model displays all relevant classes, attributes, services, relationships, and cardinality.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

7. **Holistic Score**. In general, the submission provides a thorough description of the topics and provides evidence of an understanding of the topics of OOM and software design patterns.

Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree

APPENDIX E

INSTRUCTIONS FOR ASSIGNMENTS IN FIELD STUDY

Assignment instructions were created for every course participating in the larger field study. In the three courses implementing repeated measures, two assignments were integrated into the course work. The assignment instructions for all research assignments are shown in this appendix.

E.1 Assignment Instructions for IS_331_SPR14

You will be exploring one of the following topics related to databases for this assignment:

- **Graph databases**
- **NoSQL/Nonrelational databases**
- **Data warehouses**
- **Distributed databases**
- **Object oriented databases**
- **Database security**

For this assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Part I requires an individual submission.
2. Part II requires a group submission.

Your assignments must be submitted through the Moodle assignment forums.

To store and share your resources, you have been assigned to use one of two systems**:**
Odd numbered teams use Moodle
Even numbered teams use Pearltrees

The Internet resources you find for this assignment and your assignment submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed).
2. Completing a brief online survey BEFORE beginning the individual activity.
3. Completing a second brief online survey AFTER completing the group activity.

The links to the surveys are available on Moodle.

Assignment Part 1 (Individual)

This assignment is broken into two parts. During the first part of the assignment, you will work **individually** to write your own (individual) responses to the five questions listed below.

<u>NOTE: Submit your assignment in the Moodle assignment forum but store your Internet resources in your assigned system.</u>

Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.

Select one of the database topics listed on the first page of these instructions. Use reliable information you find on the Internet to answer the following questions.

1. *Summarize your selected topic. Explain in your own words what it is.*

2. *Describe a possible situation/scenario where this technology could be used effectively.*

3. *Identify at least 3 key elements of this technology that make it suitable for this situation/scenario. Remember to store your Internet resources in your assigned system and provide links to the sources in your assignment submission.*

4. *Show how the elements you identified in Question 3 are applicable to the scenario you selected in Question 2. Remember to store and cite your Internet resources.*

5. *Justify why this technology is applicable over other technologies in your chosen scenario or argue why you don't feel this technology offers any advantage of other, more conventional technologies.*

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.

Assignment Part II (Group)

Once all individual assignments have been submitted, you will share your resources and thoughts with your group to create a group summary that responds to the same five (5) questions, listed below.

1. *Summarize your selected topic. Explain in your own words what it is.*

2. *Describe a possible situation/scenario where this technology could be used effectively.*

3. *Identify at least 3 key elements of this technology that make it suitable for this situation/scenario. Remember to store your Internet resources in your assigned system and provide links to the sources in your assignment submission.*

4. *Show how the elements you identified in Question 3 are applicable to the scenario you selected in Question 2. Remember to store and cite your Internet resources.*

5. *Justify why this technology is applicable over other technologies in your chosen scenario or argue why you don't feel this technology offers any advantage of other, more conventional technologies.*

To create your group assignment, share and discuss your responses and the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment Survey

After submitting your group assignment, please complete the post-assignment survey. A link to the survey is available on Moodle.

E.2 Assignment Instructions for IS_331_FL14

This assignment is broken into two parts:

Week 1 (10-16 November) each person will do individual research using Internet resources that you feel are realible and informative. The topics you will research are non-relational databases including NoSQL and MongoDB as well as MapReduce. While you're researching these topics, store the links to any helpful websites, videos, and so on, that you use. You will be assigned to use either Moodle or Pearltrees to store your resources. After completing your research, you will take the online quiz provided in Moodle for this week.

(The individual quiz questions are shown below. Students were asked to respond to a random selection of four of the five questions.)

Q1. A relational database organizes data in tables that have some relationships between them. What are they key characteristics of a non-relational database?

A. They do not use tables or keys.
B. They are typically used when dealing with big data.
C. They require very large amounts of disk space to achieve performance.
D. A and B. (correct answer)
E. A, B, and C.

Q2. MongoDB is a special example of a non-relational database that is a:

A. Document-oriented database (correct answer)
B. Graph database
C. XML database

Q3. What role does MapReduce play in the domain of non-relational databases and big data?

A. MapReduce is a special server configuration specifically built to handle big data.
B. MapReduce is an alternative database format to NoSQL.
C. MapReduce is a framework that describes the distributed parallel processing of big datasets. (correct answer)

Q4. When discussing non-relational databases, the concept of scalability refers to:

A. The ability of a non-relational database to incorporate any type of data in real time.
B. The ability to add more rows and columns to the database in real time.
C. The ability to simultaneously distribute the data across multiple servers. (correct answer)

Q5. One of the requirements of data in a NoSQL database is that it cannot be structure.

- True
- False (correct answer)

Week 2 (17-23 November) You will combine your knowledge and resources with those of your teammates to answer the questions provided about non-relational databases and MapReduce. Share and discuss your individual resources with your group. You will be using the same system that you used in your individual assignment to share and discuss your resources (either Moodle or Pearltrees). Remember to cite the reosurces you use for your group submission in your written assignment.

(The group quiz questions are shown below. Students had to respond to all three questions as a group.)

Q1. Explain in your own words what a non-relational database is. Give some examples of non-relational databases. Copy and paste the URLs of the sources you use for your answer at the end of your response. Your response should be 1-2 paragraphs in length.

