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Games for Learning: Which Template Generates Social Construction of Knowledge

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DISSERTATION

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DEDICATION

My dissertation is dedicated to my brother Marcos Ryan Garcia. He passed away January 25th, 2010, at the age of 24, during the second semester of my doctoral program. Nearly six years later, I completed my journey. He has been with me every step of the way. He was a playful & gentle soul who loved using games to interact with others. Nintendos and PlayStations, Monopoly, gin rummy, blackjack, GuitarHero – he knew how to bring us together.

Creating Knowledge Through Games: Which Template Generates Social Construction of Knowledge?

by

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Abstract

The purpose of this study was to discover how three person teams use game templates (trivia, role-play, or scavenger hunt) to socially construct knowledge. The researcher designed an experimental Internet-based database to facilitate teams creating each game. Teams consisted of teachers, students, hobbyist, and business owners who shared similar interests and goals of creating knowledge to share with others.

Four main questions guided the research. The first question and its sub questions seek a quantifiable measure of how social construction of knowledge occurs during the game creation process. The Interaction Analysis Model (IAM) (Gunawardena et al., 1997) was used to measure the lower and higher levels of knowledge created by each team. The first question asked which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) with sub-questions that studied the lower and higher SCK phases of the IAM. Questions two and three captured qualitative aspects of the participants' experience creating knowledge games. Question four adds additional quantifiable analysis based on system usage data.

The study deployed a quasi-experimental mixed methods research method. The broad framework of this study – communities of practice, knowledge creation and measurement, and experimental constructivist learning – called for quantitative and

qualitative data to understand how SCK occurs online through games. The researcher was at the center of data collection by recruiting participants, designing the system, and collecting research data.

Data collection lasted for a span of nine months. Demographic surveys, coding and ANOVA testing of computer messages for SCK using the IAM Model, a thematic review and content analysis of interviews, observations, analysis of game completion surveys, and a report of system usage data encompass the data analysis for this study.

All templates generated SCK according to the IAM Model′s definition of social construction of knowledge even though there was no statistical significance in terms of which game template was superior in generating SCK coding. Teams initially struggled with the format of the system and messaging system, but gained familiarity by the second and third games.

The majority of the games created in this study were rated by the researcher as containing relevant and well written content. The researcher found that familiarity of teammates with one another, complexity of the system, collaboration, contributions, and communication tendencies within each template, and limitations of the technology as factors that influence how SCK occurs.

All three game templates generated SCK as supported by findings from mixed methods research. Participants preferred to construct knowledge using the trivia template because of its ease-of-use and straight-forwardness. Role-play offered engaging complexity; even though it was short and simple, discussion and disagreements were needed to construct the activity. Scavenger hunt was found to be an intriguing template for teams to create in-depth activities and share with others, despite taking the most amount of time and writing to complete. Overall, participants expressed optimism for using the system to create knowledge games in order to share with others.

Future researchers must employ mixed-methods research when studying custom-built SCK systems. Other suggestions include recruiting larger pools of participants, diversifying the types of teams in the study, providing better incentives, allowing flexible team sizes, and incorporating suggested improvements of the system's design and message board.

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Chapter 1

Introduction

Younger generations live in a globalized and interconnected world where information and entertainment reign supreme. The turn of the century ushered in a new digital era where Internet accessible phones, televisions, tablet devices, and video game consoles allow people to interact and play almost any type of game with family, friends, or complete strangers. Nearly a decade and a half into the new century, children and grandchildren are teaching older generations how to play video games and use computers. Despite the bad publicity that video games often receive, there are many promising benefits being explored by researchers today. Osterweil (2006) of the MIT learning arcade states, "critical thinking, problem solving, trial and error experimentation, and collaboration are all observable in the play of many games." (p. 15). Modern educational systems are considering video game methodologies applied in the classroom as promising avenues for achieving multiple levels of student performance.

The military, schools, and businesses are constantly searching for new ways to make learning and training stimulating and entertaining for learners. These types of organizations look towards game-based learning as a viable option for engaging and connecting learners. Evidence of this change is apparent through Prensky’s (2001) and Gee’s (2003) descriptions of a changing workforce of younger workers who are more familiar with and accustomed to technology. The ability to harness the power of technology in order to create a fun and engaging online learning environment offers enticing possibilities for instructional designers. According to the authors of the New Media Consortium’s Horizon Report, “gamification” or “the notion that game mechanics can be applied to all manner of productive activities" is already impacting organizations through social media and mobile applications (Johnson et al. 2013, pp. 20-21).

Another predicament organizations must face involves replacing a large retiring workforce. Companies need to capture the valuable work-related knowledge and expertise of baby-boomers before they retire. The United States' largest employer, the Federal government, is an example of an employer considering how to make this transition. According to Greenfield's (2006) workforce estimates based on census data, 45.3 percent of the workforce was between 40-61 years of age. In terms of public sector jobs, the Federal government employed 64.1 percent of workers in this age group, state government employed 54.3 percent, and local government employed 57.2 percent (Greenfield, 2006, para. 2). These numbers indicate that the government employs approximately half of the population. Organizations, like the government, must strive to effectively connect generations of workers in order to ensure that a transfer of knowledge takes place.

Methods for training and sharing knowledge have changed with the new digital age. Pelgrum (1999) first noted that for many countries, educational technology plays a major role in the instructional shift towards constructivist methodologies. Rote learning or memorizing tidbits of information from specific subject areas was the accepted method of teaching and learning prior to 21st century. Present day, teachers guide learners by providing educational scaffolds across multiple disciplines as they explore and discuss authentic and complex problems. Bransford, Brown, and Cocking (2000) affirm that learning is changing from rote memorization of facts and procedures towards a process of knowledge creation. Modern day learners yearn for more than a teacher-centered structure that offers merely a textbook and chalkboard.

Prensky (2001) acknowledges a constructivist approach to learning with games. He argues that “stuff to be learned – information, concepts, relationships, and so on, cannot just be ‘told’ to these people. It must be learned by [original emphasis] them, through questions, discovery, construction, interaction and above all, fun.” (p. 17). Papert (2002) refers to this as “hard fun” and reflects that since everyone likes “hard challenging things to do”, these things must be matched carefully to the individual and “the culture of the times.” (para. 3). With this in mind, great expectation and pressure are placed on designers’ to develop systems that can provide this type of learning opportunity. It is unlikely that any one person can create a game for learning without the help of others. However, with technology and the Internet, anything is possible. Games could be a scaffold for teams of people to interact and create knowledge. This study will explore that concept.

1.1 Research Background

Despite the mixed success rate of custom-built software being used for supporting information and business practices (Devadoss & Pan, 2007), the significance of this study is to demonstrate how organizations can effectively record, preserve, share, and transfer knowledge using games as a platform. The amount of investment organizations make towards technology warrants further investigation of how to best leverage and profit from these tools.

Modern learning theories rely upon meaningful experiences and group interactions to transfer knowledge to an individual. Vygotsky and Cole (1978), as well as

Kolb (1984), consider that knowledge is best constructed using a first-hand experience involving the people and world around an individual. Small group interactions provide low risk and meaningful learning activities for exploring and refining new knowledge. Constructionism is difficult to define succinctly, yet Papert and Harel (1991) write, “the simplest definition…evokes the idea of learning-by-making” (p. 6). By providing the learner an opportunity to experiment and interact with peers and the environment, social negotiation of meaning flourishes.

Due to the complexity of our society, knowledge does not remain stagnant and changes over time. Modern culture calls for individuals to remain lifelong learners as personal and business opportunities occur. Piaget (1952) imagined an individual’s knowledge as constantly shifting and forming new mental structures, or schemes, through a process of constant assimilation and accommodation. For most organizations, knowledge is a valuable commodity for both current and future community members to access and learn. Organizations must find a way to connect past, present, and future employees to all knowledge generated at work.

However, not all work-related knowledge is easily put into words. Innovative and forward thinking companies must attempt to capture tacit knowledge and make it explicit for other members. Tacit knowledge is considered unique, personalized knowledge that is not easily explained to others (Salisbury, 2009; Von Krogh, Ichijo, & Nonaka, 2000). Tacit knowledge, for example, could be the complex aspects of administering autism tests to preschoolers; all the way to physically complex tasks such as cutting down and removing an overgrown tree from a private residence. Tacit knowledge is constantly generated as learning objectives or business challenges change. New tacit knowledge is constructed when groups meet and exchange knowledge. Tacit knowledge is more important than factual or procedural knowledge for a pioneering organization.

Modern technology facilitates the spiraling exchange of knowledge within an organization that is innovative and progressive. Innovative organizations support knowledge sharing in order to create new tacit knowledge after the learner uses previously recorded knowledge. Tacit knowledge that becomes explicit is shared back into the community, applied and expanded in practice, and transformed into new tacit form – thus creating a cycle (Salisbury, 2009, p. 55-56). The "tacit-explicit-tacit" knowledge cycle (Salisbury, 2009, p. 55) is critical for an organization to remain innovative. When knowledge is shared and put into practice, new adaptions are discovered and new tacit understandings are formed. Organizations are on the hunt for technologies and methodologies that enable this type of environment.

Constructivist philosophies are at the heart of modern online learning systems. Exploration of what these systems can achieve is typical. Additionally, technology never ceases to amaze us with new innovations from year to year. Reiber (1996) stresses that the interconnectedness of theory, research, and practice within instructional technology are dynamic and interconnected - not casual. The need for experimentation is essential in order to reconcile theory into practice. One radical idea is *play*. The concept of play offers instructional designers an avenue to explore and test environments for learning.

The use of play by humankind travels back into ancient times. Gray (2009) asserts that play provides foundations for governance, religion, approaches to productive work, and a approach for education – especially in hunter gatherer societies. Play offers people a chance to confront difficult situations that are not easily solved. Play can be thought of as activity that is (1) self-chosen and self-directed; (2) intrinsically motivated; (3) structured by mental rules; (4) imaginative; and (5) produced in an active, alert, but non-stressed frame of mind (Gray, 2009). Constructivist learning activities, such as play, can allow people to generate and construct knowledge if intentional and structured support is put in place.

1.2 Theoretical Framework

Communities of practice create and share knowledge among members. A learner needs to create and validate knowledge with peers to be considered a part of a knowledge sharing community. Technology allows for the creation of special knowledge systems for recording and sharing information. These systems not only store information for future members, but also allow current members to access and use important organizational knowledge for work or trade.

Modern learners thrive in experimental and constructivist learning activities, something a learning game can provide while at the same time enabling organizational knowledge creation and sharing. This line of reasoning situates this study to help organizations explore if members can create and record knowledge in the form of games.

1.2.1 Communities of practice. Custom-built knowledge repository systems are easy to create and access using modern electronic devices. People with common interests can stay connected through the Internet in ways never before experienced by humankind. Humans still play games today - just as they have for centuries in order to share culture and experience community. If possible, an online database system may allow for groups to create knowledge games to share with others. By counting how often knowledge is socially constructed in such a system, it may be possible to understand how games can preserve knowledge for an organization. Despite technology's limitations, as Taylor (2000) said, technology is "certainly a useful tool that enables us to link various learning communities together in new and different ways" (p. 4).

Core community members lead knowledge creation and sharing efforts. Members maintain expectations for learning within the community as well as identify new members in need of mentorship. Lave and Wagner (1991) describe a community of practice (CoP) as groups of learners who share learner-oriented collaborative projects connected to situational cognitive experiences. In a CoP, current members mentor new recruits as the community expands its knowledge and actively collaborates on current projects. A CoP believes that by sharing knowledge within a professional community, members increase the knowledge power of the entire community. A CoP can leverage the power of modern technology to expand their reach and influence as an embodied representation of organizational knowledge to be shared with others.

A CoP has the ability to connect practitioners who do not have a forum to interact and share ideas. Thanks to modern technology, a CoP can be formed virtually with little to no cost. Nagy et al. (2006) identified four strengths of virtual CoPs: a high degree of collegiality, generous sharing of time and resources, interactive and progressive problem solving, and breakdown of geographical and hierarchical barriers. A virtual CoP fosters a sense of community and incentivizes members to solve complex problems together in order to share solutions. Members can erase geographic distance between each other and remove hierarchical chains of command to provide access to leaders who may not have the time to meet face-to-face.

In order to understand how communities share knowledge, Kim, Hong and Suh (2012) identified four distinct types of CoPs: the active community, spreading community, learning community, and inactive community (p. 13099). An active community contains a high ratio of knowledge propagation and receiving within the core group. The spreading community has high propagation of knowledge sharing, but low levels of knowledge receiving by the core group. A learning community contains members who are active in knowledge receiving activities, but are low in knowledge propagation. The inactive community has neither knowledge propagation nor receiving (Kim, Hong, & Suh, 2012, p. 13099). The identification of a CoP's knowledge sharing tendencies assists designers and organizational leaders to understand the degree to which the CoP will work together.

Within the communities, four types of members can be distinguished: the balanced player, egoistic propagator, egoistic receiver, and knowledge isolator (Kim, Hong, & Suh, 2012, p. 13098). The balanced member propagates knowledge as well as receives it. The egoistic propagator disseminates knowledge to other members but does not receive knowledge from others. The egoistic receiver mainly receives knowledge from other members but does not share it with others. Finally, the knowledge isolator neither propagates nor receives knowledge (Kim, Hong, & Suh, 2012, p. 13099). In order to design collaborative knowledge sharing systems, designers must anticipate how each different type of CoP and its members will perform within a virtual knowledge-sharing CoP.

1.2.2 Knowledge creation and measurement. Knowledge sharing requires group interactions for sharing, critiquing, and modifying written ideas about various subject matters. Knowledge creation is a slightly more difficult process. Von Krogh, Ichijo, and Nonaka (2000) describe five critical knowledge creation steps: (1) sharing tacit knowledge, (2) creating concepts, (3) justifying concepts, (4) building a prototype, and (5) cross-leveling knowledge. The tacit knowledge needs to be recorded, critiqued, published, and shared with members of the community. A new knowledge artifact represents previously unwritten information that is constructed and ready for sharing with the community. Sharing information, such as knowledge artifacts, expands the expertise of all group members and provides a system for discovering new knowledge.

Knowledge construction typically occurs through group discourse facilitated by socio-cultural processes. As Merrill (1991) points out, people's lives are intertwined in various communities; and there are certain individuals who are naturally looked towards for advice helping with life's challenges. Modern technologies enable today's adult learners to access a virtual world of audio, video, and writing communications to interact with everyone - from a close confidant to a complete stranger. According to Gunawardena, Lowe, and Anderson (1997), learning is a social phenomenon where learners collaboratively construct knowledge through exchanges of information sharing, negotiation of meaning, and modification. Through this interaction and knowledge exchange, individuals share and create knowledge. Today's computers often log a transcript of communication that can be used to record the knowledge construction process.

The Interaction Analysis Model (IAM) (Gunawardena, Lowe, & Anderson, 1997) provides a model for examining social construction of knowledge in computer conferencing environments using a five phase coding scheme. This model describes five successive phases of knowledge construction: (i) sharing, comparing, contributing of information; (ii) discovery and explanation of dissonance or inconsistency among ideas, concepts, or statements; (iii) negotiation of meaning or knowledge co-construction; (iv) testing and modification of a proposed synthesis; and (v) statements of agreement and applications of newly constructed knowledge (Gunawardena, Lowe, & Anderson, 1997, p. 414). By reviewing a transcript of group messages, one can determine how much and to what degree knowledge construction took place.

Marra, Moore, and Klimczak (2004) argue that Gunawardena's model provides "a more holistic view of discussion flow and knowledge construction" (p. 39) as compared to other content analysis approaches, such as Newman et al.'s (1995) technique, to measure critical thinking during group learning. Gunawardena's et al. (1997) IAM model was adopted in other studies (e.g., Marra et al. 2004; Schellens & Valcke 2005; Schellens et al. 2005; De Wever, Schellens, Valcke, & Van Keer, 2006) as one of the predominant methods for determining SCK occurring online. This coding scheme comes from a social constructivist theoretical perspective.

1.2.3 Experimental constructivist learning. Educators have a myriad of educational philosophers and theorists to look towards when designing learning systems. Modern learning systems attempt to enhance student learning through the adaptation of classic learning theories. For example, Bruner (1961) is credited for discovery learning that is an inquiry-based instructional method for learners to make discoveries, uncover facts, and build mental models. Online students often complete open-ended assignments and access a nearly infinite pool of Internet resources thanks to modern technology.

Students can build authentic mental structures faster and easier when compared to traditional approaches for instruction.

Classic works from Piaget (1952) and Vygotsky (1978) maintain that knowledge must be experienced and gathered from a learner's peers and surrounding world. Vygotsky's (1978) social development theory that argues social interaction is required for the development of a learner's cognition. Nowadays, learners take center stage as educational systems shift from a teacher-centered to a student-centered learning philosophy. Notions of constructionism (Papert and Harel, 1991) come to fruition through technology's ability to create virtual learning environments for exploration and experimentation. Both the learner and the teacher are encouraged to take risks for the sake of learning from new experiences within the constructivist philosophy. The constructivist approach has long been accepted as an effective approach for distance learning (Jonassen, Davidson, Collins, Campbell, & Haag, 1995).

Educators use technology as a platform to reach individual students with mixed success. Discussion boards, wiki pages, and social networks are commonly used today to facilitate peer to peer or peer to mentor relationships. Kolb's (1984) description of experiential learning influences modern learning design by offering experiences to support a learner's observation and reflection, create new action, and form the foundation for new concrete experiences. Online learning designers incorporate numerous tools that provide unique individualized learning experiences and offer group communication capabilities. Cutting-edge learning technology promises great reward but is usually untested and too expensive to incorporate into all classrooms.

In an online setting, Conole, Dyke, Oliver, and Seale (2004) describe popular e-learning pedagogies as being didactic and behaviorist. Despite the difference, online instruction methods are continuing to change along with the traditional classroom. Today's instructional designers use a combination of group interactions and personal learning tasks to deliver instruction. Although collaborative technologies enhance communication and provide access to important documents, it is not clear how knowledge sharing and learning takes shape in these settings.

Researchers believe that learning can occur in virtual environments using situational learning and embodied perspectives (Barab et al., 2007; Gee, 2008). Games can be considered a way to record and share knowledge across a virtual environment according to certain needs and conditions of learners. Innovative game technologies and concepts help achieve this type of environment. Barab et al. (2007) describes the "situative embodiment" present in games that helps learners "establish a narrative, perceptual, and social world" to help explore underlying frameworks of knowledge. Games can be considered mechanisms to generate social knowledge that is reflective of the current nature of the world surrounding a group of learners.

Games provide entertaining learning scenarios that put the learner in the control of the action. Jensen (2002) notes that gaming adopts an entirely different principle for instruction in that the learner is no longer subjected to "display and exposition" forms of teaching, but rather encouraged to participate in "interactivity" presented in a learning experience (p. 5). Borrowing concepts from entertainment games, players (the learners) learn from exploring a world and negotiating experiences within it. Learners can make mistakes without penalty and progress through each learning objective, all while the game adapts to the player. Learning occurs naturally, individually or socially, when experiencing an event that is engaging.

1.3 Research Questions

Despite the fact that nearly 60% of enterprise information systems are not successful (Devadoss & Pan, 2007), knowledge management systems, discussion boards, and databases are considered important tools by organizations to capture knowledge. When carefully assembled and strategically implemented, technology provides opportunities for all types of organizations to connect employees and preserve information.

Through careful consideration of learning design, social construction of knowledge theory, and game-based learning ideas, it is unclear how technology and games can be used to create and record knowledge. This line of reasoning presents the following research questions:

(1) Which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) as participants use each template to create a knowledge game?

  a. Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?
  b. Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?
  c. Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application).

d. Which game template shows the progression of knowledge creation from Phase I to V?

(2) What factors influence SCK as participants engage in constructing games?

(3) What are participants' perceptions of their ability to construct the games?

(4) What do system usage data show about a team's knowledge construction patterns (time spent on task, system navigation trends, amounts of words used, and game items created)?

The first main question and its four sub-questions provide the quantitative analysis for this study. The last three questions provide a qualitative understanding of the factors influencing the knowledge construction process.

1.4 Study Method

The purpose of this study is to explore how teams of people can socially construct knowledge online as they build a game. In this quasi-experimental mixed methods research study, teams of three people will create knowledge games for their respective organizations. The researcher will not randomly assign participants to knowledge creation teams; rather the teams will be self-forming. Teams will create a trivia game, role-play activity, and a scavenger hunt. The sequence of games to build will be randomly assigned to each team. A website made accessible via computer, tablet, or smartphone devices will coordinate interaction among the participants. Data collection will involve observations, interviews, game completion surveys, and analysis of coded computer messages. Supporting information will also be provided by system usage data.

1.5 Limitations

The intent of this research study is not to design the ideal knowledge creation system, but to explore which game generates greater amounts of socially constructed knowledge. The study deploys a customized online database that may be difficult for organizations to replicate. Also, since the knowledge will exist in game form, the games may not be appropriate for formal organizational adoption. Since teams will generate knowledge according to their own literacy skills and depths of understanding, it may prove appropriate for organizations to edit the game for formal organizational adoption.

Another limitation for the study will be that teams will be self-forming and the researcher will have no influence in the formation of each team. The researcher will help individuals understand the purpose of the study and advise how to pick appropriate knowledge creation topics, but will not actively recruit in the behalf of a single interested participant. The two main requirements for teams, that members be knowledgeable within their respective fields and that teams consist of three people, will be the only guidelines for recruiting participants.

The games created by the teams will not be studied during the actual playing of by other people. This study will not provide a formal proofreading or writing review of the teams' games. The games will be accepted as is without any editorial corrections. Knowledge will exist in text form supported by pictures, audio, and/or video as conceptualized and written by each team.

1.6 Delimitations

Delimitations of this study include the standards for recruiting and forming teams, the research setting, and the types of knowledge generated from the study. Adult learners, people considered 18 years or older, will be the target of the study's recruiting efforts.

Three person teams will be required for participation. Participant teams will consist of individuals who are familiar with one another through work or similar interests. Adults 18 years or older not affiliated with a public K through 20 as a student will be allowed to participate.

The researcher will help participants form teams based upon sensible and realistic expectations for participation. If a team loses a member after creating the first game, the team will not be allowed to replace the member who left but will still be included in the analysis for this study. Once a team is formed and the participants have no more initial questions about the study, research protocol forms and disclaimers will be gathered and teams will gain access to the knowledge game center.

The study will be conducted entirely online through a web browser. Teams will be instructed to facilitate all game-building activities through the system and to avoid personal discussions concerning the study. The researcher's observations will occur through the system and in-person as the situation necessitates. Interviews will occur in person, over the phone, or through web conferencing software.

Finally, teams must seek approval from organizational leaders (i.e. supervisors, company owners, administrators) as to what type of knowledge is acceptable for recording and sharing, if required. Generally speaking, the types of knowledge that teams will create will be innocuous and contain no harmful or sensitive information (i.e. trade secrets, company sensitive information, and/or information about clients). The knowledge topics will touch on subjects suitable for knowledge creation and sharing publically. Teams will use text, audio, pictures, and video to convey the knowledge for the games.

1.7 Definition of Terms

Important terms and concepts are used throughout this study. ***Social construction of knowledge (SCK)*** is best described by Pea (1993) as such: "Knowledge is commonly socially constructed, through collaborative efforts toward shared objectives or by dialogues and challenges brought about by differences in persons' perspectives." (p. 48). SCK is the fundamental driving force for this study and assumes that experts can be brought together to construct knowledge.

Knowledge creation (KC) is at the heart of SCK and is a delicate social process that involves human emotions and intuition. Von Krogh, Ichijo, and Nonaka (2000) define KC as "… not simply a compilation of facts but a uniquely human process that cannot be reduced or easily replicated. It can involve feelings and belief systems of which one may not even be conscious." (p. 6) KC is a back and forth negotiation process that ultimately results in knowledge that can be recorded.

The goal of this research is to create and record knowledge in the form of a game. The types of games created by the teams will not be considered pure entertainment games, but "serious games", since they contain knowledge from each team's profession and are intentioned for use in the workplace. Susi, Johannesson, and Backlund (2007) describe ***serious games*** as "games that engage the user, and contribute to the achievement of a defined purpose other than pure entertainment" (p. 5). The goal of the game creation process will be to create a knowledge artifact in the form of a game that each group's organization can use for training purposes.

Simulation is a broad term that includes both real life and computer-based environments. Aldrich (2005) describes the concept as "a variety of selectively interactive, selectively representational environments that can provide highly effective learning experiences"(pp. 270-271). The simulative learning environment for this study will deploy a role-play approach. Morrison, Ross, and Kemp (2007) consider a ***role-play*** approach as:

> … the spontaneous dramatization by two or more persons of a situation relating to a problem. The incident might have to do with interpersonal relations or an operational problem within an organization. Each person acts out a role as he or she feels it would be played in real life. Other learners or trainees observe the performance and then, when the performance ends, discuss the feelings expressed and actions observed. (p. 226)

1.8 Summary

Corporations invest heavily in specialized software to create environments for groups of people to interact and share learning experiences with one another. Given the need for establishing and supporting a CoP through constructivist learning philosophies, organizations must acquire systems that allows for SCK and can measure levels of SCK created.

In addition to the uncertainties of technology, adults always require a fresh approach towards team trainings. The research proposal presented in this chapter attempts to answer these questions by looking towards games as a structure to achieve social constructivism. This quasi-experimental mixed methods study presented thus far aims to explore how SCK occurs in a custom-built online database called the knowledge game center.

The research questions guiding this study investigate how SCK occurs within a trivia, role-play, or role-play knowledge creation template. Additionally, the degree to which SCK occurs according to the IAM model's five phases will be explored. Furthermore, factors influencing how SCK occurs, determining participant's perceptions of their ability construct each game, and what statistics from system usage data reveal about group tendencies during the SCK process encompass the research questions guiding this study.

Teams of three people will be recruited to take part in the study. Adults only, 18 years or older and affiliated with a public K through 20 school as a student, will be allowed to participate. The teams will access the knowledge game center through any web browser, on any device. Observations, interviews, coding of computer messages according to the IAM model, results from game completion surveys, and analysis of system usage data will provide answers to this study's research questions.

Knowledge sharing, communities of practice, and game-based learning philosophies are important areas guiding this research. People must interact to create and refine knowledge worthy of sharing with others for any innovative organization. By creating learning materials that are fun to create, easy to implement, and encourage group participation, an organization can provide a learning system that generates excitement and participation among members. Custom-built database systems can potentially provide this type of environment. The following chapter provides an overview of how collaborative learning design, adoption of game based learning principles, support for communities constructing knowledge, and interaction analysis of human activities sets the stage for creating a knowledge game center.