Q2. What is the difference between NoSQL and MapReduce? Provide descriptions of both and explain how they are similar and how they are different. Justify your answers by citing the URLs of the Internet resources you used to create your answer. Your response should be 2-3 paragraphs in length.

Q3. Describe why non-relational databases have become important in certain domains. Give examples of the types of environments in which they are more appropriate than relational databases. Contrast this with environments in which relational databases might be more effective. Justify your answers and cite the URLs you use for your response at the end of this question. Your response should be 3-4 paragraphs in length.

E.3 Assignment Instructions for IS_390_SPR14

You will be exploring the case of the security breach at TJX and incorporating information from the recent Target breach in an analysis of corporate IT strategies. For this assignment, you must:

3. Create an assignment submission to be submitted through Moodle
4. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

3. Part I requires an individual submission.
4. Part II requires a group submission.

Your assignments must be submitted through the Moodle assignment forums.

To store and share your resources, you have been assigned to use one of two systems**:**
Odd numbered teams use Moodle
Even numbered teams use Pearltrees

The Internet resources you find for this assignment and your assignment submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed).
2. Completing a brief online survey BEFORE beginning the individual activity.
3. Completing a second brief online survey AFTER completing the group activity.

The links to the surveys are available on Moodle.

Assignment Part I (Individual)

This assignment is broken into two parts. During the first part of the assignment, you will work **individually** to write your own (individual) responses to the five questions listed below.

NOTE: Submit your assignment in the Moodle assignment forum but store your Internet resources in your assigned system.

Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.

By now, you've read about the TJX security breach, and you have no doubt heard about the even larger security breach that occurred in 2013 at Target. Based on the TJX case, as well as reliable information you find on the Internet about TJX and Target, answer the following questions.

1. *Describe TJX's business model and business strategy.*

2. *Relate TJX's business strategy to its IT strategy.*

3. *Compare TJX's response to the security breach with that of Target. How were they different? How were they the same? Remember to store your Internet resources in your assigned system and provide links to the sources in your assignment submission.*

4. *What common elements (if any) existed between TJX's business and IT strategies and those of Target? Remember to store and cite your Internet resources.*

5. *Which company do you think responded better to the security breach? Justify your answer and provide links to any relevant Internet resources.*

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.

Assignment Part II (Group)

Once all individual assignments have been submitted, you will share your resources and thoughts with your group to create a group summary that responds to the same five (5) questions, listed below.

1. *Describe TJX's business model and business strategy.*

2. *Relate TJX's business strategy to its IT strategy.*

3. *Compare TJX's response to the security breach with that of Target. How were they different? How were they the same? Remember to store your Internet resources in your assigned system and provide links to the sources in your assignment submission.*

4. *What common elements (if any) existed between TJX's business and IT strategies and those of Target? Remember to store and cite your Internet resources.*

5. *Which company do you think responded better to the security breach? Justify your answer and provide links to any relevant Internet resources.*

To create your group assignment, share and discuss your responses and the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment Survey

After submitting your group assignment, please complete the post-assignment survey. A link to the survey is available on Moodle.

E.4 Assignment Instructions for STS_342_FL14

The goal of the new UN-sponsored “HeForShe” campaign is deceptively simple: to encourage men throughout the world to join with women in speaking up against gender inequality and discrimination. In asking “one half of humanity [to join] in support of the other of humanity, for the entirety of humanity”—HeForShe organizers note that men, as well as women, are “imprisoned by gender stereotypes.” The HeForShe Campaign asks us to “take action.”

How could we do this at NJIT? What significant actions could NJIT men and women take? How could we use electronic media to jump-start collective action?

Your Assignment (Overview):

Answer each of the questions above, working first individually and then in a team. Transform your answers into a set of products (“deliverables”).

1-The Deliverables:

- An online HeForShe@NJIT video.
- You will design and create this video as part of a team.
- Everybody on the team will receive the same grade.
- Format: mp4
- Approximate length: 1-3 minutes
- Delivery: upload to a Dropbox folder provided for you.

- Due date: December 8
- On December 10, you and your team will present your video in class.

2-A paper in which you explain your team's HeForShe@NJIT campaign and describe the group process/research process that produced it (individual)

- You will write this paper individually.
- Each paper will receive a separate grade.
- Your paper will include a bibliography of the resources you found in doing individual research and a bibliography of all the resources shared by the team.
- Format: 8-10 word-processed pages (double space).
- Delivery: Upload to Turnitin.com via our course Moodle.
- Due date: December 10

Identifying Resources and Models: Working individually, search the Internet for resources that you can use in designing a video to address the key problem you and your team have agreed on (i.e. How can you make people aware of the problem and motivate them to change/take action?) In addition to relevant website and online articles, include in your list of resources the URLs of existing videos that might serve as a model for your own efforts and images that you might be able to incorporate. (Be sure to check copyright permissions.)

Sharing Resources With Your Team: Using Moodle/Pearltrees, share the resources you have collected in the previous step. Reach an agreement on the final list of resources and models that you will use to make your team video.

E.5 IS_677_SPR14 Assignment 1 Instructions

Instructions

Overview

You will be using sources you find on the Internet to better understand the four components of an information system (People, Technology, Structure, and Process) described in Chapter 2 of the textbook. The assignment is a two week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Week 1 (Part I) requires an individual submission and stored Internet resources.
2. Week 2 (Part II) requires a group submission and shared Internet resources.