Chapter 2

Review of Literature

Instantaneously, and with the touch of a button, our interconnected world allows people to share knowledge. Given the complexity and independent nature of society, tablets and smart phones continue to expand the ability of individuals to communicate and solve complex problems. Technology encourages experimentation, and along with the Internet, makes anything possible. From an entertainment perspective, technology serves as a source of enjoyment and pleasure and is the preferred avenue for communication, especially for younger generations. Learning system designers face the challenge of keeping students engaged and maintaining pace with new technological trends, all the while accomplishing learning targets and objectives.

Figure 1 conveys the topics and relationships covered throughout this chapter. Activity theory (bottom-right) is the foundation for organizations as they navigate 21st century technologies. Activity theory describes how complex human systems operate and defines all components involved concerning human activities.

In order to accomplish organizational goals and objectives, human-computer interaction (HCI) and connectivism provide an approach to organize activities and perform daily work. Both concepts explain how computers assist humans to execute work-related tasks using computers, varying networks, and other human resources. While considering change and improving products after receiving feedback from users, rapid prototyping must be adopted to help manage technological change. Through a activity theory approach, an understanding of HCI and connectivism, and with a commitment to

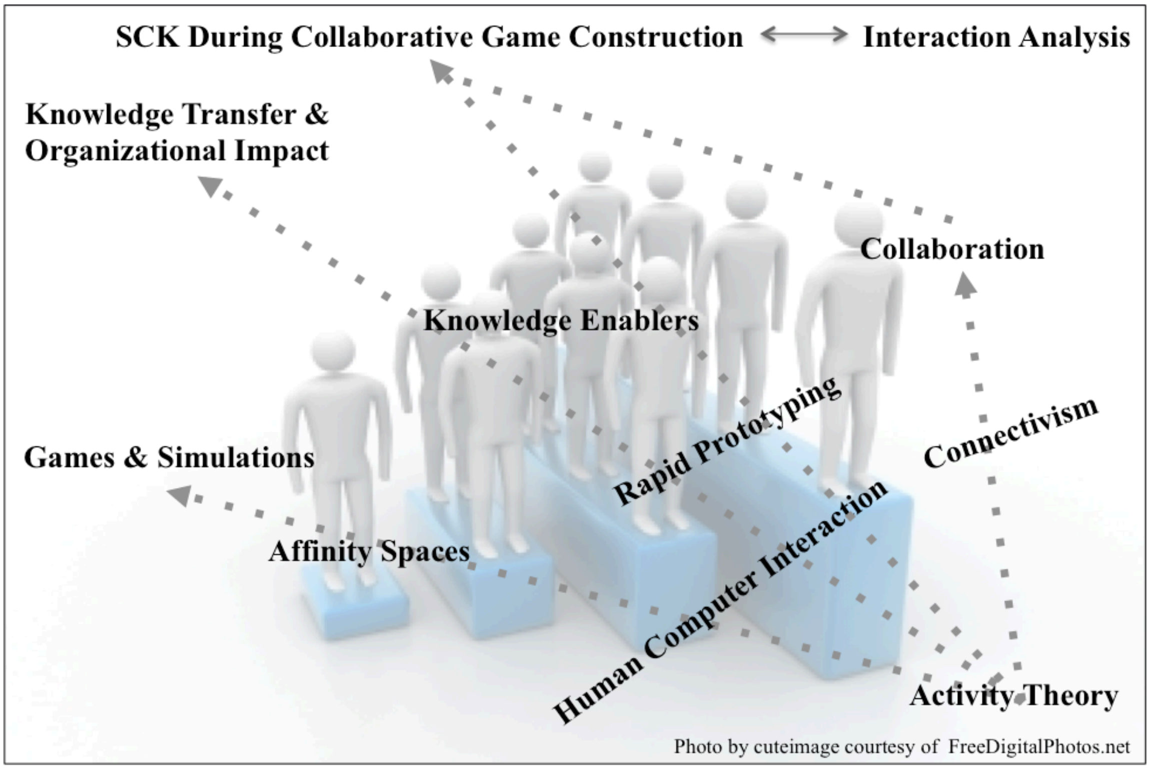


Figure 1. Conceptual diagram of topics.

rapid prototyping, an organization's intentions emerge – intentions such as providing affinity spaces, establishing knowledge enablers, and encouraging collaboration for members of the organization.

Affinity spaces, knowledge enablers, and collaboration are pathways to successful and innovative organizations. Affinity spaces serve as arenas where people can pursue interests and experiment with tools applicable to a given profession. Additionally, in order to support the exploration of new approaches towards learning, knowledge enablers are an internal condition established by an organization to promote knowledge sharing. An organization must foster a culture of collaboration in order to ensure success.

The remainder of the diagram displays outcomes and research opportunity that members of an organization experience thanks to knowledge creation and sharing efforts. Starting from the bottom left and moving clockwise, games and simulation are a unique approach for educating people explored through an affinity space. Next, knowledge transfer and organizational impact occurs if knowledge enablers are established to encourage sharing. Additionally, SCK emerges using alternative collaborative strategies, such as collaborative game creation, jigsaw activities, or debates. Finally, interaction analysis as a method of research serves as a tool for measuring and understanding how online communication and SCK occurs.

This framework describes how collaborative game creation can lead to SCK when specific organizational philosophies are put in place. Given the foothold that technology has in daily life, and people's desire to have fun (especially at school and work), a unique and novel way for engaging employees to construct and share knowledge is plausible. The following major sections - learning design for collaborative technologies, games for learning, communities constructing knowledge, and understanding knowledge construction: a method for assessing SCK provide a blueprint for such a system.

2.1 Learning Design for Collaborative Technologies

Last century's technological breakthroughs caused major shifts in instruction. Present day, schools, businesses, governments, and other types of organizations undergo changes due to this change. Kilfoye (2013) wrote:

> Just as newspapers attempt to reinvent themselves as virtual sources of all things information, schools can re-establish themselves as institutions focused on technology-mediated approaches that mirror the relevant and essential skills from digital literacy to critical thinking required for success in today's society and workplaces. (p. 56).

School administrators and business executives face the difficult task of keeping pace with technological change while ensuring that learning or training still takes place. Adults of the future will be required to instantly interact and collaborate to achieve work-related goals. Despite the challenges of creating an ideal online learning or training environment for a given organization, technology brings people together and provides a virtual environment for collaborative group work. It is from this perspective that an overview of how human systems operate is first presented.

2.1.1 Activity theory. Activity theory provides a descriptive framework to understand how complex socio-technological systems operate. The Soviets Vygotsky, Leont'ev, and Rubinstein pioneered this type of social science theory and research through a desire to understand human activities as complex, socially situated phenomena. They wanted to go beyond describing human actions simply as behaviorism – or simple, automatic responses to the environment. Activity theory takes into account the environment, history of those involved, surrounding culture, roles of certain items, and the complexity of every day life.

Recently, activity theory has resurfaced as a way to guide research for humans using technology. Kuutti (1996) described three major principles of activity theory to guide research. The first principle is that all actions performed by an individual are situated within a given context called an activity. Activity theory requires that a minimal meaningful context be provided for individual actions, thus making an activity the basic unit of analysis.

The second is that activities are not static but dynamic occurrences that provide a history. The components of an activity are variable and never guaranteed to be linear.

Therefore, an activity's history can be recorded that contains remnants of past phases to provide understanding and development for future use.

The third principle highlights artifacts and mediation. An activity consists of various elements that rely on artifacts or tools to help mediate action between individuals and objects. Artifacts contain history of past learning events and allow researchers to study how the process occurred. Kutti's (1996) principles provided a foundation to view activities involving humans and technology.

Human actions involve numerous variables and factors given the complexity of our social order. Engeström (1987) characterized this complexity as an "activity system" (see Figure 2) represented as a large triangle, containing a smaller triangle, with the total area divided by six components: subject, object, community, tools, rules, and division of labor. These components serve as vertices of a large and small triangle. Subject, object, and community form the inner triangle, thought of as the driving force of the action. The outer triangle consists of rules, tools, and division of labor, or a basic control framework for the actions occurring in the inner triangle. Travelling around the outside of the diagram, one side of the system consists of rules, subjects, and tools; the next side contains tools, objects, and division of labor; and finally the remaining side of the triangle diagram contains division of labor, community, and rules.

Subject refers to individuals or groups of people involved in the activity. *Object* refers to the objective of the activity in which all intention is directed. *Community* refers to outside individuals or groups who also work together to achieve the objective. *Tools* help manipulate or build the outcome of the objectives mentioned before. *Rules* refer to explicit and implicit regulations that guide activities within the system. *Division of Labor*

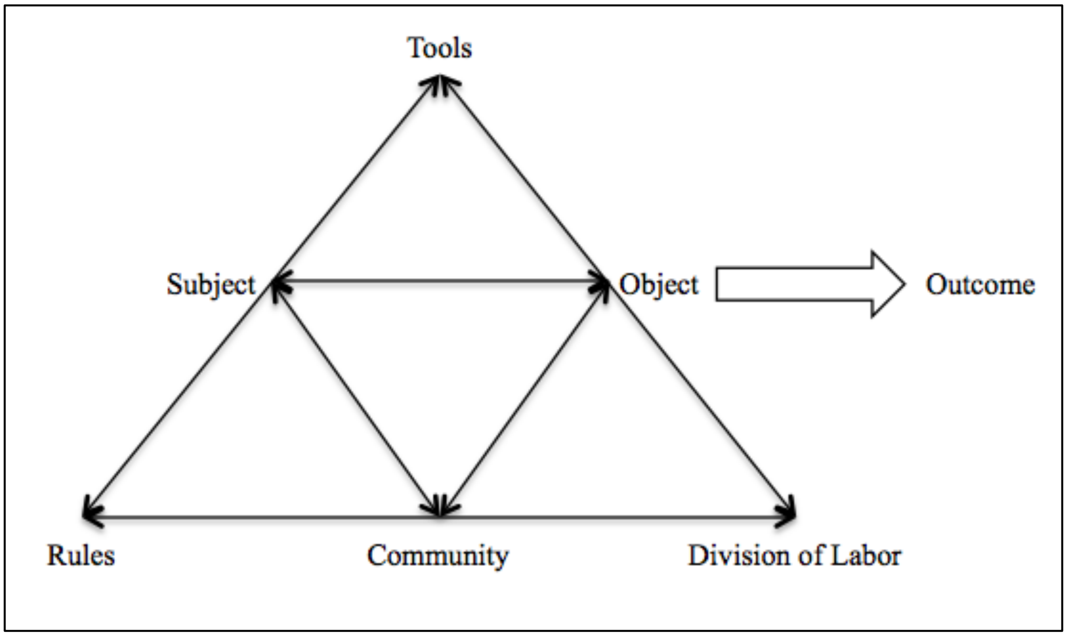


Figure 2. Engeström's (1987) human activity system model

refers to the multiple levels of duties and responsibilities divvied among the community (Engeström, 1987)

Engeström's triangular activity system provides a blueprint to make sense of how people perform using complex tools, like technology. Engeström's (1987) activity system placed an outside component, outcome, as the activity system's direct result coming from the object that was transformed by tools, division of labor, subjects, rules, and community.

An activity system's intricate framework demonstrates how all components are connected during the execution of collaborative tasks. When one of the components changes or fails to perform, the rest of the system feels the effects. This interconnectedness is a concept that explains how HCI and connectivism play a critical role bringing workers and learners together in today's complex world.

2.1.2 Technological connections. With careful consideration, collaboration-focused learning environments prepare learners for the opportunities of the 21st century. Activity systems provide a broad perspective on how complex human systems operate. Vygotsky's (1978) social development theory argued that social interaction is required for the development of a learner's cognition. Present day, modern technology provides social interaction through a virtual platform. Today's leaders choose between a mix of face-to-face and online settings to offer learning opportunities for all students. Instructors draw upon numerous websites, journals, and communities to broaden lessons.

Modern-day collaboration occurs virtually using computer-based systems. On a continual basis, governments, businesses, and the public sector experiment with new electronic devices and applications that impact how business and daily life transpires. Technological systems are socio-technical creations; thus it is crucial to understand how humans interact using computers. Bullinger, Ziegler, and Bauer (2002) characterized human-computer interaction (HCI) as "a multidisciplinary and multifaceted area … strongly influenced by technological, organizational, and socioeconomic factors" (p. 2). Humans want to accomplish multiple parallel tasks quickly and precisely through the assistance of computers. The way in which humans interact with computers is moving towards a more natural and interactive format; much like how humans interact with other humans.

HCI is evolving away from a manipulation approach towards computers (point and click, pop up menus, mouse interfaces) and more towards a delegation approach, or "agent-based interfaces" (Negroponte, 1995, pp. 101-102). Despite the fact that computers play an essential role in daily life, humans do not want to be bogged down using technology nor want to spend time and effort learning how to use new technological systems. Humans want computers to quickly accomplish mundane tasks and provide instant notification, like an agent, after certain conditions are met.

Humans require multiple approaches towards performing work, providing community access, and an opportunity to share feedback. Technology provides a starting point for facilitating interaction, but opportunity for improvement remains. Technology still has yet to capture the dynamics of face-to-face communication and the surrounding environment during collaborative moments. Three concepts suggested for improving the intuitiveness of HCI in the future are: dynamic visualizations, multimodal interaction, and cooperative exploration (Bullinger, Ziegler, & Bower, 2002, pp. 5-12). A technique for understanding how humans use technology to interact and make decisions provides a starting point.

Connecting people to resources creates a network of knowledge for learning. Siemens (2005) described this theory as “connectivism” or “the integration of principles explored by chaos, network, and complexity and self-organization theories” (p. 7). *Connectivism* provides learners linkages to new learning opportunities that arise from our complex society. Connectivism rests on the notion that the network continuously creates important and unimportant new information that is vital to the learner for making decisions (Siemens, 2005, p. 7). Principles of connectivism are:

- Learning and knowledge rests in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.

- Capacity to know more is more critical than what is currently known
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision. (Siemens, 2007, p. 7)

Connectivism is the new reality of the world as more people gain access to technology like smart phones and tablets. Technology and the Internet make it possible for an individual to construct and share information with nearly the entire world.

Social media technology supports connectivism by creating equal opportunity for all learners. Social media, according to Kaplan and Haenlein (2010), is “a group of Internet-based applications” that “allow creation and exchange of User Generated Content” (p. 61). Fong (2003) said that social media, and other similar types of networks, serve as the primary mechanism for information and knowledge exchange, where teammates rely upon others as “rich resources for generating design knowledge” (p. 483). Our technological world, connected by devices and social media, removes barriers that once confined people from interacting and sharing with others. Mostmans, Vleugels, and

Bannier (2012) stressed that learners learn by asking questions, pursuing lines of inquiry together, teaching one another, and seeing how others are learning in online collaborative settings (p. 110). Technology makes interaction convenient and instantaneous for learners and instructors - two notions made possible through connectivism. Learning activities succeed when learners are placed in social settings and exposed to various scenarios. Connectivism helps one understand “the tectonic shifts in society where learning is no longer an internal, individualistic activity” (Siemens, 2005, p. 9).

Collaborative learning technology, available through Internet-based programs like social media, creates avenues for people to exchange diverse and varying opinions within personal learning environments (PLE). Häkkinen and Hämäläinen (2012) emphasized the benefits of PLE where learners and knowledge workers (adults in the workforce) learn how to combine similar and divergent perspectives, along with locating complementary expertise, in order to solve complex problems and construct new knowledge (p. 232). The challenge, unfortunately, is choosing the right technology for a given context. Despite learning technology’s alternatives, such as the instructional methodology deployed, use of synchronous or asynchronous communication, the inclusion of multimedia, levels of user support, etc., - no superior exists. Proper organizational planning and design ensure that PLEs are given the proper technological tools to succeed. Administrators and technology designers constantly strive to meet consumers’ expectations and demands by adjusting products after initial release.

2.1.3 Managing technological change. With each passing year, more companies and designers create collaborative learning technologies that push the limits of human learning and performance. Instructional designers deploy technologies that attempt to provide fun and flexible learning activities while taking into consideration the learners' surrounding environment. Rothwell and Kazanas (2007) called instructional design a broad concept that systematically analyzes human performance problems, identifies root causes, considers all solutions, and then implements solutions to reduce the need for corrective action (p. 3). More succinctly, Reigeluth (1999) said that instructional design "focuses on means to attain given goals for learning or development" (p. 6). Through both definitions, it is evident that designers must understand and anticipate all factors for creating the perfect learning environment for learners and workers. Designer face the challenge of educating, along with entertaining, learners using only limited resources.

With the multitude of considerations and factors involved in designing a collaborative learning system, it is critical that best teaching practice impacts design. It is frustrating, however, when an adopted design methodology becomes outdated or replaced by a newer, more popular approach. Buchmann and Floden (1991) wrote that "teaching has an endemic uncertainties, which can be managed or appreciated but never eliminated … [since] the unexpected will happen" (p. 71). Modern learning and training systems are experiencing a shift from face-to-face, traditional classroom instruction to anytime, anywhere online learning.

System designers prefer to select adaptable designs that are flexible and modifiable for reuse after deployment. Streibel (1991) lamented, "I have begun to believe that the discrepancy between instructional design theories and instructional design practice will never be resolved because instructional design practice will always be a form of situated activity" (p.122). Situated activity is unique and contains circumstances that are different from past learning scenarios. Technology and learning designers of today are close to solving this dilemma using design methodologies and philosophies that allow for exploration of ill-structured topics.

In order to avoid failure and to be sensitive to the current status of the world, a commitment must be made towards designing a flexible and modifiable instructional approach. Anderson and Shattuck (2012) defined design-based research (DBR) as a methodology created and used by teachers that attempts to increase the “impact, transfer, and translation of education research into improved practice” (p. 16). DBR stresses theory building and design principles development (Anderson & Shattuck, 2012). DBR attempts to take feedback from the current nature of the world and make design improvements to the systems that facilitate learning. Through the feedback received from instructors, design can take into account what is and is not working in order to release new and improved versions of instruction. Thanks to computers and the Internet, breakthroughs can be shared with learners almost instantly.

Educational designers must adapt to the fast-paced action of the world and continually release relevant and interesting versions of learning environments. Rapid-prototyping (RP) is an iterative, fast-paced development methodology that affords designers the flexibility to conduct research that maintains instructional improvements. Ruiz-Iniesta, Jiménez-Díaz, and Gómez-Albarrán (2012) proclaimed that RP helps make “critical design decisions as early as possible” and that RP must “support maximal re-use and innovative combination of existing methods, as the simple and quick integration of new ones” (p. 169). RP fits activity systems and connectivism well with its dynamism and commitment to improvement.

Originally intended for use in producing physical models and technology related products (i.e. software and hardware), RP is relevant to the field of instructional design and ever-changing nature of technology. Jones, Li, and Merrill (1992) described RP methods as helping to realize conceptual structures of the final product without paying the cost of the full product development. RP encourages exploration and adjustments for the purposes of achieving an ideal design for instruction. Tripp and Bichelmeyer (1990) provided a model for RP with the overlapping components: (1) assess needs and analyze content, (2) construct prototype, (3) utilize prototype, (4) set objects, and (5) install and maintain system (or for courses, deliver and maintain instruction). The RP model assists instructional designers to meet the needs of learners and seek continuous improvement of products as technology transforms with each passing year. Tripp and Bichelmeyer's (1990) RP theory eliminated the need for multiple linear steps and intense analysis by introducing an instructional design methodology containing overlapping parts

RP, along with DBR, are methodologies that guide the development of technology for learning and collaboration in the 21st century. Dillenbourg (2013) referred to this as "orchestration" or "how a teacher manages, in real time, multi-layered activities in a multi-constraints context" (p. 485). Orchestration occurs across digital and physical mediums thanks to organizations that support educational leaders to eliminate old, outdated systems that no longer serve the needs of members.

Input provided from technology users, both teachers and learners, assists collaborative learning designers to create online environments that are reactive and adaptable to the changing needs of today's learners. Five design principles for optimizing orchestration are: control, visibility, flexibility, physicality, and minimalism

(Dillenbourg, 2013, pp. 490-491). These principles help the instructor manage various constraints (e.g., curriculum requirements, classroom discipline) that may impede constructivist learning, while at the same time reducing the cognitive load placed on the instructor and students by learning activities. A thorough understanding of learners enables organizations to develop a product that is innovative, revered, and successful at encouraging collaboration. Smart instructional design, along with DBR and RP, increases the likelihood that people will enjoy working or learning with one another.

2.1.4 Elements of collaboration. Organizations must continuously improve technology because members carry personality traits that influence collaboration. The ability of the learner to recognize and adjust to changes within their environment, while considering how decision-making must be adjusted, is a key learning objective (Siemens, 2005, p. 6). Collaborative learning technology must encourage both group and personal experiences to support the likelihood that knowledge will be traded among the group. In years past, education was designed for a broad spectrum of students - with little to no opportunity to individualize curriculum for a student. Hu and Johnston (2012) provided lessons learned from adaptive learning technology using a four-year, wiki-based course design conducted at a major U.S. university. The researchers discovered that having an adaptive technological learning system lead to an increase in student self-responsibility, group work participation, and the recognition of value for collaboration (Hu & Johnston, 2012, p. 508). Such attributes are dependent on technology that can adapt to the wants and needs of the people who use the systems.

Understanding how adults construct and share knowledge brings attention to the ever-changing nature of information. Nonaka's (1994) *knowledge spiral* contains four zones that describe the creation, exchange, and transformation of knowledge that occurs within organizations. In simple terms, the concept begins when an individual's tacit knowledge is shared publically and consumed by others, thus becoming explicit. The newly shared knowledge is received by others and adapted through practice, thus entering a new tacit form that is shareable with others. Nonaka's (1994) model describes the four zones as socialization, externalization, combination, and internalization.

Socialization describes when individuals share tacit knowledge with others in order to build common knowledge. *Externalization* takes place when an individual attempts to make tacit knowledge more understandable, often times creating a graphical or visual representation. The *combination* phase occurs when knowledge is shared freely across an organization and made accessible to each member. *Internalization* represents when an individual receives explicit knowledge and constructs new tacit knowledge. Knowledge is transformed in each stage as follows: socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit), and internalization (explicit to tacit). The process creates a continuous cycle, thought of as a spiral, that travels from socialization, to externalization, on to combination, and ending and re-beginning with internalization. The spiral represents the collaborative process that takes place between adults as they construct new knowledge (Nonaka, 1994). The creation and exchange of knowledge is a multifaceted process that depends on both individual and social characteristics.

A deeper understanding of learning processes and considerations are necessary to create environments that encourage knowledge sharing and collaboration among adults. Bransford et al. (2000) spoke of the vast landscape of human knowledge - impossible to cover exclusively through one's formal education - and argued that the goal of education is better thought of as developing "intellectual tools and learning strategies needed to acquire the knowledge that allows people to think productively" (p. 5). In addition, working or learning with others is major expectation of work or school. Successful organizations acknowledge that people learn differently and consider all options that foster self-directed and active learning. The following three core learning principles from cognitive and neuroscience research provide a strong base for instruction:

1. Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
2. To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
3. A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. (Bransford, et al., 2000, pp. 15-19).

These findings speak to the importance of using a learner's pre existing knowledge to incorporate and strengthen new information, while at the same time allowing for exploration and personalization.

Ultimately, educators strive for creating self-aware learners who care about their own learning and make an effort to accomplish personal learning goals. An understanding of how learning occurs at the individual level provides a strong foundation for collaboration. Bransford et al. (2000) claimed that in order to create effective learning communities, learning environments must: focus on learners (learner-centered), offer well-organized knowledge (knowledge-centered), promote ongoing assessment for understanding (assessment-centered), and encourage community support and challenge (community-centered). From this broad perspective of how people learn and how to design a community-learning environment, organizations will provide the necessary elements for collaboration.

Knowledge sharing transpires in a variety of formats within today's organizations. Discussion boards, wiki pages, and social networks are commonly used to facilitate peer-to-peer or peer-to-mentor relationships. Additionally, small group learning activities are commonly deployed to offer group constructivist learning opportunities. From a broad perspective, Hyewon, MiYoung, and Minjeong (2014) reported that an Internet-based bulletin board service accessed from a desktop computer running an instant message program improves students' "taskwork", whereas a mobile device based instant message program facilitates teamwork (p. 40). Mobile devices help with scheduling and coordination, but traditional laptops and desktops are used for writing and capturing serious thought. The expansion of mobile technologies will continue to change how people communicate and coordinate activities. Hyewon, et al., (2014) shared important lessons learned from the past quarter century of experimenting with technology and learning. Further investigation is required as mobile technologies mature and learning becomes more accessible.

Due to this expanding frontier, a degree of oversight is required to support the knowledge sharing principles of the organization. Hämäläinen (2008), after investigating computer-based learning scripts, warned that collaboration is dependent on participants' willingness to work together and the ability to support individual work (p. 107). King and Marks (2008) investigated important organizational activities that motivated knowledge sharing and concluded that supervisory control "should not slavishly adopt the conventional wisdom and neglect supervisory control mechanisms for motivating knowledge sharing" (p. 141). An organization must first understand how members use technology and whether or not they will collaborate before investing in technology. In order to avoid technology investment failure and setbacks to goals and objectives, an organization must prepare for the impact that technology will have on its members and work practices.

Along with careful planning and constant supervision, the system must be fun and easy to use. Perceived usefulness and ease of use, secondary to supervisory controls, are most important to motivate knowledge sharing instead of unabashedly changing the organizational culture (King & Marks, 2008, p.141). Hämäläinen and Vähäsantanen (2011) recommend training students on how to become effective self-regulated learners that will assist them in creating, managing, and sustaining their own personal learning environment across social media (p. 7). For the purposes of designing future learning environments, designers must strive for "a wholeness of these interrelated elements" and understand that "high-level dialogue" is part of a "series of intellectual activities, some of which happen individually and some collaboratively" (Häkkinen & Hämäläinen, 2012, p. 235).

Not every system will be seen as flawless in the eyes of learners. Kreijns, Kirschner, and Jochems (2003) spoke of a functional relationship, important to designers of computer learning environments, when attempting to satisfy a participant's learning experience. The researchers claimed that "Valued Learning Experience" is a function of pedagogy, content, and community. The function states that if any of the three variables approach zero (meaning they hardly exist) then the total valued learning experience is zero as well (Kreijns et al., 2003, p. 342). The implications for learning design is that all three factors - pedagogy, content, and community - must be assuredly created and continually fostered in order to deliver a near-authentic learning experience for students.