Your assignments must be submitted through the Moodle assignment forums.

To store and share your resources, you have been assigned to use one of two systems**:**
Teams 1, 3, 5, 7, and 9 use Moodle
Teams 2, 4, 6, and 8 use Pearltrees

The Internet resources you find for this assignment and your assignment submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed).
2. Completing a brief online survey BEFORE beginning the activity.
3. Completing a second brief online survey AFTER completing the activity.

The links to the surveys are available on Moodle.

Assignment Part I (Individual)

This assignment is broken into two parts. During the first week of the assignment, you will work **individually** to write your own (individual) responses to the five questions listed below.

NOTE: Your assignment should be submitted in Moodle regardless of which system you are assigned to use to store your resources.

Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.

By now, you've read the mini-case at the beginning of Chapter 1 (Facing Termination) and the definitions of the four components of an information system described in Chapter 2. Based on this mini-case and your understanding of the components, as well as reliable information you find on the Internet, answer the following questions.

1. *Explain in your own words the four components of an information system.*

2. *Apply your explanations to the mini-case. Identify which components were considered by the VP of marketing and which components were neglected.*

3. *Using the list of Noteworthy System Failures in Table 2.1, research three of these failures using Internet resources. Analyze the similarities and differences between those failures and the mini-case in terms of the components of an IS. Provide the links to the Internet resources you used.*

4. *Based on these examples of failed IS systems, describe what you would have done differently if you were the VP of Marketing in the mini-case.*

5. *Evaluate your proposed solution against the four IS components. Does it address all of them? Which is/are most important in your solution? Why?*

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.
Assignment Part II (Group)

Once all individual assignments have been submitted, you will share your resources and thoughts with your group to create a group summary that responds to the same five (5) questions, listed below.

1. *Explain the four components of an information system by integrating your individual responses.*

2. *Apply these explanations to the mini-case. Identify which components were considered by the VP of marketing and which components were neglected.*

3. *From the Noteworthy System Failures in Table 2.1 you've already explored individually, select three to discuss as a group. Analyze the similarities and differences between those failures and the mini-case in terms of the components of an IS. Provide the links to the Internet resources you used.*

4. *Based on your individual responses to this question, summarize your best recommendations of what could have been done differently if you were the VP of Marketing in the mini-case.*

5. *Evaluate your group's solution against the four IS components. Does it address all of them? Which is/are most important in your solution? Why?*

To create your group assignment, share and discuss your most relevant resources with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment 1 Survey

After submitting your group assignment, please complete the post-assignment 1 survey. A link to the survey is available on Moodle.

E.6 IS_677_SPR14 Assignment 2 Instructions

Instructions – CASE STUDY

Overview

You will be using sources you find on the Internet to analyze an Information Systems case, develop an alternate solution, and integrate the information from your analysis with the topics covered in the course.

The assignment is a one week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Each student must create an individual analysis that will be part of the final submission.
2. All individual analyses must be combined into a coherent group analysis.

Your final submission must be submitted through the Moodle assignment forum. It should include each student's individual analysis (be sure to put your name at the beginning of your analysis) and a group analysis.

To store and share your resources,
you will now be using the system you DID NOT use in Assignment 1**:**
Teams 1, 3, 5, 7, and 9 use Pearltrees
Teams 2, 4, 6, and 8 use Moodle

The Internet resources you find for this assignment and your submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. If you agreed to participate in the research by completing the consent forms, you must also complete the following additional tasks:

1. Complete a brief survey online BEFORE beginning the assignment
2. Complete a second brief online survey AFTER completing the activity.

The links to the surveys are available on Moodle.

Assignment Individual

This assignment is broken into two parts. For your individual summary:

1. Skim the cases provided and work with your team members to choose one you find most interesting.
2. Read the case individually and look for additional Internet resources about it.
3. Work **individually** to write your own summary covering the 7 sections below.

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). Include the links to the URLs you used at the end of your individual summary in addition to a formal reference section. Storing your resources is part of this assignment.

<u>NOTE: Your assignment MUST be submitted in Moodle regardless of your assigned system.</u>

Questions 1 through 7 should be answered individually by each student in the group.

1. **Summary (5 pts) –** provide a summary of the case.

2. **Problems and Relevance (10 pts) –** identify the problem(s) and the relevance of the case to the IS field. Support your comments and arguments with the course material and Internet resources.

3. **Alternative Solution (10 pts) –** develop an alternative solution. (Think current and include current information about companies and technologies discussed in the case. Justify your answer. Save and cite the Internet resources and academic articles you use.)

4. **Course Integration (10 pts) –** Integrate course concepts with the technology. (**Very important**.) Show me that you are reading the text and articles and watching the videos. Show how the materials relate to the case. Use MISQ format to cite scholarly references and paste links to URLs you use (minimum of 5 relevant sources).

5. **Critical Analysis (10 pts)** - (See Bloom's taxonomy of the article based on course material and other articles and the Critical Thinking resource in Moodle.) Critically assess the case. Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources).

6. **Lessons Learned (10 pts) –** Thinking about your own point of view and the company's, support your comments and arguments with course materials.

7. **References (5 pts) –** Scholarly/academic papers in MISQ format; Internet resources copy and paste URL.