Human systems expanded in size and complexity due to technological innovations of the past decades. Collaborative connections are easy to maintain using smart phones and tablets despite the challenge of pinpointing the ideal system for learning or training. One area experiencing success on smart phones and tablets is entertainment - such as multimedia sharing, multiplayer games, and social networking. Designers must look towards entertainment, such as games, in order to discover how people interact, collaborate, and enjoy spending time with one another.

2.2 Games for Learning

Many factors that influence learning - such as culture, teaching styles, learning preferences, and technology - are important factors when designing an engaging collaborative learning experience. Today's society depends on technological connections that deliver multimedia instantaneously. Designers must continuously seek new ways of connecting people to provide conditions where knowledge creation and sharing thrives. Away from school or work, people spend downtime with family and friends doing enjoyable things, such as playing games. By borrowing aspects of games and applying them to learning, educators engage learners at deeper levels that are hard to achieve in a traditional classroom setting. Games are seen as viable teaching tools to exchange knowledge and encourage group interactions.

2.2.1 Game foundations. Inevitably, people will learn or perform work in social settings. Many of today's games are designed for multiplayer experiences driven by computers and the Internet - much like the conditions in which today's workforce operates. Technology makes it easy to integrate game elements into social situations where people interact to construct and share knowledge. Designers create group games that promote interactions and connections that go above and beyond the confines of the classroom.

Excitement is evident when people come together online to play games. Squire and Steinkuehler (2005) reported, "playing on-line community games actually is a matter of creating knowledge together…[it] fosters various types of information literacy as well as developing information-seeking habits" (as cited in Susi et al., 2007). Numerous online gaming communities, like World of Warcraft™ or Call of Duty™, offer examples of communities that maintain connections via the Internet. Websites, blogs, and online videos are commonly offshoots of popular games and help quench the thirst for the community's fanfare.

Classic studies, such as Grabinger and Dunlap's (1995) investigation into rich environments for active learning (REALs), predicted the role technology would play for group learning. According to Grabinger and Dunlap (1995), a REAL must:

- offer study and investigation in genuine contexts;

- encourage the student's growth, initiative, decision making, and intentional learning;
- support collaboration between students and teachers;
- use dynamic, interdisciplinary, generative learning activities that promote higher-order thinking to enable students to construct rich and complex knowledge structures; and
- assess student learning within authentic contexts (Grabinger & Dunlap, 1995, p. 10).

Nearly a quarter century after the idea of REALs was first conceptualized, the ability to create a REAL online and engage numerous people through cell phones, tablets, and computers is a reality.

Rollings and Adams (2003) advanced the notion that dreams can become reality through games. The authors state that, "[games on the] computer can create almost any sort of experience...even experiences that are physically impossible in the real world" (Rollings & Adams, 2003, p. 30). When people play games, time passes quickly and engagement occurs naturally. Prensky (2001) described *stealth learning* as learning that is easy and inspiring (pp. 16-17). Games achieve a level of stealth learning that is difficult for classroom teachers to create without a large investment of time and effort.

Games that engage the user to achieve a defined purpose other than entertainment are called serious games (Susi, et al., 2007). Serious games appear in various fields of e-learning, edutainment, game-based learning, and digital game-based learning projects (Susi et al., 2007, p. 1). With the introduction of tablet and smart phones, serious games are reaching more people each and every year. Games offer benefits to learners that are not easily obtained in the traditional classroom setting. Carefully designed learning environments provide scenarios that reinforce concepts and encourage exploration.

2.2.2 Simulation. Simulation and games have similarities that enhance learning. Both recreate environments that are difficult to achieve in real-life and allow an individual to explore and take risks without harm. The difference between games and simulation is that simulation deploys elements of games like a goal, rules, competition, etc. – but simulation is considered more of a tool (Prensky, 2001, p. 212) (e.g., an airline pilot training simulator). Designers create simulative environments that are ideal for learning or training that promote experimentation and risk-taking. Successful simulation achieves the perfect combination of fidelity and presentation, or what Prensky called a “kick-ass situation” (2005, p. 212-215). Simulation provides learning opportunities that are difficult or impossible to coordinate in real life situations.

Simulation is an experimental constructivist learning activity that engages learners in numerous ways and encourages group participation. Simulation is used for teaching of information systems (Martin, 2000), business management (Doyle & Brown, 2000), strategic management (Jennings, 2002), development of course materials (Tomlinson & Masuhara, 2000), and operations management (Goffin, 1998). One of the largest practitioners of simulation, the military, uses a variety of web resources and real-life experiences to train soldiers and civilians.

Raybourn (2014) described how the U.S. Army uses “transmedia storytelling” to craft a narrative, through games and simulation, across multiple platforms that is memorable and increases retention (p. 472). The Army presented a cohesive system through “serious games, immersive simulations, intelligent tutoring systems, virtual environments, machinima (video or short films made with game technology), mobile learning, graphic novels, motion comics, film, radio, print, and social media" (Raybourn, 2014, p. 473). The flexibility provided by technology allows instructors to lead students through a variety of learning environments, much like the military.

The limitations of the physical classroom setting are overcome using a simulation. Aldrich (2004) summarized what he believed to be the necessary ingredients for the successful implementation of a simulation:

- Authentic and relevant scenarios;
- Applied pressure situations that tap users' emotions and force them to act;
- A sense of unrestricted options; and
- replayability (p. 9)

Aldrich argued that simulations "enable discovery, experimentation, role modeling, practice and active construction of systems, cyclical, and linear content" (Aldrich, 2005, p. 81). Educational simulation calls for learners to experience and manipulate artifacts that behave in dynamic and unpredictable ways. Unpredictability and customization are nearly impossible to transfer from the pages of a textbook to a student's long-term memory.

Games and simulation are used in the workplace to take the burden off mundane tasks and improve relationships among employees. However, as mentioned previously, careful planning and restructuring are necessary to develop an organizational culture where games and simulation succeed. Knowledge-sharing and collaboration, along with support for individual customization and recognition, position learning and technology designers to better serve an organization's constituents.

2.2.3 Gamifying a learning task. Designing games for learning is a delicate task that cannot be underestimated. Categories of learning (e.g., factual versus higher-order thinking) and different types or learners (e.g., learners with disabilities or second language learners) must first be aligned to learning objectives in order to design a learning game for a given audience and situation. Ke (2008) warned against using games in a “one-shot and decontextualized manner” and that educationalists must spend ample time identifying and measuring influential factors for a game-based learning environment (p. 23). Learning theories and game design are converging at an increasing rate as technology continues to expand and educators turn towards games to engage learners.

Certain aspects of pedagogy and general design must first be considered to create an educational game for online education. Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, and Fernández-Manjón (2008) stressed the importance of first deriving pedagogical requirements and then targeting specific educational game designs that incorporate those requirements. Pedagogical factors such as integration with online education, adaptation, and assessment provide an educational foundation to develop instruction (Moreno-Ger et al., 2008, pp. 2533-2534). After establishing the pedagogical background, general design considerations follow such as choosing the appropriate game genre, adding assessment and adaptation to design, and allowing for integration with an online learning environment (Moreno-Ger et al., 2008, pp. 2534-2536). Through careful preparation and planning, a framework for a generic online educational game affords designers opportunity for creating an entertaining and enriching learning experience.

Games offer experiences that captivate and entertain people with little attention given to the passage of time. Kiili (2008) presented a model for game-based learning based on linking gameplay to experiential learning in order to facilitate flow experience (p. 18). Csikszentmihalyi (1991) described flow as a state of complete and total engagement in an activity that is considered the ultimate experience. Flow is evident when people play games and is a desirable state to achieve for learning. Flow is equivalent to Prensky's (2001) notion of stealth learning. Educators believe that engaging learners through firsthand experiences will build personalized cognitive models that have the greatest impact on learning. Kiili's model stressed that learning is both cognitive and behavioral, where learning is defined as "a construction of cognitive structures through action or practice in the game world" (Kiili, 2008, p. 18). Game-based learning environments provide interactive experiences and offer challenging cognitive tasks that make learning more enjoyable and rewarding, instead of arduous and unpleasant.

From this intersection of cognitive and behavioral aspects, the experiential gaming model contains an ideation loop, an experience loop, and a challenge bank (Kiili, 2008). The challenge bank contains educational objectives meant to sustain and engage the learner, whereas the ideation loop is thought to "cleanse the experience loop of old solutions" and provide new solutions to be tested and reflected. The experience loop allows players to test solutions and observe the outcomes of actions (Kiili, 2008, pp. 18-19). The experiential model for game-based learning provides a holistic view of game design that allows a learner to experience a multitude of challenges, opportunity to test solutions, and reflect upon experiences.

When it comes to introducing games into real-life activities, careful thought and planning must go into creating a system built on games. This concept is known as *gamification*. Deterding, Dixon, Khaled, and Nacke (2011) defined gamification as the application of game design elements into non-game contexts. Routines, investigations, and scenarios from everyday life benefit from gamification because the concept alleviates the drudgery and boredom of performing ordinary tasks. Simões, Redondo, and Vilas (2013), coming from the experience of integrating gamification into a K-6 learning platform, viewed social gamification as game mechanics and game-thinking from social games applied to non-game applications, specifically in social learning environments (pp. 347-348).

Gamification supports constructivism and student-centered learning. de-Marcos, Domínguez, Saenz-de-Navarrete, and Pagés (2014) suggested that games help improve student performance on practical assignments related to skill acquisition (p. 90-91). Less time is spent teaching basic facts and procedures, while more effort is made towards guiding students to higher levels of learning. For example, instead of passively educating a new employee by requiring them to read a company handbook, a company can use an interactive game to bestow valuable work related knowledge on a new employee.

Games serve as a flexible tool to explore design possibilities based on group constructivist learning principles. Hsu, Chang, and Lee (2013) studied the gamification of collaborative storytelling websites and found the following five attractive gamification features: (1) the relationship between acts and rewards be clear so that the user pays as much attention to feedback after conducting certain behaviors; (2) use unpredictable time pressure to create challenges that help increase user involvement, (3) instructions must be easy to learn and use by the user; (4) users must be allowed to build groups to socialize and affiliate when collaborating; and (5) reward diverse and interesting badges for user accomplishments to enhance learning involvement (pp. 431-432). In other words, if a user knows how the game operates, finds it challenging, can seek extra information when needed, can interact with friends, and receive feedback of accomplishments, collaborative tasks are likely to occur.

After deciding what game features and elements to include, certain expectations and objectives must be set to help stakeholders use gamification. Examples guidelines from a gamification K-6 learning platform are as follows: (a) help students deal with failure as part of the learning process and to keep trying; (b) allow students to experience enjoyment and pleasure from school activities instead of being driven by extrinsic motivators; (c) allow students to try new identities and roles; (d) develop a school-based identity; (e) motivate students to improve skills with social rewards; and (f) motivate teachers and parents to reward student progress (Simões, Redondo, & Vilas, 2013, p. 348). Experimentation, recognition, and personalization are critical areas to consider when creating a gamification environment. Despite the challenges, and with proper planning and coordination, gamification is an exciting concept that improves the drudgery of everyday situations. A basic understanding of how games are designed for entertainment is the next step for the gamification of a learning environment.

2.2.4 Game and simulation designs. Games and simulation are a unique way for people to share experiences and exchange information. In order to create successful collaborative learning activities, they must have clear directions, be engaging and fun to play, and encourage group participation. The following areas are fundamental aspects of game design: core mechanics, storytelling and narrative, and interactivity (Rollings & Adams, 2003, pp. 8-13). Whether the game be computer-based or played face-to-face, game designers strive to create games for numerous audiences and situations.

The fundamental aspects of games determine whether games will be a success or failure. The core mechanics of a game involve the translation of a designer's vision into a set of rules that can be interpreted by a computer (Rollings & Adams, 2003, p. 9). Core mechanics refer to how the game is played, not to how the software operates. Storytelling typically involves the retelling of the *hero's journey* – from the introduction of the ordinary world and call to adventure, all the way to the return home with the reward.

Additionally, narrative refers to the non-interactive portion of a game's story presented to the player (Rollings & Adams, 2003, pp. 110-113). Modern entertainment games use a balance of storytelling determined by the player and a scripted narrative pre-determined by game designers. Interactivity is thought of as the way the player sees, hears, and acts within the game's world - or how the player plays the game (Rollings & Adams, 2003, p. 11). A delicate balance of core mechanics, storytelling & narrative, and interactivity comprise a successful game.

Advancements in home displays and audio systems, along with new periphery equipment like motion-sensing cameras and pretend musical instruments, continue to push the boundaries of how people interact during gameplay. Coupled with the advancements in mobile devices and Internet access and it becomes clear – we are in a new frontier. A person can turn on their phone, gaming console, or computer with little effort, any time of day, and enter a gaming environment with others from around the world.

The fundamental aspects of game design provide a blueprint for designing basic games. Games takes on a variety of format – such as party, children's, and video games; but three approaches stand the test of time. Three types of games or simulation - trivia, role-play, and scavenger hunt - serve as low-cost and simple games that anyone can design. Technology is not required to design each activity, but enhances the ability of designers to create professional looking products. All three are fun to play and serve as an avenue for sharing knowledge. These activities create a deep understanding of subject areas and provide a foundation for learners to explore more complex topics. The following sections describe each type in further detail.

2.2.4.1 Trivia. According to Wexler and Sept (1994) trivia is information that is factual, non-ambiguous and validated by external sources, non-ideological, and always about the past (p. 2). Trivia represents knowledge that is generally accepted and validated in a location such as a library. “Trivia can offer a useful mechanism for mitigating the psychological burden of an explosively information-rich world, and for negotiating the complex social relations that world engenders” (Wexler & Sept, 1994, p. 1). Trivia provides critical components of knowledge that a novice can easily obtain in order to enter a new field. "Knowledge of trivia is … familiarity with subjects vital to one's survival in modernity without the thorough knowledge demanded by true expertise in these areas." (Wexler & Sept, 1994, p. 2) Trivia empowers outsiders to become knowledgeable enough to enter a new field with a basic understanding and ability to work with others.

Trivia is not known for creating compelling narratives or storytelling opportunities, but offers strong core mechanics and interactivity. The rules for trivia are straightforward: choose a card, ask the question, determine if the answer is correct, and award points. Questions are ranked by difficulty and a point value assigned accordingly. Trivia can be played individually or in a group setting. Trivia is a popular activity played throughout the United States at restaurants and sports bars and is a sponsored activity at most secondary schools.

2.2.4.2 Role-play. Role-play is another technique for exploring knowledge that makes learning fun and enjoyable. McKeachie (1986) defined role-playing as semi-structured situations where learners' behaviors are improvised to fit in with the learners' conceptions of roles to which they are assigned (p. 174). McKeachie (1986) described the purpose of role-playing as allowing for students to practice what they learned, to provide a foundation for discussion, and to develop an awareness of personal and other people's feelings. Learners reinforce concepts and understand the perspective of others through role-playing. Bonwell and Eison (1991) believed that role-playing's objectives are to arouse student interest, help students apply learning material, develop insight into group dynamics in problem-solving situations, and to provide students an opportunity to develop leadership skills (p. 234). Role-playing is an enjoyable activity that places learners in an active role and encourages group interactions.

Role-play sets the stage for storytelling and narrative since it fosters creativity and imagination. The core mechanics of role-play are simple given a list of actors, the scenario, and necessary items to act out the situation. Designers can explore limitless possibilities given the open nature of role-playing activities. Role-play thrives on interactions amongst actors and encourages people to switch roles and experience different perspectives. After the role-play is finished, groups can expand their knowledge by reflecting and asking questions about the scenario.

2.2.4.3 Scavenger hunt. Finally, scavenger hunt is a unique activity to share and reinforce knowledge. Scavenger hunts provide a series of mini scenarios to help guide learners through a new environment. Doyle, Helms, and Westrup (2004) considered scavenger hunts as a broad research field for experiential and active learning (p. 74). Scavenger hunts create experiences for learners that encourage participation and opportunities for learning, such as how international business students experience culture in new countries (Doyle, Helms, & Westrup, 2004, p. 79). Duke (2002) stated that a scavenger hunt activity allows students to analyze and synthesize concepts to prepare for higher order learning activities (p. 76). Scavenger hunts assist learners to explore new environments, interact with others, and critically reflect using authentic first-hand experiences.

Scavenger hunts lead people through a journey from beginning to end, thus storytelling and narrative play a critical role when designing a scavenger hunt. By stating a purpose for the activity and guiding participants from beginning to end, designers can guide people through a conceptual or physical journey. Expanding further on core mechanics, each step of a scavenger hunt offers detailed directions, reflection questions, and a clue for the next step in the mission. Scavenger hunts are performed individually or in teams with interactive activities performed at each destination.

Modern learning design attempts to connect people, content, and learning objectives through technology. Designers strive to ensure that learning is fun and enjoyable by using games and simulation. Activities such as trivia, role-play, and scavenger hunt are unique ways to train employees through sharing knowledge and exploring unique scenarios. Trivia is a quick and easy way to share important categories of knowledge from a given field, whereas role-play and scavenger hunt provide an in-depth exploration of unique scenarios and environments. The challenge facing organizations is how to harness the collective brainpower of employees and record all facets of knowledge in these types of unique formats. Games and simulation prove to be an intriguing method for collaborative learning and knowledge sharing.

Discussion thus far leads to the importance of carefully designing spaces for learning communities to share knowledge and engage in social construction of knowledge (SCK). Therefore understanding the process of SCK, and how groups can collaboratively create knowledge, allows designers to create game-based constructivist learning activities to create and preserve knowledge for present and future workers.

2.3 Communities Constructing Knowledge

People who share ideas and receive feedback from peers construct the most valid forms of knowledge. Insights gained from social interaction, interwoven with a learner's personal understanding, contribute to knowledge construction. Technology makes it possible to socially construct knowledge in a variety of formats, including games and simulation.

Today's increasingly capable and evolving smart device movement introduces humanity to a rich array of information, news, social networking, and chatting using text, audio, and video. The following sections review how knowledge construction and exchange occurs in social settings using technology.

2.3.1 Knowledge construction process. Vygotsky's(1978) social constructivist theory introduced the "zone of proximal development" – or the ability level a novice approaches as he or she gains an understanding and familiarity with new learning content. This notion rests on the idea that initial learning must take place in the presence of another person or guided by an expert. Knowledge construction occurs within social settings as mentors and protégés interact.

Knowledge construction and sharing involves group interactions for sharing, critiquing, and modifying all forms of knowledge concerning various subject matters. Von Krogh, Ichijo, and Nonaka (2000) described five critical knowledge creation steps: (1) sharing tacit knowledge, (2) creating concepts, (3) justifying concepts, (4) building a prototype, and (5) cross-leveling knowledge. The tacit knowledge is recorded, critiqued, published, and shared with the members of the community. The new knowledge artifact represents previously unwritten information that is now ready to share with the community. Sharing information expands the expertise of all group members and provides a system for discovering new knowledge.

In order to foster knowledge creation, certain factors must be in place. Nonaka & Takeuchi (1995) emphasized the following knowledge creation enablers: (a) *organization intention*, or an organization's aspiration to accomplish its goals; (b) *autonomy*, or allow individuals to act autonomously; (c) *fluctuation and creative chaos*, which encourages organizational exploration of the surrounding world; (d) *redundancy*, or having information that goes beyond the immediate operational requirement; and (e) *requisite variety*, or the equal access to information throughout the organization. All of the before mentioned factors require that an organization take full responsibility for knowledge creation and sharing.

Through group-mediated cognition, members obtain new knowledge because of group interactions. Stahl (2006) experimented with group cognition for middle school students and observed four phases in the process: breakdown in understanding, moments of collaboration, an effort to realign shared understanding, and cross leveling knowledge among participants (p. 312). Knowledge is constructed and transferred to the lives of community members when they interact and share ideas. Mental and social signs of cognition are seen through recorded "cognitive and linguistic artifacts that function in current activities" (Stahl, 2006, p. 314). Organizations must establish a mechanism to safeguard knowledge so that it is not lost and can be used by future generations. Additionally, an understanding of how SCK occurs within an organization provides insight into improving working relationships and collaboration.

Organizations determine levels of knowledge construction, achieved through group cognition, using a method called interaction analysis. Jordan and Henderson (1995) introduced the idea of interaction analysis to assist researchers in observing and analyzing how groups interact. The authors view interaction analysis as an interdisciplinary method for investigating the interactions of humans and the objects from their environment (Jordan & Henderson, 1995). Interaction analysis assumes that knowledge and action are social in origin, organization, and use and are situated in social or material ecologies (Jordan & Henderson, 1995, p. 41). Technology drives all aspects of learning and work among people by generating and archiving documents and other artifacts; therefore, interaction analysis performed on archived documents helps determine levels of SCK.

Expert knowledge and practice are not confined to the minds of individuals but reside in community interactions engaged with the material world (Jordan & Henderson, 1995, p. 41). Examples of social or material ecologies include audio or video recordings of group interactions as well as email, chat transcripts, and other documents. Interaction analysis intends "to identify regularities in the ways in which participants utilize the resources of the complex and social material world of actors and objects within which they operate" (Jordan & Henderson, 1995, p. 41). Generally speaking, interaction analysis provides researchers with a broad view of how groups interact with the world and objects to perform various tasks. Successful organizations that comprehend and measure how members construct knowledge take appropriate action to eliminate barriers inhibiting knowledge creation.

2.3.2 A culture of organizational knowledge sharing. Supervisory control and support have a direct impact on knowledge sharing. Li and Jhang-Li (2010) warned that for decentralized organizations without monitoring or incentive policies, knowledge sharing benefits will not be achieved - even if the community grows larger (p. 1061). Along with control, participants' levels of perceived organizational support bears an influence on knowledge sharing (King & Marks, 2008). Organizations that foster a culture of knowledge sharing will likely experience more success engaging a CoP to exchange knowledge. Yu, Lu, and Liu (2010) confirmed that groups with a knowledge sharing culture will experience greater success because "members in better sharing relationships are more likely to expand effort on knowledge sharing behaviors that benefit the whole community" (p. 38). People who feel safe and comfortable to explore new knowledge, along with finding joy in helping others, will become motivated to construct and share knowledge to benefit others.

Wise managers invest time and money into a company to oversee a CoP's knowledge construction and sharing activities. Organizations that make sharing enjoyable, and prove its usefulness, experience greater knowledge sharing behavior from online communities (Yu, 2010, p. 38). Agogué, Yström, and Le Masson (2013) believed that knowledge construction is highly dependent on a structured methodology that guides teams through project phases and allows for exploration activities (p. 18). Organizational leaders must strive to establish ways of sharing within an organization that encourage groups to take risks and discuss all implications.

Management that participates in knowledge construction and sharing brings new and broader visions of what collaboration could accomplish (Agogué et al., 2013, p. 19). For organizations where supervisory control is not possible, companies should incentivize knowledge sharing and "offer an efficient communication platform to induce cooperation among community members, offering the opportunity to self-coordinate behavior" (Li & Jhang-Li, 2010, p. 1061). If the company's communication platform is easy to use, knowledge sharing is more likely to occur. Overall, organizations with a strong knowledge sharing culture experience more active CoPs.

Individuals in communities with strong positive perceptions of the community's knowledge sharing culture are more likely to build "shared networks" and create knowledge exchanging relationships with others (Yu, et al., 2010, p. 39). Leaders must strive to create online spaces that are fun, interactive, and promote people with similar interests to connect and share ideas. Through modern technology, creating spaces for CoPs to interact and share knowledge is a realistic goal thanks to numerous web-based resources.

2.3.3 Games as spaces for sharing knowledge. Along with planning for organizational conditions that foster knowledge creation and sharing, understanding participants' learning styles assists designers to create conditions that support learning and collaboration. Foster (2011) studied the process of learning in a simulation strategy game and found that knowledge construction occurred for two types of learners: explorers and goal seekers (p. 11). Both groups displayed statistically significant gains in knowledge and skills acquisition, along with transferring knowledge between pre and post-tests. However, explorers significantly valued the experience of gaming and learning content while goal seekers did not (Foster, 2011, p. 11-15). Foster’s analysis highlighted the fact that learning through games and simulation for two opposite types of students is possible - even for those who may not enjoy the activity.

Further analysis revealed sub-categories for the explorer and goal seeker learning types. Explorers consisted of localized and comprehensive explorers, whereas goal seekers were either competitors or achievers (Foster, 2011, p. 15). Localized explorers tended to be peer helpers and focused more on building instead of managing resources. Comprehensive explorers focused on comprehensive management by balancing resources creatively. Competitors or achievers tried to beat other players more than the game itself. Achievers focused more on beating the game for personal achievement and not helping peers, but would help peers if directly asked (Foster, 2011, p. 15). Foster’s experiment made clear that communities construct knowledge in a variety of ways. Knowledge construction and transfer are possible once designers understand the conditions required for each type of learner. Designers use technology to create educational games that appeal to both explorers and goal seekers by creating environments that are interesting to play and easy to access.

Technologists and learning theorists recognized the potential of establishing a culture of sharing within online learning through *affinity spaces*. Gee (2004) described affinity spaces as physical, virtual, or hybrid portals of websites, message boards, face-to-face meetings and blogs where “newbies and masters and everyone else” interact with a “common endeavor” (p. 85). Gee emphasized the open nature of the spaces and underlined notable characteristics such as self-directed multifaceted participation, having multimodal participation opportunities, offering socialization with fellow members, flexibility with establishing leadership, and a high value for recording and sharing knowledge. Games and simulation provide for the achievement of these characteristics while using technology to establish a culture of sharing. Games and simulation are playable any time of day by both experts and novices, are great forms of socialization, encourage competition, and promote achievement.

Lammers, Curwood, and Magnifico (2012) investigated affinity spaces and concluded that the spaces broke geographic barriers, easily shared the historical record of the groups’ practices, and forced members to consider new web portals, modes, and texts (p. 50-52). Furthermore, the researchers recommended more research of affinity spaces because “as new tools and spaces are developed and gain traction, the size, scope and practices of affinity spaces will change” (Lammers et al, 2012, p. 55). Despite the fact that technology constantly changes and investments become obsolete, affinity spaces are an important topic in need of further research.

Any custom-built online affinity space can suffer from implementation challenges among community members. Chiong, Jovanavic, and Gill’s (2012) review of collaborative study groups using a knowledge recording system found that lack of participation from classmates reduced a student’s willingness to participate. Groups lacking social interaction fail to construct group knowledge. A new or innovative approach towards group learning is needed in modern class or training room. Pantelli and

Sockalingam (2005) described knowledge sharing's delicate relationship between trust and conflict. Knowledge sharing is positively related to organizations that promote trust in partnerships, discourage dysfunctional conflict, and encourage functional conflict (Pantelli & Sockalingam, 2005). Unfortunately, companies tend to overlook the importance of designing fun and enjoyable activities for group members to develop and share ideas.