Assignment Part II

Once all individual analyses have been completed, you will share your resources and analyses with your group to create a group summary that responds to the questions listed below.

1. **Alternative Solution (10 pts) –** Based on the individual analyses of all group members, decide on a best alternative solution. (Justify your answer and save and cite the Internet resources and academic articles that apply to this solution.)

2. **Course Integration (10 pts) –** Examine the individual analyses of how this case integrates with the course material and create a coherent summary of how the course materials tie in with the case analysis. Cite at least 5 relevant sources using MISQ format for scholarly references and paste links to URLs you use.

3. **Critical Analysis (20 pts)** - (See Bloom's taxonomy of the article based on course material and other articles and the Critical Thinking resource in Moodle.) Critically assess the case. Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources).

To create your group assignment, share and discuss your individual analysis and the resources you feel were most relevant in your individual submission with your group using your assigned system:
Moodle or Pearltrees.

Post-Assignment 2 Survey

Upon completion of the assignment, if you are willing to participate in the research portion of this assignment and you completed the pre-assignment 2 survey, please complete a brief **post-assignment survey** regarding your experience. A link to the survey is available on Moodle.

E.7 IS_679_SPR14 Assignment 1 Instructions

Overview

You will be using sources you find on the Internet to better Hofstede's National Cultural Dimensions described in Figure 3.6 (Chapter 3) of the textbook. The assignment is a two week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Week 1 (Part I) requires an individual submission.
2. Week 2 (Part II) requires a group submission.

Your assignments must be submitted through the Moodle assignment forums.

To store and share your resources, you have been assigned to use one of two systems**:**
Teams 1, 3, and 5 use Moodle
Teams 2, 4, and 6 use Pearltrees

The Internet resources you find for this assignment and your assignment submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed).
2. Completing a brief online survey BEFORE beginning the first activity.
3. Completing a second brief online survey AFTER completing the second activity.

The links to the surveys are available on Moodle.

Assignment Part I (Individual)

This assignment is broken into two parts. During the first week of the assignment, you will work **individually** to write your own (individual) responses to the five questions listed below.

<u>NOTE: Submit your assignment in the Moodle assignment forum but store your Internet resources in your assigned system.</u>

> **Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.**

By now, you've read about Cognizant Technology Solutions, Tata Consultancy Services (TCS) and how they adapted their organizational structures to better match their business and IS strategies. You've also been introduced to Hofstede's National Cultural Dimensions. Based on these descriptions, as well as reliable information you find on the Internet, answer the following questions.

1. *Explain in your own words Hofstede's five National cultural dimensions. Cite the Internet resources you used to research this topic.*

2. *Apply your explanations to both Cognizant Technology Solutions. Identify which cultural dimensions you feel were most important in influencing Cognizant's ultimate organizational structure.*

3. *Contrast the national cultural dimensions you discuss in Question 2 with the cultural dimensions evident in the organizational structure of TCS.*

4. *Find Internet resources that discuss the national culture dimensions as they relate to India. How are the cultural norms of India represented in both Cognizant and TCS? Remember to cite the Internet resources you use in your research.*

5. *Evaluate the organizational structures of Cognizant and TCS. Which do you feel is more applicable to Indian culture? Why?*

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.

Assignment Part II (Group)

Once all individual assignments have been submitted, you will share your resources and thoughts with your group to create a group summary that responds to the same five (5) questions, listed below.

1. *Explain Hofstede's five National cultural dimensions by integrating your individual responses. Cite the relevant Internet resources you used.*

2. *Apply these explanations to both Cognizant Technology Solutions. Identify which cultural dimensions your group considers most important in influencing Cognizant's ultimate organizational structure.*

3. *Contrast the national cultural dimensions you discuss in Question 2 with the cultural dimensions evident in the organizational structure of TCS.*

4. *Integrate the Internet resources you found about the national culture dimensions as they relate to India. Summarize how the cultural norms of India are represented in both Cognizant and TCS. Remember to cite the Internet resources you used.*

5. *Discuss your evaluations of the organizational structures of Cognizant and TCS. Explain which your group feels is more applicable to Indian culture? Why?*

To create your group assignment, share and discuss your responses and the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

After submitting your group assignment, please complete the post-assignment 1 survey. A link to the survey is available on Moodle.

E.8 IS_679_SPR14 Assignment 2 Instructions

Instructions – CASE STUDY

Overview

You will be using sources you find on the Internet to analyze an Information Systems case, develop an alternate solution, and integrate the information from your analysis with the topics covered in the course.

The assignment is a one week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Each student must create an individual analysis that will be part of the final submission.
2. All individual analyses must be combined into a coherent group analysis.

Your final submission must be submitted through the Moodle assignment forum. It should include each student's individual analysis (be sure to put your name at the beginning of your analysis) and a group analysis.

To store and share your resources,
you will now be using the system you DID NOT use in Assignment 1**:**
Teams 1, 3, 5, 7, and 9 use Pearltrees
Teams 2, 4, 6, and 8 use Moodle

The Internet resources you find for this assignment and your submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. If you agreed to participate in the research by completing the consent forms, you must also complete the following additional tasks:

1. Complete a brief online survey BEFORE beginning the assignment.
2. Complete a second brief online survey AFTER completing the activity.

The links to the surveys are available on Moodle.