When it comes to designing affinity spaces that promote knowledge creation and sharing, certain factors provide a roadmap for implementation. Braganza, Hackney, and Tanudjojo (2009) studied an advanced knowledge management platform for an oil company operating in over 100 countries and identified 30 attributes essential to the "creation, mobilization, and diffusion of organizational knowledge" (p. 499). The following attributes were statistically signficiant and important for a knowledge sharing organization:

- accessibility to knowledge
- a training program
- provide answers to user needs
- offer problem solving activities
- have knowledge brokers
- identify existing expertise – yellow pages
- have a knowledge champion
- identify subject matter experts
- communities of practice
- relevant knowledge

- an awareness program
- a recognition system
- a system for knowledge feedback (Braganza, et al., 2009, p. 516)

Of the 30 attributes, accessibility to knowledge, provide answers to user needs, having knowledge brokers, and communities of practice were more dominant than others (Braganza, et al., 2009, p. 516). The authors stressed that organizations must address these attributes before establishing a starting point for knowledge management (Braganza, et al., 2009, p. 519).

Affinity spaces provided through games and simulation for the purpose of knowledge creation and sharing enables individuals to interact with peers and validate knowledge. Vygotsky believed that high-level cognition appears twice in a person's lifetime: first as an interpsychological process and later as an intrapychological process. This is similar to a child's knowledge changing and adapting from primary school through adulthood. When a child's cognitive structure interacts with other children, adults, and artifacts, the new experiences and perspectives strengthen the child's ability to adapt and function in the future without assistance from others (Vygotsky & Cole, 1978). In other words, as a child tests and compares personal knowledge with others, the child gains new abilities and grows self-confidence.

Knowledge shared with others and accessed via artifacts or documents is a concept known as group cognition. Vygotsky referred to tools of intellectual adaptation as being culturally determined and learned by children for effective use as they grow older (Vygotsky & Cole, 1978). Vygotsky considered the beliefs, values, and tools of intellectual adaptation, created by the culture in which a person develops, as influencing all levels of cognitive function. Cognition, therefore, is socially determined and influenced by the most influential people in a person’s life. Affinity spaces, especially in unique forms such as games and simulation, facilitate group cognition by capturing the knowledge and beliefs of a certain cultural group and sharing that information with all members of an organization.

The various forms of affinity spaces offer companies a chance to create customized spaces for CoPs, posing both risks and rewards. Games and simulation are unique forms of affinity spaces with great potential for connecting peers and exchanging ideas. The ability for groups to discuss the unknown and learn from each member’s mistakes and misunderstandings form the foundation of knowledge construction. The culture and beliefs of a community influence the cognition of individual members. Therefore, creating friendly and positive spaces for people to interact and share ideas promotes the ability of groups to expand knowledge. Organizations that make an effort to understand the needs of employees and establish mechanisms to promote knowledge construction and sharing are more likely to offer genuine affinity spaces. However, one more piece is needed to go along with careful planning and a thorough understanding of concepts. Organizations require research methods to understand how the SCK process occurs among members using specific tools of interaction analysis.

2.4 Understanding Knowledge Construction: A Method for Assessing SCK

A custom-built knowledge system can be designed to construct low-risk and enjoyable knowledge games or simulation for learning or training purposes. Before attempting such a task, researchers must adopt techniques to understand how groups interact and learn in online environments. The following overview of interaction analysis, as well as presentation of a model for measuring group knowledge construction online, strengthens intentions of designing a knowledge system based on games and simulation.

2.4.1 Interaction analysis. As stated in previous sections, interaction analysis is a research technique that investigates how humans interact. Interaction analysis operates under the assumption that all knowledge and action reside in community interactions and material ecologies (Jordan & Henderson, 1995). Gunawardena et al. (1997) provided the interaction analysis model (IAM) as a technique for understanding the flow and patterns of SCK occurring through computer-mediated communication. Gunawardena et al. (1997) correlated the IAM to Vygotsky's (1978) notions of a learner's movement from lower to higher mental functions and defined five general phases. Phases I and II represent lower orders of cognition - sharing and comparing of information and dissonance, while Phases III through V represent the higher orders - negotiation of meaning, testing of proposed synthesis, and agreement statements (Gunawardena et al., 1997). The model includes sub phases within each general phase to further capture the intricacies of group cognition (Gunawardena et al. 1997). The IAM is a widely used tool for analyzing complex online interactions, such as SCK (Buraphadeja & Dawson, 2008)

Interaction analysis, in general, deploys participant observations, in situ interviewing, historical reconstruction, and analysis of artifacts, documents, and networks to help frame context (Jordan & Henderson, 1995, p. 43). The process occurs inductively and attempts to generate statements about general patterns observed from many empirical observations (Jordan & Henderson, 1995, p. 43). Interaction analysis contains "analytic foci" that are typical and prove relevant in practice (Jordan & Henderson, 1995). The analytic foci are: the structure of events, the temporal organization of activity, turn-taking, participation structures, trouble and repair, the spatial organization of the activity, and artifacts and documents (Jordan & Henderson, 1995, pp. 57-79). Researchers make sense of the complexities of group interaction following the framework of interaction analysis.

The learner's ability to interact with others sharpens their ability to construct new knowledge. Gunawardena, Lowe, and Anderson (1997) referenced Smith (1994) to define two fundamental elements of group-mediated cognition. The first is that group meetings influence an individual's cognitive and conceptual processes - referred to as group-mediated cognition. The second is a process of relieving "tension" between individual and group understandings, by exploring disagreement and dissonance in order to achieve a group consensus of meaning (Smith, 1994). The ability for mentors and protégés to interact and construct or modify knowledge enhances the ability of a community to support shared interests. Modern technology enhances the ability of organizations to record knowledge construction events and to measure learning success.

An individual benefits from communicating with others in order to build a knowledge base. Jordan (2014) wrote that an individual asks questions of a room full of people "not so much because workers don't know where the information they need is located and therefore don't know whom to ask … [but] acknowledges that anybody could hold the answer, given the distributed access to the information producing technologies and social networks" (p. 112). Organizations are complex systems that contain multiple departments and professionals. Young and veteran employees depend upon coordinating efforts and accessing important work-related knowledge to achieve organizational goals and objectives.

Distributed cognition is a concept that describes how knowledge is dispersed across all members of an organization and contained in historical artifacts or documents. Hutchins (1995) believed that the mind is in the world, not the world within the mind. He used the example of a naval vessel - the knowledge and cognition required to operate a ship is not contained in the mind of one individual; it is dispersed across objects, individuals, artifacts or documents, and tools in the environment (Hutchins, 1995). Modern organizations are as complex as a naval vessel, requiring a distribution of knowledge and cognition from several individuals to operate and perform.

The culture of an organization influences the cognition of all members. Salomon (1993) summarized that cognition is dispersed across individuals, that knowledge is constructed socially through joint efforts to accomplish common objectives within cultural settings, and that people process information using tools and artifacts provided by their culture. Distributed cognition systems place equal importance on the knowledge contained within the minds of individuals and the knowledge recorded in artifacts or documents (Halverson, 2002). Modern society accesses information available online and generates commentary via social media; therefore, distributed cognition is now a reality. Interaction analysis research provides researchers the tools for understanding complex interaction, such as distributed cognition, in order to assess both lower and higher levels of SCK.

2.4.2 Interaction Analysis Model (IAM). A table of messages generated during a group's knowledge construction process allows researchers to measure knowledge construction. Gunawardena, Lowe, and Anderson's (1997) IAM (see Figure 3) provides a system for measuring frequencies and levels of knowledge being constructed in an online forum. Some studies consider Phase III of the IAM, negotiation of meaning and co-construction of knowledge, as the initial phase in which knowledge co-construction occurs , whereas other studies (Lang, 2010) include Phase II, discovery and exploration of dissonance, as a part of knowledge construction.

Studies interpret the IAM model broadly and devise numerous ways to count SCK. Marra (2006) pointed out that the majority of studies using IAM report percentages of codes in each of the five phases, followed up by discussion of how many messages fall in level III or above (where knowledge construction first takes shape). Interestingly, previous studies (e.g., Kanuka & Anderson, 1998; Lang, 2010) found that Phase I, sharing and comparing of information, is the predominant activity that occurs within computer based discussions, not group knowledge construction. Investigation is warranted as to why, even though knowledge sharing is strong, people hesitate to construct new knowledge in an online setting.

Phase I: Sharing/Comparing of Information. Stage one operations include:
A. A statement of observation or opinion.
B. A statement of agreement from one or more other participants.
C. Corroborating examples provided by one or more participants.
D. Asking and answering questions to clarify details of statements.
E. Definition, description, or identification of a problem.

Phase II: The Discovery and Exploration of Dissonance or Inconsistency Among Ideas, Concepts, or Statements.
A. Identifying and stating areas of disagreement.
B. Asking and answering questions to clarify the source and extent of disagreement.
C. Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view.

Phase III: Negotiation of Meaning/ Co-Construction of Knowledge
A. Negotiation or clarification of the meaning of terms.
B. Negotiation of the relative weight to be assigned to types of argument.
C. Identification of areas of agreement or overlap among conflicting concepts.
D. Proposal and negotiation of new statements embodying compromise, co-construction.
E. Proposal of integrating or accommodating metaphors or analogies.

Phase IV: Testing and Modification of Proposed Synthesis or Co-Construction
A. Testing the proposed synthesis against "received fact" as shared by the participants and/or culture.
B. Testing against existing cognitive schema.
C. Testing against personal experience.
D. Testing against formal data collected.
E. Testing against contradictory testimony in the literature.

Phase V: Agreement Statement(s)/Applications of Newly-Constructed Meaning
A. Summarization of agreement(s).
B. Applications of new knowledge.
C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction.

Figure 3. Interaction Analysis Model for examining social construction of knowledge in computer conferencing (Gunawardena et al., 1997, p. 414)

Lucas, Gunawardena, and Moreira's (2014) critique of the IAM model confirmed the propensity for sharing and comparing (IAM's Phase 1) across a variety of designs and communication tools. The authors found almost "non-existent" indicators for Phases IV and V across studies using IAM (Lucas et al., 2014, p. 577). Discussion goals set for problem solving, instead of goals set for discussion of assignments and reporting of daily activities, increased the likelihood that group discussion will enter the higher phases of the IAM model (Lucas et al., 2014, p. 580).

Gunawardena (2014) acknowledged the lack of dissonance (IAM's Phase II) displayed during group discussions and questioned if it truly is a prerequisite for group knowledge creation, or simply, a western or American philosophy. It is suggested that the IAM's higher levels need further consideration and perhaps be merged into one unique phase (Lucas et al., 2014, p. 580). The authors urged researchers to continue the investigation of how various technologies use the IAM model to understand the benefits for learning and to provide insights how students learn when interacting online (Lucas et al, 2014, p. 580). The interaction analysis model is a widely accepted method for measuring SCK through interaction analysis and used by numerous other studies in a variety of contexts. Due to its focus on knowledge creation and established research base, the IAM model positions itself as the ideal rubric for performing content analysis and determining SCK.

2.5 Summary

The era of ubiquitous Internet access and limitless connectivity pushes the boundaries for learning and training. Therefore, the tools and theories required for studying such systems are equally complex. Discussion thus far leads one through a vast landscape of ideas, technology driven human systems, games and simulation, knowledge construction, and interaction analysis techniques (see Figure 1). From the foundations of HCI, to Kuuti's (1996) activity theory and Engeström's (1987) activity system model, research into the multifaceted nature of human behavior must now include technology. Connectivism ties all the components together and highlights the complex relationships humans share with one another.

Technology provides a foundation for personalized learning while at the same time facilitating group work. Collaboration is a critical component of the workplace that thrives within systems that adapt and expand to maintain pace with technology. The ability to gather feedback from users and integrate suggestions into design increases the likelihood of product success. Better yet, rapidly deploying technology and performing adjustments when needed keeps systems up-to-date and well liked by users. From the past quarter century of technology being a major influence in the home and office, teachers, students, and researchers continue to learn what is feasible and what obstructs from learning and performing work.

Games and simulation are popular forms of learning that come from an experiential constructivist philosophy. Both generate learning scenarios and group interactions that are difficult to achieve in real life, thanks to technology support. Gamification of school or work environments is an exciting idea that appeals to both students and workers. To design games for learning or training, first learning goals and other educational factors are identified. Second, choosing a game or simulation design to achieve the desired outcomes follows (Moreno-Ger et al., 2008). Trivia, role-play, and scavenger hunt activities are examples of games or simulation that are appropriate for learning and training situations. All three make possible the inclusion of the fundamentals of game design – core mechanics, storytelling and narrative, and interactivity (Rollings & Adams, 2003) – all the while offering personalization and flexibility. Knowledge is incorporated into games or simulation by designing the activities to share and play with others.

Organizations that deploy knowledge construction and sharing initiatives must not underestimate the impact knowledge transfer will have on organizational culture. Sharing tacit knowledge, creating and exploring concepts, building a prototype, and cross-leveling knowledge are the critical knowledge creation stages requiring support at each milestone (Von Krogh, Ichijo, & Nonaka, 2000). An understanding of the knowledge creation process, along with establishing knowledge enablers, assists organizations to create a culture that supports the free-flow of knowledge. Based on this philosophy, online affinity spaces encourage members of all learning types to engage with peers and to construct individual and social knowledge.

In order to verify whether or not knowledge creation and sharing is occurring within complex human systems, interaction analysis serves as a research method to measure human collaborations. Interaction analysis operates under the assumption that all human knowledge and action reside in community interactions and material ecologies (Jordan & Henderson, 1995). One particular model, Gunawardena's, et al., (1997) IAM, gives researchers a coding scheme for assessing SCK in computer-mediated environments. Phase I - sharing and comparing of information, and Phase II - discovery and exploration of dissonance, represent lower orders of cognition. On the other hand, Phase III – negotiation of meaning, Phase IV – testing and modification of proposed synthesis, and Phase V - agreement statements and applications of newly constructed meaning, represent higher orders of cognition. The IAM model applied to human interaction captured through computer-mediated communication, such as electronic messages, is a popular tool used by researchers to assess levels and patterns of SCK occurring online.

Commentary thus far places an emphasis on experimental constructivist learning environments and group cognition through affinity spaces. Collaborative games and simulation construction are proposed activities within spaces where people who share similar interests can generate knowledge. Thus, it is appropriate to explore how and if a group will construct knowledge within an online affinity space using games and simulation as a template. The following chapter describes a research study that explores such possibilities.

Chapter 3

Methods

A database system called the *knowledge game center,* created using FileMaker™ technologies and made available through any web browser, was the primary system used for this study. This chapter begins with an overview of the knowledge game center system, including the administration of and requirements for participation. Discussion will shift towards the research design of the study, criteria for recruiting participants, data collection techniques, and the data analysis approach for this study.

The study used a quasi-experimental mixed methods design to determine SCK that occurred in three different game creation templates. Researchers in natural settings use a quasi-experimental design where data collection is possible, but random assignment of a treatment is not (Campbell & Stanley, 1963). The researcher is thought to have limited leverage and control over the selection of study participants (Levy & Ellis, 2011).

In order to determine causality of a phenomenon, such as how SCK occurred online among different types of learners, the researcher recruited teams of people who share similar interests and were willing to participate. Therefore, random assignments of participants to teams or topics for discussion were not possible. Conversely, the order of games to create by each team was randomly assigned. Thus, a quasi-experimental approach was adopted by this study.

Qualitative data collection, along with quantitative measures of how much SCK occurred, provided a deep understanding via mixed-methods. Based on the topics and theories presented, the research questions were:

(1) Which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) as participants use each template to create a knowledge game?

a. Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?

b. Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?

c. Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application).

d. Which game template shows the progression of knowledge creation from Phase I to V?

(2) What factors influence SCK as participants engage in constructing games?

(3) What are participants' perceptions of their ability to construct the games?

(4) What do system usage data show about a team's knowledge construction patterns (time spent on task, system navigation trends, amounts of words used, and game items created)?

The first main question and its four sub questions addressed the quasi-experimental design of this study. The final three questions explored qualitative information gathered from participants to understand the main question. Table 1 presents the major components of this study.

Table 1

Research Methods Overview

Research Questions	Design	Participants	Instruments	Analysis Methods
(1) Which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) as participants use each template to create a knowledge game?	Quasi-experimental mixed methods study with random assignment of order of games to build.	Three person teams of adults eighteen years or older.	Transcription of teams' messages using the IAM model for evidence of SCK (overall). (Quantifiable measure)	Repeated measures ANOVA analysis of amounts of SCK occurrences per round within each game template type.
(Sub question 1a) Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?	"	"	Transcription of teams' messages using the IAM model for evidence of Phase I. (Quantifiable measure)	"
(Sub question 1b) Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?	"	"	Transcription of teams' messages using the IAM model for evidence of Phase II. (Quantifiable measure)	"
(Sub question 1c) Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application)?	"	"	Transcription of teams' messages using the IAM model for evidence of Phases III-V. (Quantifiable measure)	"
(Sub question 1d) Which game template shows the progression of knowledge from Phase I to V?	"	"	Transcription of teams' messages using the IAM model for evidence of message showing progression of Phases I-V during the construction of a particular game. (Quantifiable measure)	Repeated measures ANOVA analysis of frequency of IAM model's phases I through V demonstrated progression within each game template type.
(2) What factors influence SCK as participants engage in constructing games?	Researcher observations recorded on observation form (Appendix A) and auto-generated game completion surveys.	"	Thematic review and content analysis of observations for SCK. Game completion surveys. (Qualitative Aspect)	Observation conclusions (e.g., quality of games created, team participation, technology challenges). Game completion survey results.
(3) What are participants' perceptions of their ability to construct the games?	Personal interviews conducted at end of game creation (Appendix B) and auto-generated game completion surveys.	"	Thematic review and content analysis of interview transcripts for SCK. Game completion surveys. (Qualitative Aspect)	Participant interview highlights. Game completion survey results.

Table 1 (continued)

(4) What do system usage data show about a team's knowledge construction patterns (time spent on task, system navigation trends, amounts of words used, and game items created)?	Compilation and analysis of system usage data.	“	System usage data. (Quantifiable measure)	Connection logs, system usage data, and game building trends (e.g., average amount of words used, number of items created per game, time elapsed).

3.1 Knowledge Game Center Design

An online FileMaker™ database system presented game templates to participants for creating knowledge games. The database was built using computer programming scripts, game form templates, a message posting system, and an email reminder notification system. The *knowledge game center* was used to discuss and socially construct *knowledge games* that were worthy of becoming organizational training tools.

3.1.1 Administering the study Overall, the knowledge game center looked and felt like a website. The screen area included components like navigation buttons, links to team and individual profile pages, a game building progress section, knowledge game printing pages, and the templates themselves. Each game template and its subsections consisted of text boxes, drop down lists, help and example sections, and navigation buttons that helped teams construct games.

The following images are screen captures from the system. The images display the knowledge game center's home screen, the discussion messaging system, and each game building template. Figure 4 represents the main home page for the knowledge game center.

Figure 4. Knowledge game center home page

Underneath each game template construction area will be a discussion message system (Figure 5) where teams can communicate and save a record of their conversation. The purpose of the message system was for participants to seek clarifications, debate, and share information pertaining to creating each game. The participants were able to review the history of all messages, create a new message, and reply to any message. The messages were displayed in a scrolling portal of messages.

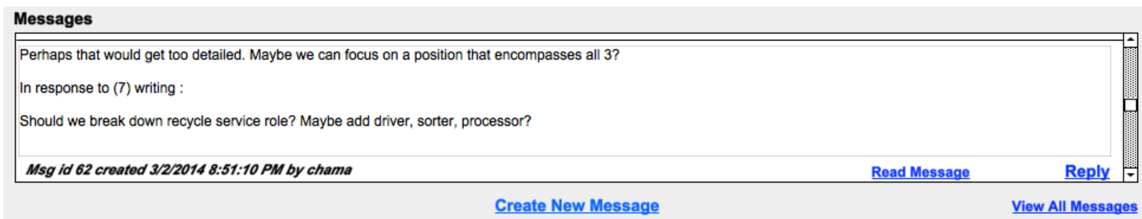


Figure 5. Knowledge game center message

The knowledge games that each team built were trivia (Figure 6), role-play (Figure 7), and scavenger hunt (Figuer 8).

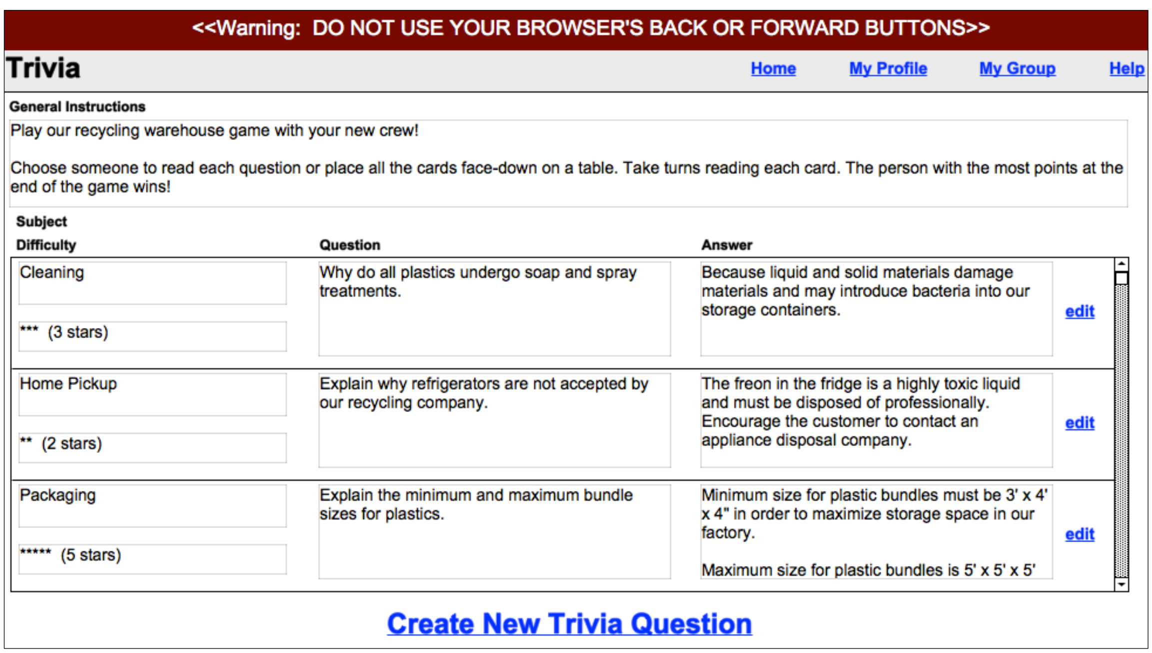


Figure 6. Trivia Template

In terms of each template's details, the trivia game template (Figure 6) included a text box for the activity's general instructions. The participants added trivia questions underneath the instructions. Trivia questions included data fields for subject, difficulty, the question, and the answer. Teams were asked to choose three to five subjects and create as many questions as they possible, with the recommended amount being 25 questions.

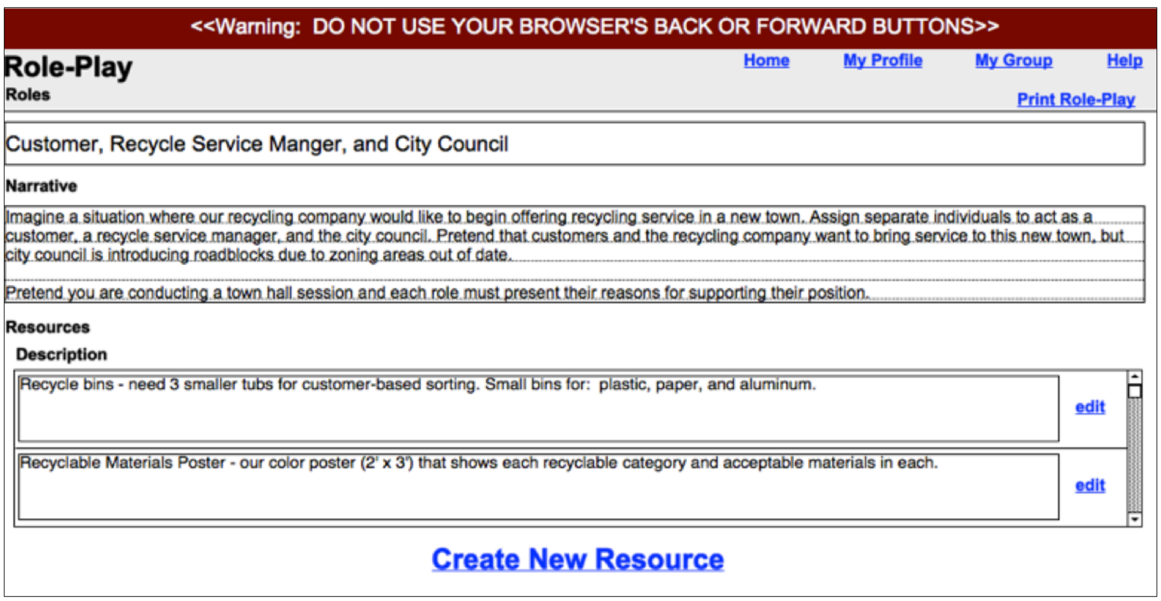


Figure 7. Role-play template

The role-play template (Figure 7) included a general instructions text box to describe and stage the role-playing activity. Items (or resources) for the activity, such as website links or references to pictures, audio clips, movies, and other electronic documents were chosen by the participants to enhance the scenario. The data field for each role-play resource item was a text box that contained a description of an item or a web link to the item stored online. Three to five roles, along with three to five resources for conducting the activity, were recommended.