For MISQ Case

You are responsible for finding a relevant case for your analysis. The case study should be from the Management Information Systems Quarterly journal (MIS Quarterly). To find a case:

1. Go to http://library.njit.edu/databases/subject.php#Business_and_Management
2. Click on Business and Management
3. Then select Business source premier; this takes you to EBSCO Host. You are looking for Case Studies in Management Information Systems Quarterly (MIS Quarterly)
4. Select Advanced Search

Assignment Individual

This assignment is broken into two parts. For your individual summary:

1. Work with your team members to find an interesting case study from MISQ (as shown on the previous page).
2. Read the case individually and look for additional Internet resources about it.
3. Work **individually** to write your own summary covering the 7 sections below.

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). Include the links to the URLs you used at the end of your individual summary in addition to a formal reference section. Storing your resources is part of this assignment.

NOTE: Your assignment MUST be submitted in Moodle regardless of your assigned system.

Questions 1 through 7 should be answered individually by each student in the group.

1. **Summary (5 pts) –** provide a summary of the case.

2. **Problems and Relevance (10 pts) –** identify the problem(s) and the relevance of the case to the IS field. Support your comments and arguments with the course material and Internet resources.

3. **Alternative Solution (10 pts) –** develop an alternative solution. (Think current and include current information about companies and technologies discussed in the case. Justify your answer. Save and cite the Internet resources and academic articles you use.)

4. **Course Integration (10 pts) –** Integrate course concepts with the technology. (**Very important**.) Show me that you are reading the text and articles and watching the videos. Show how the materials relate to the case. Use MISQ format to cite scholarly references and paste links to URLs you use (minimum of 5 relevant sources).

5. **Critical Analysis (10 pts)** - (See Bloom's taxonomy of the article based on course material and other articles and the Critical Thinking resource in Moodle.) Critically assess the case. Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources).

6. **Lessons Learned (10 pts) –** Thinking about your own point of view and the company's, support your comments and arguments with course materials.

7. **References (5 pts) –** Scholarly/academic papers in MISQ format; Internet resources copy and paste URL.

Assignment Part II

Once all individual analyses have been completed, you will share your resources and analyses with your group to create a group summary that responds to the questions listed below.

1. **Alternative Solution (10 pts) –** Based on the individual analyses of all group members, decide on a best alternative solution. (Justify your answer and save and cite the Internet resources and academic articles that apply to this solution.)

2. **Course Integration (10 pts) –** Examine the individual analyses of how this case integrates with the course material and create a coherent summary of how the course materials tie in with the case analysis. Cite at least 5 relevant sources using MISQ format for scholarly references and paste links to URLs you use.

3. **Critical Analysis (20 pts)** - (See Bloom's taxonomy of the article based on course material and other articles and the Critical Thinking resource in Moodle.) Critically assess the case. Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources).

To create your group assignment, share and discuss your individual analysis and the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment 2 Survey

Upon completion of the assignment, if you are willing to participate in the research portion of this assignment and you completed the pre-assignment survey, you must complete a brief **post-assignment survey** regarding your experience. The link is available on Moodle.

E.9 IS_677_FL14 Assignment 1 Instructions

Overview

You will be using sources you find on the Internet to complete this assignment. The assignment is a two week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Week 1 (Part I) requires an individual submission and stored Internet resources.
2. Week 2 (Part II) requires a group submission and shared Internet resources.

Your assignments must be submitted through the Moodle assignment forums.

To store and share your resources, you have been assigned to use one of two systems**:**
Teams in ODD numbered groups use Moodle
Teams in EVEN numbered groups use Pearltrees

The Internet resources you find for this assignment and your assignment submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. The research study includes three additional tasks:

1. Reading and signing the consent form (already completed).
2. Completing a brief online survey BEFORE beginning the activity.
3. Completing a second brief online survey AFTER completing the activity.

The links to the surveys are available on Moodle.

Assigment Part I (Individual)

This assignment is broken into two parts. During the first week of the assignment, you will work **individually** to write your own (individual) responses to the five questions listed below.

<u>NOTE: Your assignment should be submitted in Moodle regardless of which system you are assigned to use to store your resources.</u>

Remember to complete the pre-activity survey BEFORE beginning this assignment if you are participating in the extra credit research associated with this assignment.

In Chapter 3 of the textbook you read Case Study 3-2 about the introduction and initial failure of an IT system introduced into the FBI.

1. *Explain in your own words the four types of organizational structures (hierarchical, flat, matrix, and networked).*

2. *Use your definitions to identify which type of organizational structure best describes the FBI. Explain why you selected that organizational structure by comparing it to the culture of the FBI.*

3. *Using sources you find on the internet, identify at least one other company or organization that has that same organizational structure. Briefly describe the culture of that organization, comparing it to that of the FBI. Remember to provide the links to the Internet resources you used.*

4. *Describe the Information Systems strategy of the company you selected in Question 3. Does their system address any of the cultural issues that caused the FBI's first system to fail? Remember to save and cite your Internet resources.*

5. *Do you think the Information Systems Strategy of your selected company would work for the FBI? Explain why or why not, and be sure to save and cite your resources.*

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). When you complete your individual summary, include the links to the URLs you used at the end of the summary instead of a formal reference section.

Assignment Part II (Group)

Once all individual assignments have been submitted, you will share your resources and thoughts with your group to create a group summary that responds to the same five (5) questions, listed below.