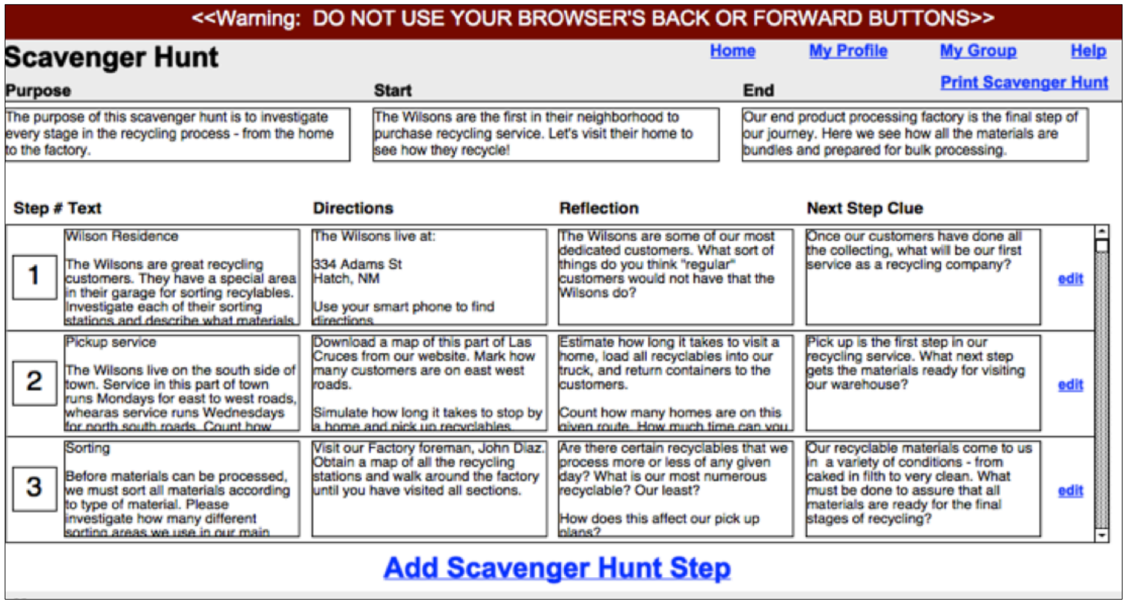


Figure 8. Scavenger hunt template

Finally, the scavenger hunt (Figure 8) template included a box to describe the purpose, starting scenario, and ending scenario. Each scavenger hunt step helped the learner travel around the work environment. The scavenger hunt steps included a general text box, directions, a reflection question, and the next step clue. Five to seven steps were recommended for each scavenger hunt.

Teams accessed a *game finished verification section* (Figure 9) linked from the bottom of each template. The verification system provided a menu for a team to indicate that a game was finished. Once a team marked a game complete, the team could not further modify game. Teams were allowed to read locked versions of the games if they chose to reference them for construction of other games.

Figure 9. Game finished verification section

The knowledge game center served as the primary engine for participants to build games and communicate.

3.1.2 Knowledge game center participation Teams of three people constructed games containing organizational knowledge suitable for sharing and playing with others. Participants were assigned a username and password to access the system through secure connections.

Teams were randomly assigned one of the three game templates to build when they first began the study. Upon completing the first task, the remaining games were randomly assigned, in sequence, for completion. Teams who completed at least the first game were included in the study. The researcher encouraged teams to finish all three games; but teams that did not complete all three games still had all research questions addressed. Teams that dropped out before completing the first game were removed from the study.

Built-in instructions, examples, and hints helped learners use each game template. The knowledge game center used programming scripts to operate the system. Teams were required to communicate exclusively through the knowledge game center to record team conversations and share ideas regarding the creation of each knowledge game. Participants received email updates requesting their participation in the team's game construction. Participants used all means necessary to obtain Internet access in order to access the games. The researcher oversaw and maintained the knowledge game center system throughout the research.

3.2 Research Design

This study employed a quasi-experimental, convergent parallel mixed methods design. Venkatesh, Brown, and Bala (2013) reviewed past mixed methods studies involving information systems (IS) and recommended guidelines for conducting mixed methods research in the future. The authors encouraged a mixed methods approach when a "holistic understanding of a phenomenon for which extant research is fragmented, inconclusive, and equivocal" (Venkatesh, Brown, & Bala, 2013, p.38). Given the broad framework of this study – CoPs, knowledge creation and measurement, and experimental constructivist learning - a quasi-experimental mixed methods approach provided a comprehensive view of how SCK occurs online through games.

3.2.1 Mixed methods Creswell (2009) defined mixed methods as an inquiry approach that involves philosophical assumptions, has both qualitative and quantitative data collection, and mixes both approaches to perform research (p. 4). This study operated under a philosophy of knowledge creation, as presented by Von Krogh, Ichijo, an Nonaka (2000), Conway and Sliger (2002) and Salisbury (2009), that successful and innovative organizations need to record knowledge and enable a culture of knowledge sharing to thrive. Game based learning philosophies presented by Prensky (2001), Aldrich (2005), Gee (2004), et al., call for research to introduce fresh and innovative approaches for sharing knowledge among adults. From this perspective, a theoretical lens of pragmatism is adopted to research the broad ideas presented by the research questions.

Pragmatism requires a focus on the research questions and necessitates multiple methods of data collection to inform the problems underlying the study (Creswell & Plano-Clark, 2011, p. 41). The research questions for this study provided an umbrella of inquiry that called for observations, interviews, analysis of computer messages, administering game completion surveys, and review of system usage data to formulate conclusions. Research data gathering opportunities were merged and critiqued to present an understanding of the research questions.

Creswell and Plano-Clark (2011) described a convergent parallel design as when the researcher collects and analyzes both quantitative and qualitative simultaneously during the research phase and merges the two strands into an overall interpretation (p. 77). Based upon the qualitative data collection through researcher observations and participant interviews, as well as the quantitative analysis of IAM model (Gunawardena et al., 1997) coded message transcripts, results of game completion surveys, and review of system usage data (e.g., system access records, learner tracking information, and the number of games and messages produced), the exploration of how knowledge creation occurred online using games was pursued.

3.2.2 Quasi-experimental A quasi-experimental design, as defined by Green (2010), aims to investigate the causal effect of an intervention on a target population without randomization. Campbell and Stanley (1963) first distinguished this research approach by describing natural settings where experimental design could be introduced to data collection schedules (e.g. the when and whom of measurement), but is lacking the full control of scheduling of experimental stimuli (e.g. the when and to whom of exposure) (p. 34). The teams were self-forming and the researcher asked teams to participate on a volunteer basis. The intervention for this study was the random assignment of the order of game templates to construct knowledge.

3.2.3 Qualitative aspect The study deployed Lincoln and Guba's (1985) naturalistic research approach to gather data from the participants and system until theories took shape. The researcher used Glaser and Strauss's (1985) constant comparative approach to build emergent and initial data categories that described how SCK occured within the system. Themes and categories from the interviews and observations were compared to the findings revealed by the IAM message coding, game completion surveys, and system usage data. The researcher merged the results to connect findings and draw interpretations.

3.3 Participants

3.3.1 Population. Teams from a variety of professions and organizations were asked to participate in the study. The population consisted of individuals who live and work in the United States. All participants were at least eighteen years old. No student teams were selected from a K-12 public or private school settings. The participants had varying levels of education from high school diplomas to higher education degrees. The researcher screened participants for basic reading, writing, and keyboarding skills. Additionally, participants were screened for basic understanding of computers and Internet web browsing.

3.3.2 Sampling procedure. A snowball and opportunistic purposeful sampling approach was used to obtain adequate amounts of participants. Creswell (2007) defined snowball sampling as when the researcher "identifies cases of interest from people who know people who know what cases are information rich" (p. 127). Additionally, opportunistic sampling, or sampling that follows new leads and takes advantage of the unsuspected was employed (Creswell, 2007, p. 127). The researcher encouraged people to refer others to the study's recruitment website and explored all possibilities for recruiting participants. Overall, purposeful sampling (Creswell & Plano-Clark, 2011, p. 174) guided the researcher to screen participants who are willing and able to share and construct knowledge.

Past studies that adopted the IAM model for measuring knowledge construction varied in amount of participants. Hou, Chong, and Sung (2009) recruited 470 volunteer teachers to construct online blogs, whereas Wang, Woo, and Zhao (2009) followed 17 students through a semester long education course. Another study by Lucas and Moreira (2010) recruited 56 postgraduate students studying educational multimedia to discuss course content online. This study aimed to recruit a maximum of 60 total participants, or 20 three-person teams.

The study's website was used as the main recruitment tool. It was shared through professional networking and social media advertisements such as in Facebook™, LinkedIn™, and Reddit™. Recruitment posters were shared on public bulletin boards, Craigslist™, and other Internet bulletin board services. Professional networking and oral presentations were the primary recruitment efforts utilized by the researcher.

The website's homepage provided a brief background for the study, such as the necessity for knowledge sharing and creation and how games can be a way to achieve both. Remaining pages explained the purpose of the study, requirements and expectations for participation, and a web form to contact the researcher. Images or descriptions of the knowledge game center and the types of games to build were not shared through the website. The website consisted of four sections: (a) a home page providing an overview of knowledge sharing and its purpose, (b) the general research purpose and requirements (including research protocols, forms), (c) the database's login portal, and (d) a researcher contact form for those who are interested in participating. Figure 10 displays the website (visit http://www.kgcenter.net) and a screenshot of its homepage.

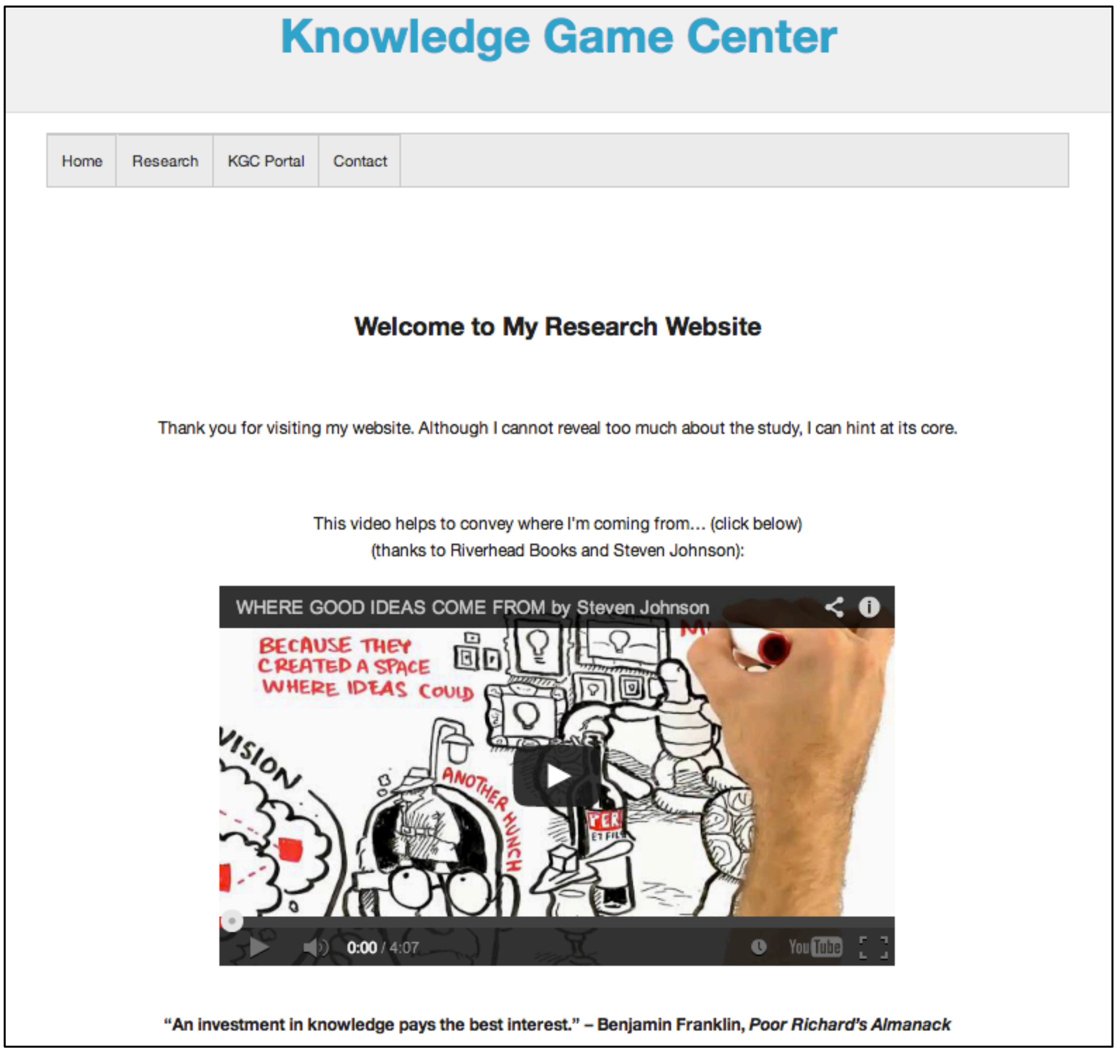


Figure 10. Knowledge game center website

Protocol presented included time and effort expectations for participants, how to request technical assistance, and tips for forming teams. Consent forms, disclaimers for organizations, and time requirements for participation were the remaining details made available through the website. The knowledge game center's login portal was a hyperlink to the system where a participant used an account and password to enter.

3.3.3 Setting and location. A FileMaker database system hosted by a web server used password-protected accounts to facilitate knowledge games creation. The participants used computers, smart phones, or tablets to access the system via a web browser and the Internet. The FileMaker login portal was linked from the study's website.

Teams were required to discuss the games only within the system's messaging system. The researcher tested accessing the knowledge game center through computers, smart phones, and tablets through similar work related projects using FileMaker instant web publishing technologies. The researcher assisted participants with technology issues and supported the understanding of the game formats being constructed.

3.4 Instrumentation

Tools for gathering research data included researcher observations notes, interview transcripts, game completion and demographic surveys, and computer messages generated by the participants. Furthermore, programming scripts allowed the system to auto-generate system usage data (i.e. connection date and time, knowledge game center activities, amount of game items created). The surveys and game templates contained text input boxes, drop down lists, and checkmark boxes. Table 2 presents the instrumentation for this study.

Table 2

Research Variable Construct, Assessment, and Examples

Construct	**What is being assessed?**	**Example of items**
Observations	Team's process of knowledge creation, quality of knowledge being constructed, and technology performance.	Game creation, team participation, team communication, understanding of game template, need for technical assistance, etc.
Interviews	Participants' perceptions of knowledge creation through the co-construction of games.	Open-ended questions regarding how the team formed, shared ideas, communicated, collaboration challenges, which game is ideal for the profession, etc.
Analysis of message transcripts	Occurrences of SCK according to the IAM model (Gunawardena et al., 1997).	Interaction analysis of number of occurrences of a team's messages display evidence of knowledge construction (IAM Phase I, II, and III-V) per game template type. Results of repeated measures ANOVA tests on game template type.
Game completion surveys	Participants' experiences during the construction of each game.	Ten point Likert scale ratings for levels of team interaction, contribution, communication, leadership, and value of game created.
System usage data	Participant behaviors and actions within the system.	System access records, learner tracking information, and the number of games and messages produced.
Demographic surveys	Demographic data for reporting purposes.	Gender, country of origin, education level, age range, employment status, amount of time associated with company, and self-rating of computer skills.

3.4.1 Observations Observations were designed following Creswell's (2007) steps for qualitative observations (pp. 134-135). Observations were conducted after each team completed each game. The reviewer remained a silent observer, did not intrude on any team meetings, and only offered basic technical support.

Observation forms recorded general information such as location, date and time, type of game being created by the team, and how participants were accessing the system.

A rubric for assessing the process of knowledge creation, quality of knowledge created, and technology performance structured observations. The researcher rated sub-questions from each area using a four point scale, with zero representing not observed, one representing low, two representing mid, and three representing high observational evidence. An open notes section provided the researcher an area to document any other information following Bogdan and Biklen's (1992) recommendation to record aspects such as physical settings and/or particular events or activities.

3.4.2 Interviews Voluntary interviews were conducted after a team completed all three games (see Appendix B). The researcher attempted to interview all team members. Interviews were conducted following Creswell's (2007) general description of interviewing steps (p. 132-133). An ideal time and method for each interview was scheduled between the researcher and participants. The researcher conducted one-on-one, face-to-face interviews when possible. Otherwise phone interviews were used instead.

The researcher developed 11 interview questions that were based on the research questions for this study. The researcher recorded notes during the interview using an interview form (see Appendix B). An audio recorder recorded the interview and was later transcribed for analysis.

3.4.3 Analysis of message transcripts The researcher transferred each team's communication messages into a spreadsheet for content analysis according to theories presented in Gunawardena et al.'s (1997) IAM model. Spreadsheet columns for the IAM model's five phases and all subphases will helped coders measure SCK. The spreadsheet also included the message number, date, time, a list of reference post numbers, markers for social interactions and project management, and a general comment field for coders' notes. A coding spreadsheet was generated for each game created by each team.

3.4.4 Game completion surveys Participants responded to five question game completion surveys to gauge the knowledge creation occurring within the team. The surveys were generated by the system after a team constructed each of the three games (see Appendix C). Surveys contained five 10-point Likert scale questions modeled after Gee's (2004) affinity spaces. Questions asked the participant to rate levels of team interaction, contributions, communication, leadership, and intentions of sharing with others. Also, a free-response text box was provided for reporting other information.

3.4.5 System usage data Additionally, system usage data was analyzed and statistics calculated to gauge participants' SCK experiences transpired. The knowledge game center created "event" records to capture all action that users perform. The event records included data fields for learner number, time created, and text data to describe the action taking place. The text data was modeled according to the Tin Can application-programming interface (API) (see http://tincanapi.com/overview) to track participants' actions. The Tin Can API specification for learning technologies enables system designers to capture data in a consistent format of a person's stream of activities occurring within a given technology. Event records were reviewed and reports of time and participation based on system usage data such as a participant's time accessing the system, knowledge game center navigation trends, game creation tendencies, and other summary results. Table 2 reviews the research variable constructs that guide the instrumentation used in this study.

3.4.6 Demographic surveys A seven question demographic survey was administered to all participants once initial access was granted to the system (see Appendix D). Questions included gender, country of origin, education level, age range, employment status, time associated with company, and self-rating of computer skills. The data was used to describe the participants.

3.5 Data collection

3.5.1 General procedures A relational database system provided a framework for collecting data gathered throughout the teams' knowledge construction processes. Observation notes, personal interviews, game completion surveys, and team messages provided the means to measure team knowledge construction. Thematic review and content analysis of the observation notes, personal interview transcripts, and coding of teams' messages, along with analysis of game completion surveys, measured evidence of SCK. Additionally, system usage data were auto-generated using programming controls to provide supporting information.

Throughout the research, the investigator completed observation forms after each team created each game. Observations included date, time, details of the observation, and a rubric for critiquing the knowledge game and team interactions. All observations were stored within the knowledge game center and kept hidden from the participants (see Appendix A).

Follow up personal interviews were scheduled as soon as each team finished creating all three game. The researcher attempted to interview all members of a team. The researcher to conducted the interview within one month of a team finishing. Interviews lasted 10 to 15 minutes and notes were recorded on an interview protocol form (see Appendix B). The conversation was audio recorded and later transcribed for analysis.

3.5.2 System procedures Game templates were introduced in random order. The system handled the randomization assignments and tracked each team's game creation progress. An email notification system provided email alerts reminding team members to participant or to alert of an approaching deadline. Until the team marked the template as complete, the system sent reminder emails to each team member every three days. Teams were expected to immediately start creating the next game after creating a given game.

3.6 Data analysis

Determining evidence of team knowledge construction occurred using five research variable constructs (Table 2). The first two constructs, observations and interviews, involved thematic review and a qualitative content analysis of research instruments. The third technique involved coding of computer messages for SCK according to the IAM model (Gunawardena et al., 1997). The fourth approach reviewed results of game completion surveys and the fifth approach analyzed system usage data to reveal trends of the SCK occurring within the study. See Tables 1 and 2 for an overview. The five areas were merged in order to compare and contrast research data. The demographic surveys were used to describe the participant population.

Creswell and Plano-Clark (2011) encouraged a merged data analysis for convergent mixed methods studies. Merged analysis consists of merging the results, assessing whether the quantitative and qualitative data agree or disagree, and if in disagreement, "analyzing the data further to reconcile the divergent findings." (p. 223). The researcher created a joint display of research to present the quantitative and qualitative research findings, along with overlapping themes or categories, to report results (Creswell & Plano-Clark, 2011, p. 226).

3.6.1 Observation and interview analysis A thematic review and content analysis of observations notes (see Appendix A) revealed trends of knowledge construction from the perspective of the researcher. Averages of the researcher's four point Likert scale scores were calculated for each sub-question and presented in summary table form. An overview of conclusions presented in narrative form, along with examples of games created or messages from the system, further detail the observations. Identifying information on the games were graphically modified to protect the anonymity of the participants.

Additionally, personal interviews (Appendix B) were conducted on a wide variety of participants of the study. A thematic review and content analysis of interviews revealed perspectives held by the study's participants concerning SCK occurring online through games. The interviews followed a protocol form and were audio recorded using a voice recorder. Responses were transcribed from the audio recordings and analyzed according to this study's research questions. Quotes and a summary of interview responses are presented in the analysis section.

3.6.2 IAM coding Each game template provided a messaging system for participants to communicate as they built each game. The messages were coded using the IAM model (Gunawardena et al., 1997) for evidence of SCK occurring in Phases I, II, and III through V (see Figure 8), as discussed by Marra, Moore, and Klimczak (2004). Past studies generated 122 posts for only 17 participants (Wang, Woo, and Zhao, 2009), whereas large-scale studies generated 1455 messages for 470 participants (Hou, et al., 2009).

The messages were reviewed and transcribed by experienced coders familiar with the IAM model. The dependent variable, the amounts and levels of SCK in messages coded according to the IAM model, is a continuous ordinal variable since values occur in five intervals, Phases I through V. Messages containing one or more count of SCK, and the degree to which SCK occurs using the IAM model's five phases, are reported as done in past studies (e.g., Shellens & Valcke, 2005). Coding results are reported in chart and table form.

A successive-treatment design was deployed to randomly assign the order of games to build for each team. This study calculated a repeated measures ANOVA test for teams that fully complete all three game constructions (see Table 1). A repeated measures ANOVA test was performed on each team's three game building rounds to determine if the amount and types of SCK occurring was significant. As presented in Keppel and Wickens (2004), a repeated measures ANOVA test is appropriate when an opportunity is available to make more efficient use of subject resources, provide more consistent research conditions, and reduce the error variance (p. 369). The *F*-statistic was calculated for each game building round.

Concerning assumptions (Keppel & Wickens, 2004) that must be met for a single factor and repeated measures ANOVA, the categorical independent variable was game template type. Game template type has the categories of trivia, role-play, and scavenger hunt. The continuous dependent variable was the number of incidences of codified messages containing evidence of SCK as determined by the IAM model. All statistical analysis was performed at a 95% confidence level and conducted using IBM's SPSS™ statistical software.

Homogeneity of variance was determined using Levene's statistic and ratio comparisons of large and small variances among the means. Normality tests such as skew and kurtosis tests, analysis of Q-Q and detrended normal Q-Q plots, review of Kolmogrov-Smirnov and Shapiro-Wilk tests, and analysis of histograms were used to test for normal distribution. Assuming homogeneity of variance and normality and to control type I errors, post hoc comparisons using Tukey's procedure were performed. Outliers were detected using SPSS and adjustments were made to deal with the outliers. Sphericity was tested in SPSS using Mauchly's Test. Effect size was determined by calculating the omega-squared statistic.

The researcher employed two independent coders familiar with the IAM coding system to review the messages. Inter-rater reliability was calculated using Cohen's (1960) kappa, with a moderate agreement value of 0.40 to 0.74 being the range of acceptable reliability. Studies using the IAM framework were found to use Cohen's kappa as an alternative way to determine inter-rater reliability (De Wever, et al., 2006; Lucas, et al., 2014). Differences in codes were rectified through review and discussion between coders using Marra's et al. (2004) approach's "post inter-rater reliability discussions" that allowed for coding discrepancies to be discussed, re-determined, and reported (p. 31). Pre and post inter-rater statistics were collected to check for agreement between coders before and after this meeting.

3.6.3 Surveys and system usage data Game completion surveys were calculated for average response scores from a 10-point Likert scale. Scores range from one to 10 (low to high). Scores were disaggregated according to game template type and presented in summary table form. Free response excerpts of participants are included to enhance findings.

Demographic surveys responses are presented in summary table form. The researcher used the information for reporting the sampling characteristics of participants. No statistical testing was performed on demographic data in relation to SCK or any other potential outcome of the study. The researcher classified each team as a student, business, or hobbyist team and presented the classification alongside demographic data.

Finally, system usage data were produced by the FileMaker system. Chronological information, such as system access information, time spent creating games, participation patterns of teams, number of trivia questions generated per team, amounts of role-play resources added per team, and number of trivia questions, role-play resources, and scavenger hunt steps used per team were tabulated. Additionally, the system recorded when a user answers, attempts, completes, creates, interacts, and voids (delete) any part of each knowledge games. This type of quantitative data helped provide insights into the knowledge construction process to support triangulation, reduce threats to validity, and provide support for findings.

Chapter 4

Analysis of Results

The knowledge game center formed an activity system to investigate how experts interact and create knowledge online. Engeström's (1987) activity system elements –the subject, object, community, tools, rules, and division of labor – are contained within the knowledge game center. The knowledge game center organized and captured the activity system's interconnections through system navigation menus, participant messages, the games themselves, and reminder notifications from the system. The elements are recorded through participant messages, researcher observations, interview transcripts, survey results, system data, and of course, the game templates.

Figures 6, 7, and 8 provide readers a visual representation of each game template. The trivia template asked for general instructions and multiple trivia questions containing a subject, difficulty rating, question, and answer. The role-play template required a general description of the roles and scenario, plus brief descriptions for each required resource. Scavenger hunt had an overall purpose, starting narrative, ending narrative, and steps along the way - each requiring a narrative of the current location, directions on how to get there, a reflection follow-up on the current location, and finally a next step clue. The previous chapter described the system's framework and research methods to measure the activity system's elements. The current chapter highlights the participants' experience and analyzes the interactions that took place.

An overview of demographic data is first presented in order to examine the participants' backgrounds. Next, message coding according to the IAM model and results of ANOVA testing are reported. Following are interview highlights and observation results. Game completion survey results and a report on system usage data provide the last interpretations of how SCK occurred within the knowledge game center.

4.1 Demographics

The study took place between September 2014 and May 2015. The research study involved students, business professionals, and hobby enthusiasts who shared common interests. This chapter provides the results of analysis from data collection.

Recruitment produced 12 three-person teams, or 36 total participants. Participants were all located within the United States and were English speakers. Table 3 presents an overview of each team and the knowledge area each team addressed in random order.

Table 3

Team Overview

Type of Team	General Knowledge Area
Student	How to use YouTube, social networks, and wikis
Hobbyist	Southern Colorado road trip
Student	How to use Lynda.com, Khan Academy, and Massive Open Online Courses (MOOCs)
Student	Overview of educational gaming and simulations
Student	Recruitment for potential math department majors
Business	Title I, Part C grant service delivery
Student	Techniques for eliciting language in preschool
Student	Unit activity on The Diary of Anne Frank
Business	Establishing an essential oils business for mind and body
Student	Introducing educational technology into classrooms
Business	Campus orientation games for community college students
Student	How to create a flipped classroom

A total of 36 participants took part in the study. Nearly all the participants were female. The participants consisted of 81% females and 19% males. Table 4 displays this data.

Table 4

Gender

Gender	%	N
Female	81	29
Male	19	7
Total	100.0	36

Seventy-five percent of participants were between the ages of 30 and 64. One participant was over 65 and eight participants were between the ages of 18 and 29. Table 5 reflects this data.

Table 5

Age

Age	%	N
18-29 years old	22	8
30-49	39	14
50-64	36	13
65 and over	3	1
Total	100.0	36

Table 6 displays participants' levels of education. The majority of participants had a college degree or higher.

Table 6

Level of Education

Level of Education	%	N
Some high school	0	0
High school graduate	3	1
Trade/technical/vocational training	3	1
Some college	11	4
College graduate	22	8
Some postgraduate work	25	9
Post graduate degree	36	13
Total	100.0	36

Fifty-six percent of participants were employed, whereas 33 percent were not employed. One participant was employed part-time and three were retired. Table 7 displays this information.

Table 7

Employment Status

Employment Status	%	N
Full time	56	20
Part time	3	1
Not employed	33	12
Retired	8	3
Total	100.0	36

Fifty percent of participants were affiliated with their current organization between one and five years. Eleven percent of participants had no affiliation with an organization. Table 8 displays this data.

Table 8

Length of Time with Organization

Length of Time With Organization	%	N
Less than 6 months	17	6
Between 6 months to 1 year	3	1
Between 1 to 5 years	50	18
Between 5 to 10 years	5	2
More than 10 years	14	5
No Affiliation	11	4
Total	100.0	36

In terms of the length of time practicing within their respective fields, fifty percent of participants reported 10 years or more of experience. Forty-two participants practiced between one and five years, whereas one participant reported practicing less than six months. Table 9 summarizes this information.

Table 9

Length of Time in Practice

Length of Time in Practice	%	N
Less than 6 months	3	1
Between 6 months to 1 year	0	0
Between 1 to 5 years	42	15
Between 5 to 10 years	5	2
More than 10 years	50	18
Total	100.0	36

The majority of participants reported having intermediate computer skills. Eleven percent considered their skills at the beginner level, whereas 14 percent considered their skills to be advanced. Table 10 contains this information.

Table 10

Self-reported Computer Skills

Self-reported Computer Skills	%	N
Beginner	11	4
Intermediate	75	27
Expert	14	5
Total	100.0	36

4.2 Research Question #1 Templates Creating SCK

To answer the first research question, interaction analysis of computer messages to determine SCK occuring within each template ensued. Twelve teams of 36 participants exchanged 693 discussion forum messages. Across all 12 teams, the trivia template generated 178 overall messages with a mean of 14.83 messages per team. One team had a maximum of 53 trivia messages whereas another team had a minimum of two trivia messages. The role-play template generated 202 overall messages with a mean of 16.83 messages per team. One team had a maximum of 69 role-play messages and another team had zero role-play messages. The scavenger hunt template generated 313 overall scavenger hunt messages with a mean of 26.08 messages per team. One team had a maximum of 89 messages and another with a minimum of one scavenger hunt message. Table 11 displays this information.

Table 11

Descriptive Statistics of Messages Generated Per Game Template, All Teams

Game Template	Messages	Mean	SD	Median	Min	Max	N
Trivia	178	14.83	16.05	10	2	53	12
Role Play	202	16.83	20.49	7.5	0	69	12
Scavenger Hunt	313	26.08	28.09	14	1	89	12

Descriptive statistics of messages generated by each participant are displayed in Table 12. Participants generated 5.28 trivia messages, 5.69 role-play messages, and 8.81 scavenger hunt messages on average. Across all templates, participants generated an average of 10.97 messages. The average minimum amount of messages created by a participant was zero and the maximum was 70.

Table 12

Descriptive Statistics of Messages Generated By Participants

Game Template	Mean	SD	Median	Min	Max
Trivia	5.28	7.42	3	0	30
Role Play	5.69	13.32	1.5	0	67
Scavenger Hunt	8.81	14.00	3	0	53
Overall	**10.97**	**15.25**	**6**	**0**	**70**

In order to measure levels of SCK, the following coding procedure ensued. Two researchers with IAM coding experience coded all messages. Chi's (1997) recommended processes for resolving discrepancies between coders was followed: (1) record agreements or disagreements of the most advanced coded phase per posting, (2) determine which author used the highest phase for the posting, (3) examine the segments illustrating the highest phase, (4) determine if the code was appropriate using the IAM model definitions, and (5) if researchers agree on the highest phase to use for the posting, then the change was recorded, otherwise it remained. Cohen's kappa was calculated to determine inter-rater reliability on two different occasions: (1) after coding all messages for the first three teams and (2) after coding all messages for the remainder of the teams.

The first coding inter-rater reliability test took place and yielded a kappa of 0.813. Coding disagreements were discussed, Cohen's kappa was recalculated, and equaled one. The second inter-rater reliability calculation took place after coding the remaining teams' computer messages and yielded a kappa of 0.42 (moderate agreement).

In lieu of conducting a second round of coding discussions, a third coder with years of IAM coding experience reviewed the remaining messages. Coding disagreements among the IAM higher levels III through V were reviewed and the third coder determined which coding was correct. The researcher then merged the third coder's coding back into the overall analysis.

The researcher counted IAM phases I or II if either of the first two coders coded the messages as containing either of the two phases. For the remaining phases, the researcher counted IAM Phases III, IV, or V using the following conditions: if the first two coders were in agreement, then the code was counted. Otherwise, for disagreements, the third researcher's coding was counted.

Counts of all IAM phases were tabulated according to the combined analysis of all three researchers. Figure 11 presents the count of all IAM coding incidences for each game template. The figure represents the total number of posts within each game template according to each IAM phase. In order to interpret the graph, one chooses a game template, then an IAM phase, and reads the number of incidences that occurred in that given template. For example, trivia had 136 incidences of Phase I coded by the researchers, whereas scavenger hunt produced 225 messages in Phase I.

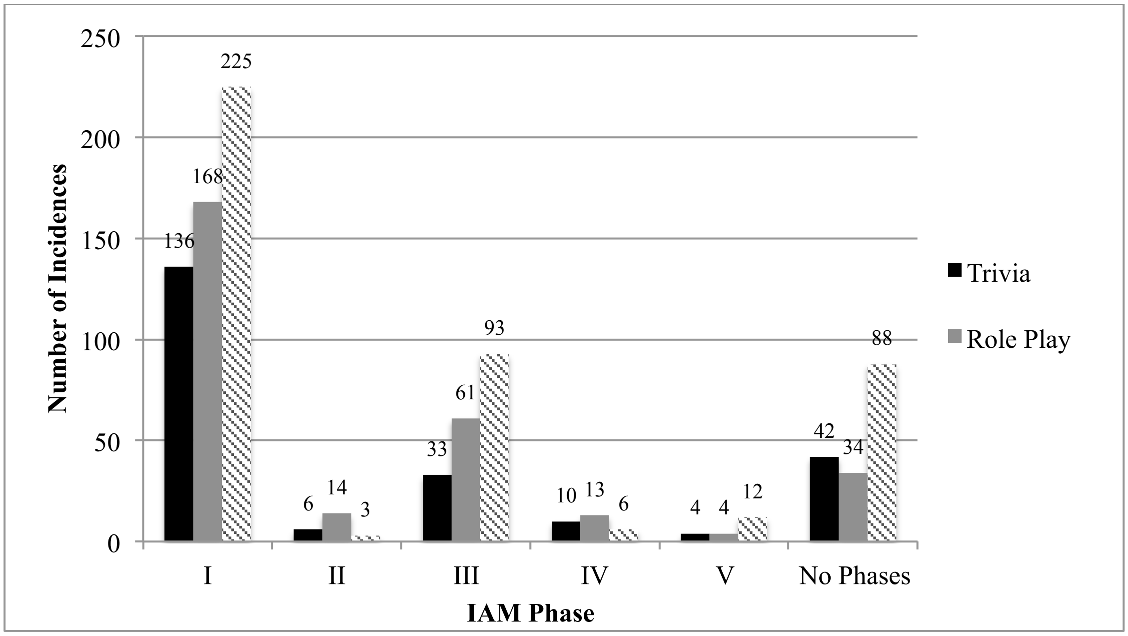


Figure 11. All messages coded according to the IAM Model per game template type

Across all trivia messages, 136 messages or 58.87% were coded as Phase I, 6 messages or 2.60% coded as Phase II, 33 messages or 14.29% as Phase III, 10 messages or 4.33% as Phase IV, 4 messages or 1.73% as Phase V, and 42 messages or 18.18% contained no phases.

Across all role play messages, 168 messages or 57.14% were coded as Phase I, 14 messages or 4.76% as Phase II, 61 messages or 20.75% as Phase III, 13 messages or 4.42% as Phase IV, 4 messages or 1.36% as Phase V, and 34 messages or 11.56% contained no phases.

Across all scavenger hunt messages, 225 messages or 52.82% were coded as Phase I, 3 messages or 0.70% as Phase II, 93 messages or 21.83% as Phase III, 6 messages or 1.41% as Phase IV, 11 messages or 2.58% as Phase V, and 88 message or 20.66% contained no phases.

4.2.1 Coding examples The following examples demonstrate how the researchers coded each message using the IAM model:

Phase I: "I reworded the narrative a bit after looking at the example provided on the help page. Please review and let me know what you think and if any thing else needs to be added or changed. I also think maybe we should each come up with an approach to teaching the child the correct use of the pronouns "me" and "I"......that way we will be able to create at least three resources as indicated in the directions for creating this game. I will check on Friday for your responses to this message and we can get this show on the road!" *(this post indicated Phase I - sharing/comparing of information in terms of describing the game's directions).*

Phase II: "I do think we should leave out weapons. Who would want to travel/tour around places that would require weapons? I think we want to make the game family friendly." *(this post indicated Phase II - the discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements regarding not including weapons).*

Phase III: "Good suggestion. Maybe we need to consider a game that will include video tutorials that prompt the learner to the next station/activity. The video tutorial is followed by a brief quiz that the tutorial has given the answers to. The learner answers and is advanced to the next portion of the game. Kind of like the mandatory on line training that we often do for our employer." *(this post indicated Phase III - negotiation of meaning / co-construction of knowledge concerning video tutorials and how to use them).*

Phase IV: "Hey team! [Teammate 1] I like your ideas. I have a few suggestions to add, I think it would be useful to take into consideration our diverse student population and the fact that many of them are non-traditional. I see students on a daily basis who have no computer skills whatsoever and their communication skills vary as well. What do you and [Teammate 2] think?" *(this post indicated Phase IV - testing and modification of proposed synthesis or co-construction because the participant wants consider the diverse student population).*

Phase V: "This looks absolutely amazing! I edited some portions of it, but it looks really good. Thank you so much for putting it in the proper format. I really enjoyed the questions that defined what the heck we were talking about to begin with. I think we are ready for submission. I'll check back probably around 10:00pm and if you guys have not submitted it yet, I will go ahead and do so." *(this post indicated Phase V - agreement statement(s)/applications of newly-constructed meaning because the participant is reflecting on the experience).*

Other Types of Posts: "Is there any time that is good for both of you to meet in here so we can kick this thing out? I just don't want to proceed without you both. I am thinking I could meet tonight. I will check throughout the day to see if you have a time that works." *(this post could not be coded as any phase of the IAM, but reflects project management and coordination – another important aspect of collaborative group work).*

The researcher tabulated the incidences of each IAM phase and moved to the ANOVA testing.

4.3 Comparison of Game Templates: Quasi-Experimental Analysis

This section analyzes question one's four subquestions. The subquestions focus on the IAM phases I through V. The questions are:

a. Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?
b. Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?
c. Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application).
d. Which game template shows the progression of knowledge creation from Phase I to V?

Game templates were randomly assigned to the teams. The order each team created all three games established the experimental component for this study. The researcher created an algorithm using a FileMaker function to generate a random number between one and three that represented each game template.

The algorithm assigned the game template for completion according to which random number was generated (e.g. one for trivia, two for role play, and three for scavenger hunt). If the random number generated was a game template already completed, the algorithm generated a new random number until an unassigned game template was determined. Table 13 displays the results of random assignment of the order of game templates completed.

Table 13

Completion Order of Game Templates, All Teams

Team	Trivia	Role Play	Scavenger Hunt
1	First	Second	Third
2	First	Second	Third
3	Third	First	Second
4	Third	Second	First
5	Second	Third	First
6	Third	First	Second
7	Third	Second	First
8	Second	Third	First
9	First	Second	Third
10	First	Second	Third
11	Third	First	Second
12	Third	Second	First

4.3.1 Testing IAM incidences. The first test of statistical significance involved the incidences of IAM Phase I (sharing and comparing). Table 14 displays the teams' incidences of IAM Phase I for each game template.

Table 14

Incidences of IAM Phase I Per Game Template Type, All Teams

Team	Trivia	Role Play	Scavenger Hunt
1	37	36	53
2	33	9	5
3	1	10	9
4	7	54	40
5	2	4	9
6	5	8	11
7	14	7	47
8	5	5	17
9	14	3	1
10	8	0	5
11	2	5	7
12	8	27	21

Descriptive statistics for the incidences of IAM Phases I are displayed in Table 15.

Table 15

Descriptive Statistics of the Incidences of IAM Phase I Per Game Template Type, All Teams

Game Template	Incidences	Mean	SD	Median	Min	Max	N
Trivia	136	11.33	11.85	7.5	1	37	12
Role Play	168	14.00	16.40	7.5	0	54	12
Scavenger Hunt	225	18.75	17.87	10	1	53	12

The first one-way repeated measures ANOVA examined which game template leads to the IAM model Phase I (sharing and comparing) when measured using a trivia, role-play, and scavenger hunt template for different teams (N=12). The data was not normally distributed; therefore Friedman's f test was adopted as the non-parametric test (Conover, 1980). Friedman's chi-square had a value of 2.426 and a p-value of 0.297, which was not statistically significant. Both parametric and non-parametric tests showed no significant difference among templates. However, in each template, there was evidence of Phase I, sharing and comparing of information.

The second test was if the incidences of IAM Phase II (exploration of dissonance) were significant. Table 16 displays the teams' incidences of IAM Phase II for each game template.

Table 16

Incidences of IAM Phase II Per Game Template Type, All Teams

Team	Trivia	Role Play	Scavenger Hunt
1	0	1	0
2	3	0	0
3	0	0	0
4	0	7	0
5	0	0	0
6	0	0	0
7	2	0	2
8	0	0	1
9	0	0	0
10	0	0	0
11	0	0	0
12	1	6	0

Descriptive statistics for the incidences of the IAM Phase II are displayed in Table 17.

Table 17

Descriptive Statistics of the Incidences of IAM Phase II Per Game Template Type, All Teams

Game Template	Incidences	Mean	SD	Median	Min	Max	N
Trivia	6	0.50	1	0	0	3	12
Role Play	14	1.17	2.517	0	0	7	12
Scavenger Hunt	3	0.25	0.622	0	0	2	12

A second one-way repeated measures ANOVA examined which game template leads to leads to the IAM Phase II (exploration of dissonance) when measured using a trivia, role-play, and scavenger hunt template for different participant teams (N=12). The data was not normally distributed; therefore Friedman's f test was adopted as the non-parametric test for a second time (Conover, 1980). Friedman's chi-square had a value of 0.421 and a p-value of 0.810, which was not statistically significant. Both parametric and non-parametric tests showed no significant difference among templates. However, in each template, there was evidence of Phase II, exploration of dissonance.

For the third test, the researcher tabulated the sum of the IAM model's phases III through V for each game template per team. The upper phases of the IAM model represent the higher levels of SCK where co-construction occurs (Gunawardena, et al., 1997; Marra, et al., 2004); therefore, the researcher added each phase together to determine an overall count of the SCK that occurred within each game template per team. Table 18 presents the combined incidences of IAM Phases III through V for each game template per team.

Table 18

Combined Incidences of IAM Phases III, IV, or V Per Game Template Type, All Teams

Team	Trivia	Role Play	Scavenger Hunt
1	7	8	22
2	7	2	3
3	0	9	8
4	0	29	6
5	0	0	2
6	0	4	8
7	18	5	35
8	2	1	8
9	8	2	0
10	2	0	0
11	0	0	1
12	6	18	17

Descriptive statistics for the combined incidences of the IAM Phases III through V are displayed in Table 19. On average, trivia generated 50 incidences, role-play generated 78, and scavenger hunt 110.

Table 19

Descriptive Statistics of the Combined Incidences of IAM Phases III, IV, or V Per Game Template Type, All Teams

Game Template	Incidences	Mean	SD	Median	Min	Max	N
Trivia	50	4.17	5.41	2	0	18	12
Role Play	78	6.50	8.81	3	0	29	12
Scavenger Hunt	110	9.17	10.58	7	0	35	12

A third one-way repeated measures ANOVA examined which game template leads to Phases III, IV, or V when measured using a trivia, role-play, and scavenger hunt template for different participant teams (N=12). The data was not normally distributed; therefore Friedman's f test was adopted as the non-parametric test for a third time (Conover, 1980). Friedman's chi-square had a value of 2.800 and a p-value of 0.247, which was not statistically significant. Both parametric and non-parametric tests showed no significant difference among templates. However, in each template, there was evidence of Phases III, IV, or V - knowledge construction, testing proposed synthesis, and agreement statements or application

Next, the researcher tabulated the progression of the IAM Phases for each game template per team. The researcher counted the progression of the IAM phases using three techniques. The first was using the full progression of SCK as defined by the IAM Phases I, II, III, IV, and V.

The second technique was to ignore Phase II and count the progression through Phases I, III, IV, and V. Two studies question the necessity of Phase II's dissonance as a pathway to higher levels of SCK in online discussions (Gunawardena et al., 2011; Gunawardena, 2014), therefore Phase II was ignored whenever Phase III occurred after Phase I.

The third way was to combine Phases IV and V and count the progressions through Phase I, Phase III, and then through either Phase IV or V. Lucas, Gunawardena, and Moriera (2014) suggest that Phases IV and V be merged, similar to Onrubia's and Engel's (2009) modification of the IAM model, where Phases IV and V are combined into a single phase of co-construction. Table 20 presents the progressions through the IAM model using these three techniques.

Table 20

Incidences of the Progression Through the IAM Phases Per Game Template Type, All Teams

Team	Trivia	Role Play	Scavenger Hunt
1	1	1	1
2	0	1	0
3	0	3	0
4	0	2	0
5	0	0	0
6	0	0	1
7	3	1	8
8	0	0	1
9	1	0	0
10	0	0	0
11	0	0	0
12	1	1	1

(Note: the number associated with the given game template and team represents how many times the team progressed through the IAM phases while building that game.)

For example, team 7 progressed through the IAM phases I through V three times during trivia, once during role-play, and eight times during scavenger hunt. Of note is that three of the twelve teams did not display any progression through the IAM phases. The smallest incidence amount was one and team seven generated the greatest amount with eight. Descriptive statistics for the incidences of progression through the IAM Phases I through V are displayed in Table 21.

Table 21

Descriptive Statistics of the Progression of IAM Phases Per Game Template Type, All Teams

Game Template	Incidences	Mean	SD	Median	Min	Max	N
Trivia	6	0.50	0.91	0.00	0	3	12
Role Play	9	0.75	0.97	0.50	0	3	12
Scavenger Hunt	12	1.00	2.26	0.00	0	8	12

A fourth one-way repeated measures ANOVA examined which game template leads to the progression of knowledge creation through Phases I through V when measured using a trivia, role-play, and scavenger hunt template for different participant teams (N=12). The data was not normally distributed therefore Friedman's f test was adopted as the non-parametric test for a fourth time (Conover, 1980). Friedman's chi-square had a value of 0.636 and a p-value of 0.727, which was not statistically significant. The progression of knowledge from Phase I (sharing and comparing of information) of the IAM model to Phase V (agreement statements or application) occurred in all three templates and showed no significant difference between the three templates.

4.3.2 Additional analyses When templates did not show any significant difference, it was tempting to explore if there was significance among the teams that engaged in game development. The 12-three person teams formed a diverse pool of participants that attempted to create games. Section 4.1 and Table 3 describe the participants' demographics and overviews of teams.

Each team's communication messages during each game's creation, coded according to the IAM model, served as the foundation for statistical testing. The researcher began by compiling each team's incidence counts of the IAM phases and progressions (see Tables 14, 16, 18, and 20) to determine if there was significance generating SCK among the teams (N=36). Using team number as the independent variable, and IAM phase or progression incidence count as the dependent, a one-way ANOVA test was performed.

Results showed no significant effect of IAM incidence counts per team for Phase I (*Welch's F*(9.361, 11) = 2.996, ρ > .05) or Phases III, IV, or V (*Welch's F*(9.149, 11) = 1.947, ρ > .05). Overall, there was no significance generating knowledge games among the teams. Of note is Welch's F as a recommended f test statistics when heterogenous data (variances not equal) are detected (Keppel & Wickens, 2004). Also, the one-way ANOVAs for Phase II and the progressions of Phases I through V test could not be determined because some teams had zero variance (see Tables 16 and 20), a requirement for Welch's F.

Initial review of the data revealed that the data was not normally distributed and did not pass homogeneity of variance checks. Furthermore, even with tests that adjusted for non-normal and non-homogeneous data, no significance between the teams emerged. It appeared that all teams share the same tendencies generating SCK in any of the three game templates.

4.4 Research Question #2 Factors Influencing SCK

The researcher conducted observations on each team after each game was submitted. To provide context for each observation, the researcher reviewed access records, examined the games created, and examined all the communication messages. The observation sheets were then completed using the information generated by each team (see Appendix A).

General categories of observations included the process of knowledge creation, quality of knowledge creation, and technology performance. Each category included sub-questions as reported in Appendix A. The researcher rated each area on a Likert scale from zero (not observed) to 3 (high). The following sections summarize the results of each observation performed by the researcher.

The process of knowledge creation for each game template revealed higher-rated observations for scavenger hunt. In terms of whether or not teams broke down and re-constructed knowledge, created the adequate amounts of items, and finished the game within the recommended time frame, scavenger hunt rated highest, role-play second, and trivia third. Table 22 displays observation ratings for this subject.

Table 22

All Games - Process of Knowledge Creation (Game Creation)

Observation	Game Template	Mean	SD
Evidence of breakdown in understanding, collaboration, realignment of understanding, and cross leveling of knowledge among team.			
	Trivia	1.92	0.90
	Role Play	2.33	0.89
	Scavenger Hunt	2.42	0.90
Team has created an adequate amount of items within the game.			
	Trivia	2.08	0.90
	Role Play	2.75	0.62
	Scavenger Hunt	2.92	0.29
Likelihood the team will complete the game by the deadline.			
	Trivia	2.67	0.65
	Role Play	2.75	0.62
	Scavenger Hunt	2.83	0.40

Response 0-3 Likert (Not Observed – High)

Team member participation was observed for all three game templates as displayed in Table 23. Trivia revealed the greatest observations for team member contributions with a mean score of 2.67, whereas scavenger hunt scored the lowest observation rating of 2.42. The researcher observed team members logging onto the system the most during role-play with an observation rating of 2.92 and the least during trivia with a score of 2.67. Team members contributed authorship the most within trivia

Table 23

All Games - Process of Knowledge Creation (Team Member Participation)

Observation	Game Template	Mean	SD
The game contains contributions from all members.			
	Trivia	2.67	0.49
	Role Play	2.58	0.67
	Scavenger Hunt	2.42	0.90
All members logged onto the system during the game building phase.			
	Trivia	2.67	0.49
	Role Play	2.92	0.29
	Scavenger Hunt	2.75	0.87
All members authored at least one portion of the game.			
	Trivia	2.67	0.49
	Role Play	2.08	0.79
	Scavenger Hunt	2.08	1.00

Response 0-3 Likert (Not Observed – High)

at a score of 2.67. Role-play and scavenger hunt shared the same score of 2.08 regarding authorship.

Observed team communication within each game template is displayed in Table 24. Scavenger hunt was observed to contain the greatest amount of socialization with a score of 1.5; trivia and role-play tied for the least with a score of 1.42. The most questions were observed within scavenger hunt with a score of 2.75 and the least within role-play with a score of 2.25. Team members replied the most to questions within

Table 24

All Games - Process of Knowledge Creation (Team Communication)

Observation	Game Template	Mean	SD
Team members are using the message system to socialize.			
	Trivia	1.42	0.90
	Role Play	1.42	1.08
	Scavenger Hunt	1.50	1.00
Team members are asking questions regarding the game creation.			
	Trivia	2.58	0.90
	Role Play	2.25	0.87
	Scavenger Hunt	2.75	0.87
Team members are replying to each other's questions.			
	Trivia	2.33	1.15
	Role Play	2.67	0.89
	Scavenger Hunt	2.75	0.87

Response 0-3 Likert (Not Observed – High)

scavenger hunt at an observed rating of 2.75 and the least within trivia with an observed rating of 2.33.

Applying the attributes of interesting and relevant information, English grammar, and clear and concise instructions to define game quality, the process of knowledge creation in terms of the quality of games created was observed as shown in Table 25. Role-play rated the highest for containing game material that was interesting and relevant and supplying clear instructions or overviews. Role-play challenged teams to be creative

Table 25

All Games - Process of Knowledge Creation (Quality of Games Created)

Observation	Game Template	Mean	SD
Game material is interesting and relevant.			
	Trivia	1.42	0.90
	Role Play	2.92	0.29
	Scavenger Hunt	2.83	0.39
Game material has minor grammatical errors.			
	Trivia	2.58	0.90
	Role Play	2.92	0.29
	Scavenger Hunt	3.00	0.00
Team wrote clear instructions/overview of the game.			
	Trivia	2.33	1.15
	Role Play	2.50	0.90
	Scavenger Hunt	2.42	0.90

Response 0-3 Likert (Not Observed – High)

and explain how the role-play takes place. Even though role-play had the least amount of input fields (the instructions and a description of each role-play resource) it proved to be the most interesting and well explained of the three templates. Trivia had the lowest observed rating of 1.42 for game material that was interesting and relevant. Scavenger hunt and role-play both emerged as superior templates for generating higher quality games.