1. *Explain in your own words the four types of organizational structures (hierarchical, flat, matrix, and networked).*

2. *Use your definitions to identify which type of organizational structure best describes the FBI. Explain why you selected that organizational structure by comparing it to the culture of the FBI.*

3. *Using sources you find on the internet, identify at least one other company or organization that has that same organizational structure. Briefly describe the culture of that organization, comparing it to that of the FBI. Remember to provide the links to the Internet resources you used.*

4. *Describe the Information Systems strategy of the company you selected in Question 3. Does their system address any of the cultural issues that caused the FBI's first system to fail? Remember to save and cite your Internet resources.*

5. *Do you think the Information Systems Strategy of your selected company would work for the FBI? Explain why or why not, and be sure to save and cite your resources.*

To create your group assignment, share and discuss your most relevant resources with your group using your assigned system: Moodle or Pearltrees.

After submitting your group assignment, please complete the post-assignment 1 survey. A link to the survey is available on Moodle.

E.10 IS_677_FL14 Assignment 2 Instructions

Instructions – CASE STUDY

Overview

You will be using sources you find on the Internet to analyze an Information Systems case, develop an alternate solution, and integrate the information from your analysis with the topics covered in the course.

The assignment is a one week graded assignment that is a required activity for this course. For each part of the assignment, you must:

1. Create an assignment submission to be submitted through Moodle
2. Store all Internet resources you use in your assigned system (Moodle or Pearltrees).

The assignment is broken into two parts:

1. Each student must create an individual analysis that will be part of the final submission.
2. All individual analyses must be combined into a coherent group analysis.

Your final submission must be submitted through the Moodle assignment forum. It should include each student's individual analysis (be sure to put your name at the beginning of your analysis) and a group analysis.

To store and share your resources,
you will now be using the system you DID NOT use in Assignment 1**:**
Teams in ODD numbered groups use Pearltrees
Teams in EVEN numbered groups use Moodle

The Internet resources you find for this assignment and your submissions will be captured as part of a research project approved by the NJIT Institutional Review Board.

Research Surveys

This activity is a graded assignment that is required as part of your coursework. However, you have also been asked to participate in a research study as part of this assignment. If you agreed to participate in the research by completing the consent forms, you must also complete the following additional tasks:

1. Complete a brief survey online BEFORE beginning the assignment
2. Complete a second brief online survey AFTER completing the activity.

The links to the surveys are available on Moodle.

Assignment Individual

This assignment is broken into two parts. For your individual summary:

1. Read the Facebook Emotion Manipulation study individually and find additional Internet resources about it.
2. Work **individually** to write your own summary responding to the 7 questions below.

Saving Internet Resources

When you find a helpful Internet resource, save it **in your assigned system** (Moodle or Pearltrees). Include the links to the URLs you used at the end of your individual summary in addition to a formal reference section. Storing your resources is part of this assignment.

<u>NOTE: Your assignment MUST be submitted in Moodle regardless of your assigned system.</u>

Questions 1 through 7 should be answered individually by each student in the group.

1. **Summary (5 pts) –** provide a summary of the study.

2. **Problems and Relevance (10 pts) –** Why did this study get so much attention? How does this relate to the IS field? Justify your answer by saving and citing Internet resources supporting your answer.

3. **Alternative Solution (10 pts) –** What could Facebook have done differently? Would these actions have affected the research outcomes? (Justify your answer. Save and cite the Internet resources and academic articles you use.)

4. **Course Integration (10 pts) –** Integrate course concepts with the technology. (**Very important**.) Think about ethics and the control of information and PAPA discussed in Chapter 9. Which of the PAPA areas are affected by the study? Use MISQ format to cite scholarly references and paste links to URLs you use (minimum of 5 relevant sources).

5. **Critical Analysis (10 pts) –** Do you feel Facebook's actions were ethical or unethical? Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources). Be sure to explain your point of view.

6. **Lessons Learned (10 pts) –** Compare and contrast your own point of view with the company's; support your comments and arguments with course materials and Internet resources.

7. **References (5 pts) –** Scholarly/academic papers in MISQ format; Internet resources copy and paste URL.

Assignment Part II

Once all individual analyses have been completed, you will share your resources and analyses with your group to create a group summary that responds to the questions listed below.

1. **Alternative Solutions (10 pts) –** Based on the individual analyses of all group members, decide on a best alternative solution. (Justify your answer and save and cite the Internet resources and academic articles that apply to this solution.)

2. **Course Integration (10 pts) –** Examine the individual analyses of how this case integrates with the course material and create a coherent summary of how the course materials tie in with the case analysis. Cite at least 5 relevant sources using MISQ format for scholarly references and paste links to URLs you use.

3. **Critical Analysis (20 pts) –** Based on your individual analyses, determine if Facebook's actions were or were not ethical in allowing users' emotions to be manipulated. Which course materials (and other materials) justify your point of view (please save and cite a minimum of 5 relevant sources).

To create your group assignment, share and discuss your individual analysis and the resources you feel were most relevant in your individual submission with your group using your assigned system: Moodle or Pearltrees.

Post-Assignment 2 Survey

Upon completion of the assignment, if you are willing to participate in the research portion of this assignment and you completed the pre-assignment 2 survey, please complete a brief **post-assignment survey** regarding your experience. A link to the survey is available on Moodle.