The researcher observed the quality of game items created for each game template as displayed in Table 26. Items for game templates are trivia questions and answers, resources for role-play, and steps for scavenger hunt. The recommended amount of trivia questions and answers were 25, resources for role play were between two and four, and scavenger hunt steps were five to seven. Scavenger hunt rated the highest for teams creating the recommended amount of items with a score of 3.00. Trivia scored the least with a score of 2.58. It appeared that seven or less scavenger hunt steps were more convenient to write than 25 trivia questions.

Table 26

All Games – Quality of Knowledge Creation (Quality of Game Items Created)

Observation	Mean	SD
Teams performance in creating the recommended amount of game items.		
Trivia questions/answers (at least 25 questions)	2.58	0.67
Role play resources (2-4 resources)	2.83	0.58
Scavenger hunt steps (5-7 steps)	3.00	0.00

Response 0-3 Likert (Not Observed – High)

The researcher observed the process of knowledge creation in terms of how the team understood the game template as displayed in Table 27. The most questions asked by the team were observed during trivia with a score of 2.58 and the least with scavenger hunt at a score of 2.33. The researcher observed trivia as containing the best game appropriate material created by the team with a score of 3.00 whereas role-play and scavenger both scored 2.75. Teams had no problem understanding and creating high-quality trivia games, but were rated slightly less for both role-play and scavenger hunt.

Table 27

All Games - Process of Knowledge Creation (Team's Understanding of the Game Template)

Observation	Game Template	Mean	SD
Team has little or no questions about the game.			
	Trivia	2.58	0.67
	Role Play	2.50	0.67
	Scavenger Hunt	2.33	0.49
Team created material appropriate for the type of game template.			
	Trivia	3.00	0.00
	Role Play	2.75	0.45
	Scavenger Hunt	2.75	0.62

Response 0-3 Likert (Not Observed – High)

Technology performance in terms of how the system performed was observed as shown in Table 28. All game templates experienced no server issues with observed scores of 3.00. The knowledge game center website and system experienced minor programming errors within role-play at a score of 2.97. The errors involved navigation controls but were quickly debugged by the researcher. The teams suffered no setbacks to due the programming errors. There was slight observed lag time within scavenger hunt at an observed score of 2.97. Reliability of system availability ensured that the templates were readily available for knowledge creation.

Table 28

All Games - Technology Performance (System Performance)

Observation	Game Template	Mean	SD
Knowledge game center is experiencing no server issues.			
	Trivia	3.00	0.00
	Role Play	3.00	0.00
	Scavenger Hunt	3.00	0.00
Knowledge game center website is online with no errors.			
	Trivia	3.00	0.00
	Role Play	2.97	2.89
	Scavenger Hunt	3.00	0.00
Knowledge game center displays no lag time navigating the system.			
	Trivia	3.00	0.00
	Role Play	3.00	0.00
	Scavenger Hunt	2.97	0.29

Response 0-3 Likert (Not Observed – High)

Technology performance in terms of need for technical assistance was observed as shown in Table 29. Users required minimal assistance accessing the system during trivia and role-play with observed ratings of 2.92 and slightly more during scavenger hunt with a score of 2.75. No bugs or errors were reported within scavenger hunt within a score of 3.00, but trivia experienced some errors with a score of 2.83. The researcher accidently left a data field unlocked for editing which in term disrupted navigation. The field was locked from editing and trivia experienced no more bugs the rest of the study.

Table 29

All Games – Technology Performance (Need for Technical Assistance)

Observation	Game Template	Mean	SD
Users are able to access the database without assistance.			
	Trivia	2.92	0.29
	Role Play	2.92	0.29
	Scavenger Hunt	2.75	0.62
No errors or bugs reported by users.			
	Trivia	2.83	0.40
	Role Play	2.92	0.29
	Scavenger Hunt	3.00	0.00

Response 0-3 Likert (Not Observed – High)

4.5 Research Question #3 Perceptions from Interviews

Convenience sampling was used to recruit 12 volunteers for interviews. The interviews were conducted face-to-face or via telephone and recorded using a smart phone. Each interview lasted 15 minutes or less. The interview questions consisted of 11 open-ended questions asking the interviewee how the team was formed, how the team communicated, what game was best for the given profession, which game teammates preferred to construct, and suggestions for improving the system (see Appendix B).

Upon completion of the interviews and transcription by the researcher, member checking was conducted to check the validity of the data. The interviewees were asked to review the data and indicate any areas of disagreement. Corrections were then made to the transcripts. The process created descriptive validity to guarantee that interviewees agreed the transcriptions accurately captured their opinions (Maxwell, 1992).

A thematic review of interview transcripts uncovered four major areas: system struggles, game template feedback, optimism, and suggested improvements. The following quotations elaborate on each area.

4.5.1 Initial struggles. Users experienced frustration when first using the system. "I just don't feel as if there was enough direction in the beginning" expressed an interviewee. Many of the participants were unclear of how to contribute to research and begin creating games with teammates, indicating that the directions given to the participants by the system should be improved. The help section and sample games were accessible from a link on the top right of all system layouts; in retrospect, a mandatory review of the help section was missing.

Another person said, "We kept putting information in as we tried to figure out what it was we were supposed to be doing." The system was entirely text-driven, and without the researcher's guidance, participants depended on accessing a help and examples section. More inexperienced users had difficulty entering the system and understanding the requirements. A participant reflected:

> *I didn't find the system very user friendly. ... That's the initial thing for me, even looking at your example I just found it harder. And so, just again, everybody seemed to be like, "were we doing it correctly?" You didn't know if you were doing it properly. That was the hardest thing.*

The participants initially struggled with the format of the system and reported difficulty coordinating with teammates.

Another participant, with a background in technology, expressed their disapproval of FileMaker being used for the study.

> *To me if it had been in a different venue, either something more web-based, or something other than Filemaker, which to me I always found to be very flat and hard to work in anyway. And hard to move around in. I think it would have been a lot better. I was really excited about trying it, but then I found the same frustrations that I had in the past dealing with that particular application. I used to maintain and work in Filemaker and I'm so glad I don't anymore.*

Despite the rough start, teams managed to cope with the system and understand research expectations. "We did have a kick-off call, which helped" was common feedback received during interviews. One participant took a leadership role and said, " it was every time initiated by me, prompting them to either start or [report] what their thoughts were. So when that occurred we were able to move forward with the game." Leaders emerged from each group and teammates began mastering navigation of the system and message board.

All in all, teams managed to create the games despite initial struggles becoming familiar with the system. Details of how teams coped emerged through the interviews.

> *Well, we would often times email each other back and forth. We scheduled once or twice to meet up at a specific time. But after doing that, we recognized that it was not the best way to do stuff, as only one of us could edit at a time.*

Co-authoring the same data record, in this case the fields for each game, is not allowed within a database. Participants had to develop team strategy when it came to dividing the work and authoring each game item.

Details emerged how teams developed strategies for creating the games. Certain teams used the messaging system to leave progress notes for each other.

> *We updated each other on what was done … So, if one person had put, whatever they put in, they would say, "This is what I added, and if there are any changes, make the changes, or leave it as is."*

People who gained a familiarity with the system, but wanted an alternative to the messaging system, used email to send progress reports.

> *There were some email exchanges, just saying, "I put the next step in. Review it. And if you like it we'll submit it." The review still happened within the game, but we still relied on emails to alert each other when we needed to make sure we went in and checked it.*

All-in-all, participants entered the system, made sense of the surroundings, and figured out how to create the first game.

When questions came about, teammates left messages for each other in the messaging system. A participant, referring to the messaging system as email, spoke:

> *Usually one of us would start one email, and say either we didn't understand what they were talking about, or "hey check out my work and tell me what you think" and we would continuously respond to the same string of emails.*

It was from these messages that the researcher found evidence of SCK and understood how the games were created.

Teams managed to gain comfort with the system and adopted a knowledge construction approach among each other. A team of retired teachers mastered the system and began to develop team strategy. One member reflected:

> *If we had an idea, we would promote that idea and then just wait for someone to respond. And it seemed like if we had at least 2/3-majority consensus, we would go ahead with the idea then and that 3rd person would agree at a later point either by letting us know or by participation.*

The group held a kick-off meeting to practice logging into the system, but then developed a schedule where all members would try to log on and edit the games on a certain day. The teachers used a majority rules decision-making process where teammates who were logged on at or near the same time would send messages saying that editing appears sufficient.

Despite struggles during the first game, teams found their stride creating the final two games where decision-making was flexible and asynchronous knowledge creation took place. A participant summed up their teams' persistence:

> *The challenge was articulating what our steps were going to be in each of the modules of the game. That was tricky and what we finally decided to do … was [that] we would just wing it, go for it, and then as a team look at it and make corrections once we started.*

The veteran teacher team was unafraid of taking risks and gaining whatever they could from the experience. The teachers figured how to use the system's technology, create the first game, and develop a schedule for editing and approving each other's work. Interviewees spoke about appreciating the experience and gaining insight into how they could grow professionally, along with gratitude for learning a new technology.

The ease of using the knowledge game center to generate information sparked the curiosity of participants as to what other types of knowledge could be entered into the system. The majority of teachers who participated said that they would use knowledge games in as many subjects possible. Overall, the flexibility and adaptability provided by the technology was noted:

> *It was wide open … it gave the people that were doing it a choice of what they wanted to do … once you put something in and looked at it, and you weren't pleased with it you, then you could go in and edit. We weren't restricted to two steps, three steps, five steps - it was wide open.*

An interviewee spoke more on flexibility with team knowledge creation:

> *I think it could be useful to generate new ways for developing learning. In kind of a quick, asynchronous way … Because you could still have the quality of the multiple perspectives, the back and forth, but you don't have to be in the same physical state … it makes it a little more fun and a little more creative.*

Initially, the system was confusing and not intuitive. But with practice, teams began to form strategies for creating content and sharing game creation progress. Therefore, even though participants experienced difficulties with the system, they were motivated to continue with the creation of games indicating a high level of interest in exploring the templates and creating the games.

4.5.2 System's messaging board. Of particular dissatisfaction was the system's messaging board. A participant summed up their frustrations by reporting, "… the challenging part came with using the message board system to communicate and making sure that we were all understanding where we wanted to go." A participant stated:

> *A number of us were unhappy with the emailing system and format, but we made do with what we had. Even though it was suggested a couple times that we just get on the phone, get on a Skype call, to talk to one another, we did what you asked us and just emailed through the system.*

Due to the design of the study, the messaging system was the only method for team communication. Some participants felt constrained and limited in communication abilities.

> *The way the database was designed, it was extremely difficult to communicate within the database. And one of the rules was that we weren't supposed to revert to email or outside resources. So there was very little communication at all.*

Participants felt constrained by the messaging system and desired more familiar communication tools. The database, flat and text driven, did not match the performance and design of other messaging services seen by participants on smart phones and tablets. An interviewee spoke about the design of the messaging system:

> *The little space we had to send messages was fairly limited. I'd rather have more of a format where we could actually discuss alongside what we were creating.*

Overall, the messaging system served its purpose despite the complaints. Teams had to learn the messaging system like they had to learn the game templates. One participant spoke of finally understanding the message board after discovering his/her first messages.

> *A couple times, there was some wait time there not knowing if the message had been read or if there was another message coming through. And then upon searching, I made the realization that "oh yeah that message had been responded to."*

Participants gained familiarity with the system and learned how to review all messages.

Overall, teams managed to cope with the message system and used it for communicating.

> *The challenging part came with using the message board system to communicate and making sure that we were all understanding where we wanted to go. After we got over that initial hump of realizing that we were all on board, then it was pretty easy going from there.*

4.5.3 Game template feedback. Participants reported positive features of each game template. Interviewees described which game template they preferred with both optimism and excitement. All three templates offered benefits for novice and expert computer users, along with options for participants to contribute

Teams considered trivia as the starting point for sharing knowledge through games. An interviewee spoke about how trivia was similar to how they learned:

> *I think the trivia game was the game that would probably help because it's varying levels of information … I loved the trivia game. For me, it was*

> *having to do a little bit of the research myself in forming the questions and getting the answers. That's actually kind of how I learn; how I like to learn. That was a real fun game for me to do [laughter].*

The previous quote was from a participant who enjoyed learning something new during the process of creating trivia games. Trivia required the participants to research and write both simple and complex questions, therefore some participants learned along the way.

Trivia was straightforward and had a clear mission: generate 25 questions containing a topic, difficulty rating, the question, and the answer. Overall, trivia emerged as the participants' preferred way to create knowledge with their teammates.

> *I liked the format, especially of the trivia. It allows you to put the question, the difficulty the category, the answer. Having that premade format for beginners helps guide the workflow - the creativity. It allows for structure when people who are inexperienced do not necessarily know how to do that.*

Participants felt confident navigating the database layouts during the trivia template activity. Teams were able to divide workloads and write individual questions and answers. Trivia's structure offered teams a systematic approach to creating knowledge games as a team.

> *I think the trivia was a lot more easy to manipulate and to create questions because it involved just knowledge of the texts we were using. So as far as from a challenging perspective, I think the trivia was less threatening and we were able to take the information and create that knowledge based on*

> *our knowledge of the text we were using. So that seemed to be less of a challenge for us as a team.*

Participants understood how to enter data into the templates and apply prior knowledge to the creation of each trivia item. Trivia allowed teams to engage in knowledge creation and did not require many questions to understand the template.

When it came to sharing the games for others, trivia was recognized for its overall potential in sharing knowledge with others.

> *I think that the trivia would be most beneficial. Because in a setting, such as like a staff meeting … the only item that you are needing to complete the activity are the trivia cards … it's something too that can open up a lot of discussion. As far as, if there were a question and some people were unclear on an answer, then our supervisors would also know what areas we need to build on.*

The interviewee realized the convenience of printing the "trivia cards", taking the material to a staff meeting, and sharing with others in order to stimulate conversation. Teachers could use a hybrid approach preparing for class by using tools– e.g., laptops, tablets, and smart phones - to generate artifacts of knowledge that could be used in important face-to-face meetings. Everyone, including administrators, could witness the topics that generated the most discussion and immediately provide follow-up during the trivia game.

The next template, role-play, required the least amount of data fields for writing but more discussion among teammates. Role-play proved to offer a simple complexity when it came to creation and application. One participant noted:

> *I think a role-playing game would be more successful in the quest for knowledge, as it would allow for a lot more backstory, decisions, mistakes, and different deviated paths from the ultimate goal.*

Role-play engaged teams, generated communication, and allowed for creativity. Role-play was completely open-ended and required simply a description of the scenario and a list of resources. Another participant shared opinions about role-play:

> *I would say, I really liked role-playing [laughter]. To me, I think it's more active and also it uses some of the elements we used in adult learning … It's more universal, you can do it with people of any sort of background, any sort of knowledge level.*

This interviewee, who had a background involving in adult learning, knew of the immediate impact that role-play activities could have in learning situations, especially for adults. Not only does role-play create active-learning environments, it provides learning opportunities for all those involved. Even if a team's role-play activity is just a short paragraph with a few resources, the debate and dialogue generated by participants during the activity could lead to learning experiences for all those who participate.

The last template, scavenger hunt, proved to be the most intriguing and having the most potential of the three templates. One participant summarized: "Scavenger hunt is a better way. People are actually getting up, getting out, and looking. Doing something active." An interviewee spoke of the flexibility provided to teams:

> *All three of us were able to be creative in what we got to do. We weren't in a box. We got to work outside the box. And each one of us got to contribute in our own learning style.*

A participant believed that scavenger hunt engaged the learner within any physical or cognitive environment in order to gain knowledge. The interviewee stated:

> *The scavenger hunt game went a little bit more than the other two towards the side of active learning … it became an active learning participation because we had directions for the participants to actually go and seek some of that information out on their own.*

Participants recognized the benefit of using a scavenger hunt in their organization and its potential superiority to trivia.

> *Scavenger hunt, would have been the most useful … I think that because of the type of institution we are, the information that we would want people to grasp and to be able to use, and to be able to retain, is better presented in a scavenger hunt type format because there's a lot of information. Whereas with the trivia game, there were just questions. Questions with answers. And there are higher-level processes [in scavenger hunt] that integrated information that we wanted to set forth.*

4.5.4 Teamwork and optimism. Despite the initial dissatisfaction with the system, teams eventually mastered the system, communicated, and used teamwork to create the knowledge games. One participant spoke of the initial confusion:

> *It was a little bit clunky [at first]. It took us a few tries to actually post something and save it correctly so that the team could see it. But once we got that, you could see from the thread that our communications [was] nearly daily.*

Understanding participation goals and how to interact with the game templates appeared to limit a team's performance during the first game. Other participants with no collaborative group work experience felt lost in the beginning.

> *I really don't know because this is new to me, because I see at the beginning it was really hard because I wasn't sure what was expected of me to do. But the 2nd or 3rd game I had a better understanding of what I had to do.*

Despite questions and ambiguity, teams gradually gained confidence for the second and third game. A participant spoke about the increase in skills and growing interest in the next game:

> *Once you get through that first hurdle of creating the game, then it sort of flowed. Then it was exciting to see what the next challenge was going to be through the game. ... It was a good experience, it was positive. I was excited to see what the other two were going to come up with. And where like one started and the other one finished. And you're like "whoa that's really awesome!"*

Overall, the structure and design of the system, along with the motivation of teams to finish, convinced participants that collaborative knowledge creation through games was possible. Like any new technology, users took time to learn the basics but became enthused with the knowledge games as time progressed. A participant reflected on the benefit of the system for creating knowledge:

> *I think the structure, with the specific steps, the message board, to be able to have the back and forth communication, and to keep that back and forth*

> *communication captured. That's the benefit of having it there versus in an email … all the communication is captured and not buried in 500 emails.*

For most people, knowledge creation takes place at work using email attachments of electronic documents. The system offered an alternative approach to traditional business practice.

> *I think a strength is that the system is pretty much a blank sheet. You can go in there and create games on any area. It doesn't matter that the team doesn't have to be in one specific area or people in one specific field. It's really suitable for everyone that can go in there and look at the examples that were provided and be able to see the direction they need to go to based on the example.*

Participants recognized the potential for using the system to record knowledge in game format. The system was seen as an example of the benefits of having a web-based location for collaborating with peers. An interviewee spoke about the system's flexibility for the teams during knowledge creation:

> *I think it could be useful to generate new ways for developing learning. In kind of a quick, asynchronous way … Because you could still have the quality of the multiple perspectives, the back and forth, but you don't have to be in the same physical state … it makes it a little more fun and a little more creative.*

Interviewees were generally optimistic about using technology and games to educate modern learners.

Participants who were educators knew immediately of the impact on learning. Not only did the system allow for flexible participation, it is an indication of how games can be used for learning in the future. An interviewee reflected:

> *I think that would be an interesting way for people to learn. It would give it a different aspect rather than just sitting there and looking through a book. If they had questions, they could go through the game and to figure it out themselves.*

Teachers are challenged with developing activities that promote learner engagement – a feature that the system provides. Future learners will depend on technology to facilitate learning in active, project-based environments. Student use of technology was noted:

> *The Internet and computers are such a good way of teaching students and reaching out to kids. We see them on their phones, we see them on their computers, and if that's what's driving them at this time, and I think if we create the games they will go there.*

The knowledge game center served as an example of what could engage learners to create knowledge to share with others. An interviewee summarized:

> *I guess in thinking about the 21st century, and the learners in this era, it is nothing like the century that preceded us, and even the decade the preceded us … you have to keep up with the times and I think this is one way to look at it. You've gotta get away from the textbooks and just the passive learning model, with teachers being upfront and center and students sitting there passively, that's not the way to go.*

Overall, interviewees were appreciative of the experience and discovered an opportunity for growth. The templates demonstrated to participants that knowledge creation through games required creativity and teamwork. An interviewee reflected on the experience and noted how it could change their perspective:

> *I thought it was going to be something simple to do and thought, "Ah this is going to be a piece of cake. Let's get this done." It took a lot of time and effort and a lot of thinking, and like I said, I'm not the type of person to do, to make up games, especially something so in depth. I think it showed kind of my weakness, and something I can improve on myself in the future, and use this experience and challenge myself later on. And maybe create in-depth games on my own.*

To summarize, interviews revealed participants' initial dissatisfaction with the system, but also efforts to overcome challenges learning the system. Additionally, interviewees spoke of the positive aspects of the system, such as the strengths of each game template and the benefit of using the system to record knowledge. Interviewees reflected on the prevalence of mobile technologies by young people today and the fact that it is here to stay. The following list represents the themes uncovered from interviews:

- Initial struggles but familiarity later
- System's message board caused issues
- Game template feedback offers unique traits about each template
- Optimism using games and recognizing applications
- Preparing for future learners

Adding to IAM coding, observations, and now interview results, next for analysis are game completion surveys.

4.6 Research Question #3 Perceptions from Game Completion Surveys

Game completion surveys were auto-generated after a team completed each game (see Appendix C). Participants were directed by the system to complete the survey after each submission before moving onto the next game template. The researcher reminded participants to complete the final survey but was not able to get all participants to complete the surveys. Of the 36 participants, 27 completed trivia surveys, 33 completed role-play surveys, and 30 completed scavenger hunt surveys for an average return rate of 83.3%. The success collecting game completion surveys allowed for insight into the knowledge game center experience after each game was created by each team.

Each survey contained five general areas inspired by Gee's (2004) characteristics of affinity spaces. Survey questions assessed whether or not participants felt as if the team collaborated during the game creation, all team members contributed, if the participant communicated with their teammates, if leaders emerged, and if they liked the game that was created and if they planned to share it. Questions were rated using a Likert scale with scores of one (low) through 10 (high). An open-ended question provided an opportunity for participants to provide their comments. Table 30 displays the overall results of the game completion surveys.

4.6.1 Questions. Scavenger hunt was reported to have the most team collaboration with a score of 6.60. Team members were considered to contribute the most during scavenger hunt with a score of 7.10. The most communication was reported

Table 30

All Game Completion Survey Results

Question	N	Mean	SD	Median
Your team collaborated with each other to create each game.				
Trivia	27	6.52	3.22	7
Role Play	33	6.33	3.10	6
Scavenger Hunt	30	6.60	2.91	6
All team members contributed to creating this game.				
Trivia	27	6.96	3.26	8
Role Play	33	6.82	3.15	8
Scavenger Hunt	30	7.10	2.86	7.5
You communicated with your team to create this game.				
Trivia	27	7.00	3.09	8
Role Play	33	7.18	2.89	8
Scavenger Hunt	30	7.03	2.75	8
Leaders emerged for your team.				
Trivia	27	7.15	2.82	8
Role Play	33	8.30	2.47	9
Scavenger Hunt	30	8.23	2.03	9
You like the game your team just created and look forward to sharing it.				
Trivia	27	6.96	3.20	8
Role Play	33	7.64	2.66	9
Scavenger Hunt	30	7.43	2.82	8.5

Response 1-10 Likert (Low – High)

during role-play with a score of 7.18. Leaders emerged the most during role-play with a score of 8.30. Finally, role-play was the game participants looked forward to most sharing with others with a score of 7.64. Role-play called for teammates to communicate and formulate leadership positions while completing the game

4.6.2 Open-ended question comments. The game completion surveys collected free response comments. Two themes emerged from the free responses: system struggles and reasons for optimism.

Free responses showed dissatisfaction with the system and message board:

> *The database is cumbersome and poorly designed. That made it very hard to stay motivated to work in it. The ability to communicate with the team within the database is also very poorly designed. I think it is Filemaker and not the concepts. The premise and the concepts are great! Good luck with your resource project.*

Another participant simply stated "A bit clunky at first and instructions unclear."

More detailed feedback was provided:

> *This was not a user-friendly start. Was not sure how or what to do at first. Communication is difficult with this system. Due to the time constraints for the game creation, there were a number of issues of getting other members motivated and active on the KGC. For future implementation, it would be helpful if the in-KGC messages also sent an email notification. (Ex: "You have been sent a message in KGC.") The timeout in the system is still very frustrating.*

Awful communication system - it made creating this project all the more stressful.

Despite the system downfalls, participants still reported optimism:

Much better as we got experience with this and comfort with the content. Excited to see the finished games!

One participant looked past the communication system struggles and wrote:

Our communication improved with this game. Our team was more productive and moving in a positive direction.

A participant chose to acknowledge another teammates' hard work and construction of the game:

[Participant 1] had a really good plan for this one prior to going about its formation. [Participant 1's] plan was very thorough and worked very well. Minimal discussion was required.

Beyond providing feedback about the system, other participants looked towards sharing with others. One participant wrote:

I would have used the Scavenger Hunt if I were still in the classroom! The team was able to collaborate, but it may have benefited us to be able to collaborate in person, or in a web conference. Still, we were able to all contribute and come to decisions easily.

Another participant reflected on the overall experience.

As the first game, it was a challenge to get into the complete understanding of what we had to do. The system was very explanatory but it took a while for everyone to grasp a complete and thorough

> *understanding of the process. By the end, I think we were working as a team.*

Overall, participants provided collaboration, contribution, communication, leadership, and intentions for sharing feedback. Additionally, open-ended free responses provided insight into the game creation process for participants.

4.7 Research Question #4 System Usage Data

The system auto-generated data whenever a participant logged on or off the system. The researcher programmed FileMaker scripts to generate event records that contained the user account, the action, and a timestamp containing the date and time. The following data presents summary usage data of how participants utilized the system.

Table 31 presents the overall completion time for each team to complete all three games. Overall completion time is the difference in time from when the first game was started and when the last game was submitted. Results are displayed in hours, minutes, and seconds.

The average length of completion time for trivia was 167 hours, 54 minutes, and 31 seconds – or roughly nine days. The average length of completion time for role-play was 191 hours, 6 minutes, and zero seconds – or roughly eight days. The average length of completion time for scavenger hunt was 277 hours, 13 minutes, and 36 seconds – or roughly eleven and a half days. The extra days required to complete scavenger hunt, as compared to the other templates, reflects that complexity of creating a scavenger hunt.