APPENDIX F

RESEARCH SURVEYS

F.1 Pre-Assignment Survey

The questions included in the pre-assignment survey are shown below.

Table F.1 Pre-Assignment Survey

1	Name (first and last):
2	UCID:
3	Course name or number:
4	Instructor:
5	Group name or number:
	Please tell us a little about yourself.
6	Gender (M/F)
7	Level of Study (Undergraduate/Graduate student)
8	Degree program: (Computer Science/Information Systems/MBA/Other)
9	Is English your first language? (Yes/No)
10	Have you ever shared education-related resources from the Internet with friends or classmates? (Yes/No)
	If Yes
11	How did you share the resources? (Please check all that apply.)
	Face to face/discussed E-mail Text message Facebook Twitter Moodle Dropbox Other (please specify)

12	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	I'm certain I can understand the ideas taught in this assignment.
	Compared with other students in this class, I expect to do well on this assignment.
	I have used the Pearltrees digital curation system to manage knowledge resources.
	I am sure that I can do an excellent job on the problems and tasks in this assignment.
	I think I will be able to use what I learn in this assignment throughout the course.
13	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Compared with other students in this class, I think I know a great deal about the topic of this assignment.
	I like the subject matter of this assignment.
	I expect to do very well on this assignment.
	I enjoy challenging and difficult tasks where I'll learn new skills.
	I think the material in this assignment is useful for me to learn.
14	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	I know that I will be able to learn the material for this assignment.
	Compared with others in this class, I think I'm a good student.
	I am willing to work on a challenging assignment that I can learn from.
	For me, developing my knowledge is important enough to take risks.
	I am very interested in the content area of this assignment.

15	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	I prefer to work in situations that require a high level of ability and talent.
	I often look for opportunities to develop new skills and knowledge.
	I am already very knowledgeable about the topic of this assignment.
	I have used Moodle to submit assignments or download course materials in the past.
	It is important for me to learn the material in this assignment.
16	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	I have a working knowledge of the topic of this assignment.
	Understanding the subject matter of this assignment is very important to me.
	I think I will receive a good grade for this assignment.
	I am familiar with the Pearltrees digital curation system.
	I have used Moodle for online discussions in this or in other courses.
	My study skills are excellent compared with others in this class.

F.2 Post-Assignment Survey

The questions included in the post-assignment survey are shown below.

Table F.2 Post-Assignment Survey

1	Name (first and last):
2	UCID:
3	Course name or number:
4	Instructor:
5	Group name or number:
6	Assigned system: (Moodle/Pearltrees)
	For students who used Pearltrees
7	Did you watch the Pearltrees tutorial video provided in Moodle?
8	Did you install the Pearltrees "pearler" browser add-on?
9	Please rate your level of agreement with the following statements about using Pearltrees for this assignment. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Using Pearltrees takes too much time from my other learning activities.
	I think that using Pearltrees fits well with the way I like to manage my learning resources.
	Using Pearltrees involves too much time storing and managing my Internet resources.
	It takes too long to learn how to use Pearltrees to make it worth the effort.
10	Please rate your level of agreement with the following statements about using Pearltrees for this assignment. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Using Pearltrees is compatible with all aspects of my learning.

	Working with Pearltrees is so complicated, it is difficult to understand what is going on.
	Using Pearltrees fits into my learning style.
	Using Pearltrees in addition to Moodle requires too much extra effort.
11	Please rate your level of agreement with the following statements in relation to the assignment you did as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The students seldom asked each other questions during the group part of this assignment.
	The quality of this assignment compared favorably with other activities in the course.
	Group members could obtain abundant content and knowledge from the shared information.
	The knowledge shared by members of my group was complete.
	I developed a good understanding of the basic concepts during this assignment.
	The system made it easy for me to discuss questions with other students.
12	Please rate your level of agreement with the following statements in relation to the assignment you did as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The operation of the system was stable.
	The system was difficult to use.
	I am satisfied with the selection of dining options available on the NJIT campus.
	The system made it hard for me to access the shared content from the group.
	I learned to see relationships between ideas during this assignment.
	The system made it hard for me to find the content I needed.
13	Please rate your level of agreement with the following statements in relation to the assignment you did as part of this research.

	(Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Group members provided meaningful comments to the shared information.
	The knowledge shared by members of my group was reliable.
	There was little interaction between students.
	The content provided through the system was hard to understand.
	The system made it hard for me to share what I learned with my group members.
	I feel the assignment resulted in high quality interactions.
14	Please rate your level of agreement with the following statements in relation to the assignment you did as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The assignment served my needs well.
	The knowledge shared by members of my group was accurate.
	My assigned system was user-friendly.
	I developed an improved ability to integrate facts through this assignment.
	The knowledge shared by members of my group was understandable.
	I was able to identify central issues about this topic.
15	Please rate your level of agreement with the following statements in relation to the assignment you did as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Students in my group seldom answered each other’s questions.
	This assignment improved my ability to communicate clearly.
	New content and knowledge was shared or posted frequently by my group.
	During this assignment, students seldom stated their opinions to each other.
	I am satisfied with this assignment.
	I am satisfied with the parking availability on campus.

	The system made it easy for me to discuss questions with others.
	I made new connections with other students during this assignment.

F.3 Repeated Measures Pre-Assignment 2 Survey

In courses included in the repeated measures study (IS_677_SPR14, IS_679_SPR14, and IS_677_FL14), students completed a second pre-assignment survey prior to beginning the second research assignment, and a second post-assignment survey after completing the second research assignment. Although similar, these surveys were different than the first pre- and post-assignment surveys and are therefore shown separately in this appendix.

Table F.3 Pre-Assignment 2 Survey

1	First Name:
2	Last Name:
3	UCID:
4	Course name or number:
5	Instructor:
6	Group name or number:
7	Please rate your level of agreement with the following statements in relation to the assignment you will be doing as part of this research. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	I have used the Pearltrees digital curation system to manage knowledge resources.
	I think I will be able to use what I learn in this assignment throughout the course.
	I like the subject matter of this assignment.
	I think the material in this assignment is useful for me to learn.
	I am very interested in the content area of this assignment.

	I am already very knowledgeable about this topic.
8	I have used Moodle to submit assignments or download course materials.
	It is important for me to learn the material in this assignment.
	I have a working knowledge of the topic of this assignment.
	Understanding the subject matter of this assignment is very important to me.
	I am familiar with the Pearltrees digital curation system.
	I have used Moodle in other courses for online discussions.

F.4 Repeated Measures Post-Assignment 2 Survey

In courses included in the repeated measures study (IS_677_SPR14, IS_679_SPR14, and IS_677_FL14), the second post-assignment survey included three additional Likert-type scale questions about whether students felt they learned more, less, or about the same, whether their group members worked more, less, or about the same, and whether they liked the second system they used more, less, or about the same. Five open-ended questions captured students' perceptions of what they liked most and least about each system used and which system they thought was better for this type of assignment. The post-assignment 2 survey questions are listed in Table F.4 below.

Table F.4 Post-Assignment 2 Survey

1	First Name:
2	Last Name:
3	UCID:
4	Group name or number:
5	Assignment system (Moodle/Pearltrees)
	For students who used Pearltrees for the second assignment:
6	Did you watch the Pearltrees tutorial video provided in Moodle?
7	Did you install the Pearltrees "pearler" browser add-on?
8	Please rate your level of agreement with the following statements about using Pearltrees for this assignment. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Using Pearltrees takes too much time from my other learning activities.
	I think that using Pearltrees fits well with the way I like to manage my

	learning resources.
	Using Pearltrees involves too much time storing and managing my Internet resources.
	It takes too long to learn how to use Pearltrees to make it worth the effort.
9	Please rate your level of agreement with the following statements about using Pearltrees for this assignment. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Using Pearltrees is compatible with all aspects of my learning.
	Working with Pearltrees is so complicated, it is difficult to understand what is going on.
	Using Pearltrees fits into my learning style.
	Using Pearltrees in addition to Moodle requires too much extra effort.
10	Please rate your level of agreement with the following statements about using your assigned system for Assignment 2. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The students seldom asked each othe rquestions during the group part of this assignment.
	The quality of this assignment compared favorably with other activities in this course.
	Group members could obtain abundant content and knowledge from the shared information.
	The knowledge shared by members of my group was complete.
	I developed a good understanding of the basic concepts during this assignment.
	The system made it easy for me to discuss questions with other students.
11	Please rate your level of agreement with the following statements about using your assigned system for Assignment 2. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The operation of the system was stable.

	The system was difficult to use.
	I am satisfied with the selection of dining options available on the NJIT campus.
	The system made it hard for me to access the shared content from the group.
	I learned to see relationships between ideas during this assignment.
	The system made it hard for me to find the content I needed.
12	Please rate your level of agreement with the following statements about using your assigned system for Assignment 2. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Group members provided meaningful comments to the shared inforamtion.
	The knowledge shared by members of my group was reliable.
	There was little interaction between students.
	The content provided through the system was hard to understand.
	The system made it hard for me to share what I learned with my group members.
	I feel this assignment resulted in high quality interactions.
13	Please rate your level of agreement with the following statements about using your assigned system for Assignment 2. (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	The assignment served my needs well.
	The knowledge shared by members of my group was accurate.
	My assigned system was user-friendly.
	I developed an improved ability to integrate facts through this assignment.
	The knowledge shared by members of my group was understandable.
	I was able to identify central issues about this topic.
14	Please rate your level of agreement with the following statements about using your assigned system for Assignment 2.

	(Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
	Students in my group seldom answered each other's questions.
	This assignment improved my ability to communicate clearly.
	New content and knowledge was shared or posted frequently by my group.
	During this assignment, students seldom stated their opinions to each other.
	I am satisfied with this assignment.
	I am satisfied with the parking availability on campus.
	The system made it easy for me to discuss questions with others.
	I made new connections with other students during this assignment.
15	This was the second assignment of this type which you completed for this class. Compare your experience this time to the first time you did this type of assignment and respond to the following statements: (A great deal less/Slightly less/About the same/Slightly more/A great deal more)
	During the second assignment, I learned…
	I liked this second system …
	During the second assignment, my group members worked…
16	What did you like best about using Moodle for this type of assignment?
17	What did you like least about using Moodle for this type of assignment?
18	What did you like best about using Pearltrees for this assignment?
19	What did you like least about using Pearltrees for this assignment?
20	Which system do you feel had better tools for completing this type of assignment? Please explain what about this sytem makes it better suited for this type of assignment.

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