The fastest time to complete a game was 5 hours, 44 minutes, and 49 seconds during a team's scavenger hunt. The longest length of time to complete a game was 760 hours, 4 hours, and 41 seconds – or a little less than thirty-two days - during a team's

Table 31

Overall Completion Time, All Teams

Team #	Trivia	Role Play	Scavenger Hunt	Total
1	97:54:06	49:27:39	27:01:14	174:23:59
2	334:31:59	320:40:55	345:01:53	1000:14:57
3	141:46:32	255:24:52	312:10:55	709:22:19
4	403:01:10	240:45:28	223:08:56	866:55:34
5	22:48:21	63:45:57	222:06:56	308:41:14
6	83:18:13	208:26:42	467:10:05	759:06:00
7	29:21:00	47:01:38	375:28:12	451:50:50
8	40:03:05	56:25:28	341:37:44	438:07:17
9	296:55:53	86:18:17	5:44:49	388:58:59
10	351:16:02	760:04:41	440:37:55	1551:58:38
11	49:06:39	190:47:54	179:37:02	419:31:35
12	164:51:09	14:12:32	386:57:31	566:01:12
Average Elapsed Time	**167:54:31 (6.99 days)**	**191:06:00 (7.96 days)**	**277:13:36 (11.55 days)**	**636:14:07 (26.50 days)**

Elapsed Time in Hours:Minutes:Second

role-play. Even though the researcher suggested that games be completed in 14 days or less, the researcher conceded and did not impose a required time period.

The system tracked access for all users. Table 32 displays the total combined time spent logged into the system at the team level and at the individual level. The average time contributed per team was 25 hours, 57 minutes, and 31 seconds – or roughly a little longer than a full day. The minimum amount of time spent by team members was 4 hours

Table 32

Team and Individual Participants' Hours Spent Creating Games

	N	Mean	SD	Min	Max
Total Combined Hours Creating Games, All Team Members	12	25:57:31	11:55:39	4:48:41	47:49:20
Total Hours Creating Games, Individual	36	8:39:11	5:42:05	0:46:47	21:42:31

48 minutes, and 41 seconds. The maximum amount of time spent by team members was 47 hours, 49 minutes, and 20 seconds – or slightly less than four days. In terms of time spent at the individual level, the average time spent by each participant was 8 hours, 39 minutes, and 11 seconds. The minimum amount of time spent by an individual on the system was 46 minutes and 47 seconds, whereas the maximum amount of time was 21 hours, 42 minutes, and 31 seconds.

The system collected event records to calculate average, minimum, and maximum individual connection lengths as displayed in Table 33. The average connection length was 29 minutes and 50 seconds. A certain participant logged on for an average of 4 minutes and 15 seconds at a time, whereas another participant would logon for an average duration of 1 hour, 30 minutes, and 6 seconds. The average minimum connection length for a participant was 10 minutes and 16 seconds and the average maximum connection length for a participant was 1 hour, 20 seconds, and 14 seconds.

Table 33

Average, Minimum, and Maximum Connection Lengths

Game Template	N	Mean	SD	Min	Max
Average Length of Connection Time	36	0:29:50	0:18:11	0:04:15	1:30:06
Minimum Connection Length	36	0:10:16	0:12:44	0:00:04	0:33:09
Maximum Connection Length	36	1:20:14	0:49:25	0:16:33	3:28:35

Table 34 displays more individual connection data. The average number of logons per participant was 18.47 times. A certain participant only logged a minimum of 6 times, whereas another logged on a maximum of 44 times. The average individual percent contribution, in terms of length of time connected to the system by the team, was 33.33% - about a third of the three-member team's contributions. A certain member contributed a maximum of 79.53 percent of the team's time across all participants, whereas another participant contributed only 4.36 percent of the team's time across all participants.

Table 34

Individual Number of Logins and Percentage of Time Contributed

Game Template	N	Mean	SD	Min	Max
Number of Logins	36	18.47	10.41	6.00	44.00
Percentage of Time Contributed to Team, Individual	36	33.33	18.85	4.36	79.53

Table 35 displays lengths of times in-between connection for all individuals. The average minimum length of time in between connections for all individuals was 6 hours, 36 minutes, and 22 seconds. The average maximum length of time in-between connections for participants was 209 hours, 59 minutes, and 1 second – or slightly less than eight days. The maximum length of time in between connections was 984 hours, 54 minutes, and 26 seconds – or about 41 days.

Table 35

Maximum and Minimum Time In-Between Connections

Game Template	N	Mean	SD	Min	Max
Minimum Time In-Between Connections	36	6:36:22	16:02:02	0:00:28	76:16:44
Maximum Time In-Between Connections	36	209:50:01	212:07:28	49:00:57	984:54:26

In order to combine and synthesize information, the researcher calculated words used in each game template as displayed in Table 36. The average amount of words for the trivia game was 654.50 words. The average amount of words for the role-play was 492.83 words. The average amount of words for the scavenger hunt template was 765.33 words. The minimum amount of words used across all templates was 86 words for a role-play activity. The maximum amount of words used across all games was 2012 words for a scavenger hunt activity.

Table 36

Words Used Per Game Template

Game Template	N	Mean	SD	Min	Max
Trivia	12	655	504.9	206	1901
Role Play	12	491	364.3	86	1307
Scavenger Hunt	12	765	458.0	333	2012

Figure 12 displays the average, minimum, and maximum words used for each game template. Scavenger hunt averaged the greatest average amount of words used with 2012 words, second most was trivia with 655 words, and the least amount was 493 words for role play.

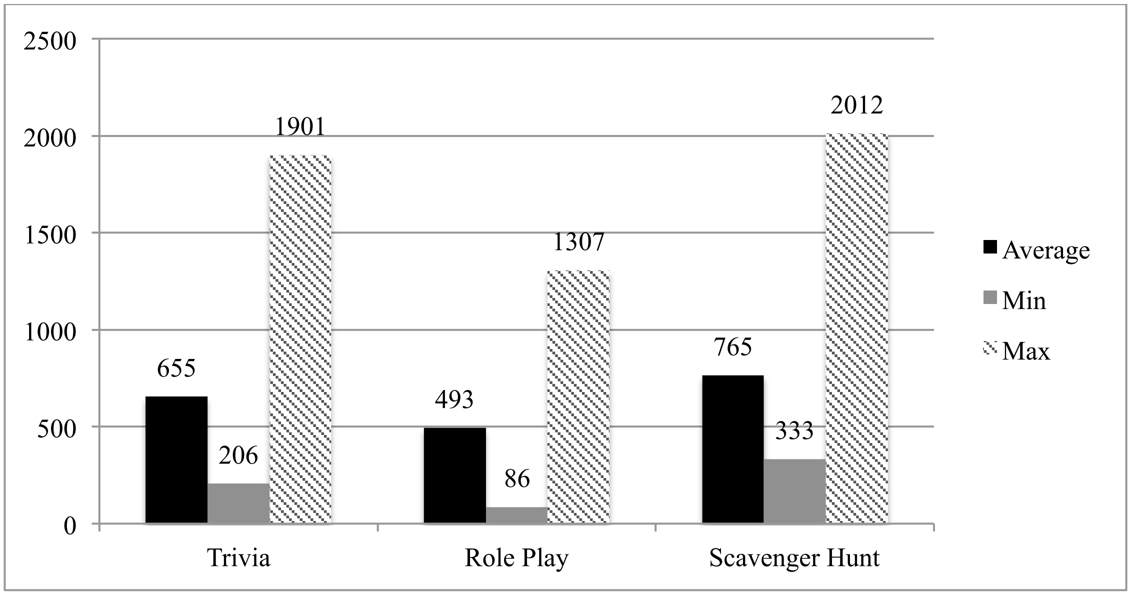


Figure 12. Average, minimum, and maximum amount of words used in games (n=12).

Another system usage statistic of note was the number of items used to create each game (see Table 37). An item for trivia was a trivia question, for role-play was a resource, and for scavenger hunt was a step. The average amount of trivia questions used was 15.42 questions, the average amount of role-play resources was 3.75, and the average amount of scavenger hunt steps involved in the process was 6.83.

Table 37

Items Created Per Game Template

Game Template Item	N	Mean	SD	Min	Max
Trivia Questions	12	15.42	8.36	5	26
Role Play Resources	12	3.75	1.29	2	7
Scavenger Hunt Steps	12	6.83	2.22	5	13

Figure 13 displays the average, minimum, and maximum items used for each game template. Trivia averaged the greatest average amount of items used with 15 questions, second was scavenger hunt with 13 steps, and the least amount role-play with 4 resources.

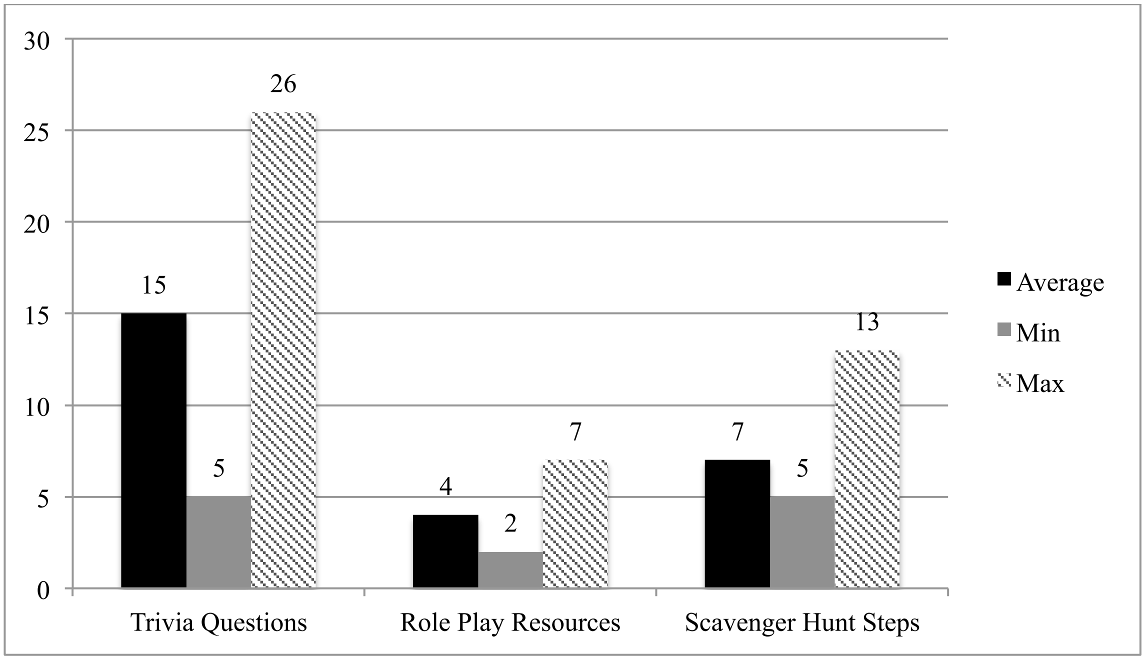


Figure 13. Average, minimum, and maximum amount of items created in games (n=12).

The final system usage data to report was TinCan actions. By definition, as noted, the Tin Can application-programming interface (API) (see http://tincanapi.com/overview) is a framework for capturing a user's actions within a given technology. The format for TinCan learning records, in general terms, is: noun, verb, object. An example of an event record is: "Learner 70 saved trivia game 27".

The top 10 verbs recorded by the system event record store are displayed in Figure 14. "Saved" was the top verb for the system with 2450 instances, followed by "interacted" with 2097 instances, and "completed" with 1137 instances.

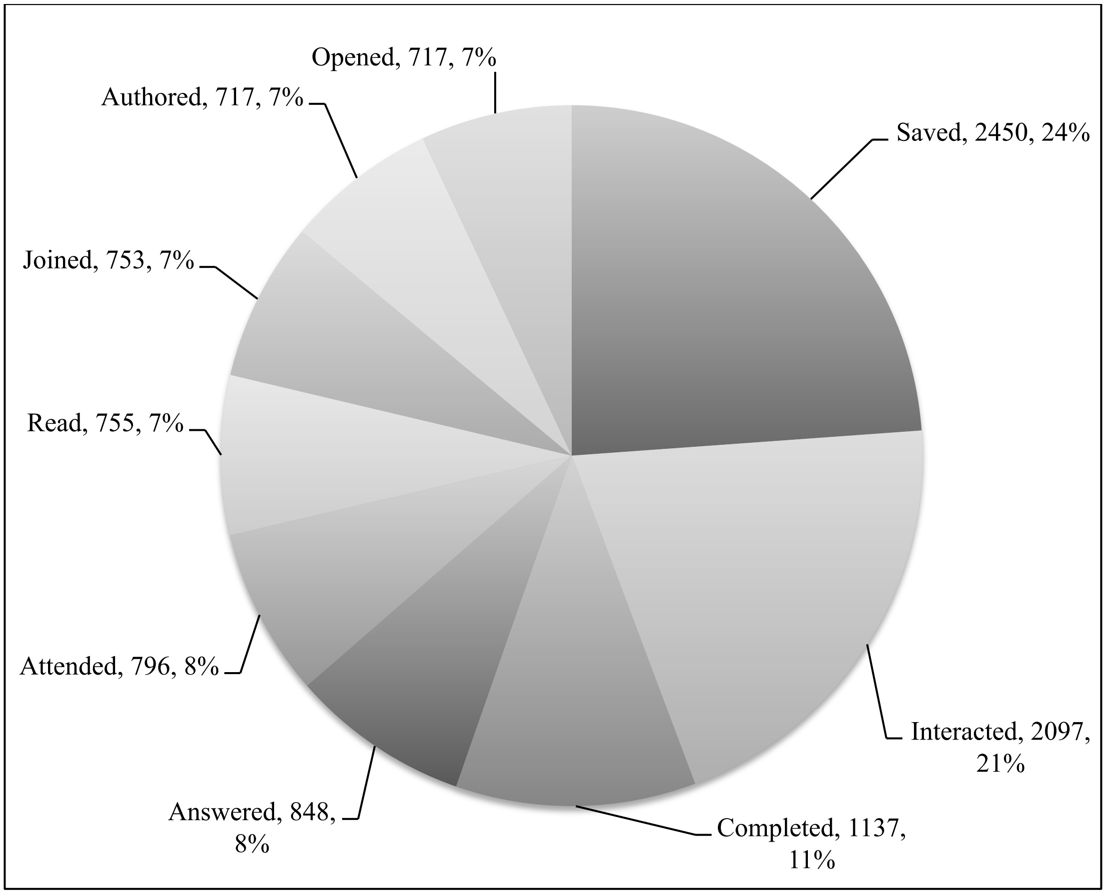


Figure 14. Top 10 TinCan Actions, System-Wide (n=10270).

4.8 Summary

Chapter four unfolded the results for this study. Seven areas of data collection assisted in understanding how SCK occurs within an environment that promotes game creation. The areas included a report of demographic data, message coding according to the IAM model, ANOVA testing of the number of incidences of messages in each game template, a thematic review and content analysis of interviews, report on observations, descriptive statistics of game completion surveys and system usage data. All seven areas provide insight into how SCK occurs within a custom-built knowledge creation system.

The participants were primarily female, educated, and experienced individuals. The results of IAM message coding uncovered that the majority of messages sent between participants were in the lower phases of the model, sharing and comparing of information. This is consistent with previous research studies (Lucas, et al., 2014).

Scavenger hunt provided the most amount of the IAM model's Phase I with 225 messages. Role-play generated the most incidences of the IAM model's Phase II with 14 messages. Scavenger hunt provided the greatest count of the IAM model's Phase III with 93 messages. The role-play template created the most IAM model's Phase IV with 13 messages. The scavenger hunt template produced the most IAM model's Phase V with 12 messages. Scavenger hunt also displayed the most progressions through the IAM model's phases on 12 occasions.

The ANOVA testing revealed no significant results in terms of which game template generated the greater incidence of the IAM Phase I, IAM Phase II, IAM Phases III, IV, or V, and the progression of knowledge creation through the IAM Phases.

Observations on the process of knowledge creation, quality of knowledge creation, and technology performance provided the researcher with insight into how teams constructed knowledge within each game template. The interviews uncovered four major themes: system struggles, game template feedback, optimism, and suggested improvements. Finally, system usage data provided information about how participants used the system, specifically in terms of length of time spent creating each game, individual access trends and contribution amounts, and the top 10 actions captured across teams. This data offers implications for other investigators, along with discussion and suggestions for future research, which are presented in chapter six.

Chapter 5

Discussion and Conclusions

This chapter discusses results and implications of this study. A custom built, Internet based system was designed to engage participants in creating three knowledge games - trivia, role-play, and scavenger hunt - to determine which game template generates SCK as participants engage in game creation. A general summary of research questions and research methodologies are first reviewed, followed by a discussion of salient findings for each research question. Commentary regarding implications, limitations of the study, recommendation for future research, and the overall conclusion complete this chapter.

5.1 Summary of Research Questions & Method

Responding to the need for organizations to construct and share knowledge with others in an enjoyable way, the researcher created an online knowledge game center system using FileMaker databases. Participants accessed the system to interact with teammates and create knowledge games relating to their respective fields.

The research questions guiding this study were:

(1) Which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) as participants use each template to create a knowledge game?

  a. Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?

  b. Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?

c. Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application).

d. Which game template shows the progression of knowledge creation from Phase I to V?

(2) What factors influence SCK as participants engage in constructing games?

(3) What are participants' perceptions of their ability to construct the games?

(4) What do system usage data show about a team's knowledge construction patterns (time spent on task, system navigation trends, amounts of words used, and game items created)?

The first question and four sub questions were analyzed using the IAM model to produce quantitative and qualitative data. The SCK phases according to the IAM are: (i) sharing, comparing, contributing of information; (ii) discovery and explanation of dissonance or inconsistency among ideas, concepts, or statements; (iii) negotiation of meaning or knowledge co-construction; (iv) testing and modification of a proposed synthesis; and (v) statements of agreement and applications of newly constructed knowledge (Gunawardena, et al., 1997). Questions two and three were examined qualitatively using interview, observations, and surveys. Question four examined quantitative information gathered from system usage data.

Six mixed-methods research approaches (see Table 2) were employed to answer each research question. Research data were gathered through observations, interviews, and analysis of message transcripts according to the IAM model, game completion surveys, system usage data, and demographic surveys. A joint display of all constructs and measures highlight the major themes discovered through this study (see section 6.2.9).

The methodological research design was defined as a pragmatic quasi-experimental mixed-methods approach. Recruitment of three-person voluntary teams occurred over a span of nine months and included 36 participants, or 12 teams. Teams were a mixture of colleagues familiar with one another, to participants meeting other participants for the first time through the study. Eight teams were classified as students, three as business, and one as hobbyist (see Table 3).

Students were scholars exploring topics related to their majors or educators participating in professional development activities. Business teams were individuals from organizations that were creating knowledge games for training with colleagues. The hobbyist team comprised of people who share a common interest, in this case a group of driving enthusiasts creating knowledge game for tourists.

Each team was challenged to create a trivia, role-play, and scavenger hunt knowledge game. The knowledge game center facilitated the knowledge construction experience and provided teams a venue to create the games and to exchange electronic brainstorms or ideas with each other. The following section reviews each research question and provides discussion of salient findings.

5.2 Discussion of Salient Findings

Research questions (RQ) and discussion of salient findings are as follows.

5.2.1 RQ1 Which game template generates SCK? All three game templates generated SCK, despite none proving to be statistically significant. All three templates generated both lower and higher levels of SCK according to the IAM model. Scavenger hunt generated the greatest incidences of Phase I (sharing and comparing), Phase III (negotiation of meaning), and Phase V (agreement statements or application), whereas trivia generated the least amount in all three phases. Role-play produced the greatest amount of phase II (exploration of dissonance) and phase IV (testing and modification of proposed synthesis) (see Figure 11). Other research methods supported the understanding of how each template facilitated knowledge construction in addition to the IAM coding. This study's mixed methods research design afforded multiple avenues to gather rich qualitative and quantitative data for analysis.

Results showed that each template produced higher levels of SCK as seen in Figure 11. According to the IAM model, where co-construction of higher levels of knowledge occurs in phases III (knowledge construction), IV (testing proposed synthesis), and V (agreement statements or application), the combined counts of phases for the entire study were: trivia with 50, role-play with 78, and scavenger hunt with 110. Teams achieved each level of the IAM model and SCK occurred across all three game templates.

All games were expected to have general instructions and contain multiple items for each game, such as trivia questions, role-play resources, and scavenger hunt steps. The researcher recommended that teams create at least 25 trivia questions, three to five resources, and five to seven scavenger hunt steps. Teams were asked to only discuss study within the system, and not in person, using the messaging system. Scavenger hunt generated the most messages with 313 total, followed by role-play with 202 messages, and trivia last with the 178 messages (see Tables 11 and 12).

Observations supported the notion that SCK occurred within each template (see Appendix A). Observation ratings were defined on a four point Likert scale – 0 (not observed), 1 (low frequency of observations), 2 (mid frequency of observation), and 3 (high frequency of observation). The process of knowledge creation among teams - specifically evidence of breakdown in understanding, collaboration, realignment of understanding, and cross leveling of knowledge - took place in all three templates at or near an observation score of 2 out of 3 or better (see Table 22).

Additionally, all three templates contained contributions from all participants with the lowest score of 2.42 out of 3 - observed during scavenger hunt. Participants logged on to the system during the game building phase with the lowest score of 2.67 out of 3 occurring during trivia. Participants authored at least one portion of each game with the lowest score of 2.08 out of 3 observed within both role-play and scavenger hunt (see Table 23). Members were asking and answering each other's questions at an observed rate of 2.25 out of 3 or better across all templates, but socialized within the system at an observed rate of 1.50 out of 3 or less (see Table 24). Teammates were observed accessing the system and creating games at a mid rate of frequency, but exhibited low rates of communication.

In addition to observations, game completion survey results disclosed participants' viewpoints that their team collaborated with each other and shared contribution responsibilities (see Table 30). Survey responses were collected using a 10-point Likert scale range – defined as 1 (low agreement), 5 (mid agreement), and 10 (high agreement). Participants felt that their team collaborated to create each game with the lowest response score given during role-play (6.33 out of 10), teammates contributed to creating each game with the lowest response score given during role-play (6.82 out of 10), and communicated to create each game with the lowest response score given during trivia (7.00 out of 10). During interviews, participants spoke of how the team "threw ideas out there" and arrived at group consensus during each game creation. Also, system usage data showed that the average time spent per participant contributing to the team was 33.3% - a balanced amount. Participants agreed in general that teammates were collaborating, contributing, and communicating during game creation. System usage data confirmed that teammates were contributing at a balanced rate.

Trivia took the shortest length of time on average to create (6.99 days) as compared to role-play (7.96) and scavenger hunt (11.55 days) (see Table 31). During trivia, minimal discussion occurred - suggesting that trivia was more straightforward and direct. Participants researched their categories and crafted each answer within the trivia question template. Role-play took a certain amount of conversation to pinpoint the topic and roles, but teams succeeded in composing a description of the role-play activity. Scavenger hunt necessitated the most creativity and coordination among each team, as evidenced by amount of messages created and length of time required to complete. The teams not only had to negotiate the order of each scavenger hunt step, but they had to create the content for each step. All three games required high levels of collaboration and coordination among teammates during game creation.

5.2.2 RQ1a Which game template leads to the highest incidence of the IAM model's Phase I (Sharing & Comparing)? Scavenger hunt generated the most messages coded as Phase I with 225 messages, role play with 168, and trivia with 136. The results make sense given the open-nature of scavenger hunt. Observations of game play confirmed that teams performed high levels of game creating activities and generated the most communication messages during scavenger hunt. Participants reported through game completion surveys that they perceived teammates to participating the most through scavenger hunt too. Teams shared numerous ideas on whether or not they should conduct a physical or cognitive scavenger hunt and what stops to make along the way. All in all, teams exchanged a plethora of ideas during scavenger hunt as discovered through IAM analysis and other mixed-methods research techniques.

Role-play required that teammates brainstorm ideas and share information concerning their topic, but trivia generated the least amount of messages coded as IAM Phase I (sharing and comparing) because participants were busy writing questions and answers. Interviewees spoke of trivia's ease-of-use and ability to easily create games by everyone, hence the reason for lesser amounts of communication during game creation.

Scavenger hunt caused teams to ask questions and share ideas as they understood the template and discussed how to turn their knowledge into a scavenger hunt. The scavenger hunt step contained four fields – the text, directions, reflection, and a next step clue. On top of each scavenger hunt step, the scavenger hunt itself had three fields – purpose, start, and end. Additionally, system data showed that scavenger hunt took teams the most amounts of words, requiring high incidences of team discussion and dialogue. The details for creating a scavenger hunt depended on careful consideration and planning among the team.

Basic sharing of facts was evident: "It looks like we are coming up with steps on how we will elicit language in preschool students. Any ideas? I started with just assessing their primary language." One participant shared their opinion on how to envision the game: "…as the learner would see it, speaking to them, as opposed to entering information about the learner and the objectives." Another participant shared an opinion and implied a general question of how to start: "I do like the High Concept relation. Now we need to start ironing out our "plot" so to speak." Scavenger hunt was a template that generated not only the lower levels of SCK concerning how to use the template, but also clarification on details for each step.

6.2.3 RQ1b Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)? Role-play generated the greatest amount of the IAM model's Phase II with 14 messages, followed by trivia with 6 messages, and scavenger hunt with 3 messages. Other studies (Lopez-Islas, 2001; Gunawardena et al., 2011; Schellens, Van Keer, De Wever, & Valcke, 2007; Hou et al., 2009) found similar results regarding the limited incidences of Phase II messages.

Gunawardena (2014) asks all to consider whether or not disagreements are needed to form SCK - or if it is merely a Western point of view. Most participants in this study were polite with one another when it came to identifying disagreements during the role-play construction. An example: "Pronouns are great, but we are looking at how to elicit language and I want Rio to stay on track with the topic." Another teammate pointed out: "I don't think we can presume our audience has the vast knowledge of games that you would have."

Other participants presented rational thought to discredit ideas: "I do think we should leave out weapons. Who would want to travel/tour around places that would require weapons? I think we want to make the game family friendly." Teammates disagreed with how the role-play template be interpreted: "I think we are to enter text into the boxes as the learner would see it, speaking to them, as opposed to entering information about the learner and the objectives."

Role-play, due to its potential complexity and tendency to engage all teammates, led teams to consider any option and compromise on disagreements. Even though teams were designing a simple activity (such as a role-play), there were complex decisions awaiting dialogue among teammates. Interviewees spoke of role-play's open-endedness; likely the cause for teams to debate and disagree on certain topics during the process of game creation.

Trivia, which was straight-forward and based upon facts, and scavenger hunt, a linear journey with little room for deviation or tangents from the overall goal, did not present different or opposing viewpoints among teammates. Role-play considered every option – pertinent or non-pertinent and some participants expressed any disagreements.

5.2.4 RQ1c Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Negotiation of Meaning, Testing and Modification of Proposed Synthesis, and Agreement Statements or Application)? Scavenger hunt emerged as the template with the greatest incidence of the IAM Model's Phase III, IV, or V with 110 posts. This computed to an average rate of 9.17 times per team that the higher levels of SCK were achieved through the scavenger hunt template.

The IAM model's Phases III (knowledge construction), IV (testing proposed synthesis), and V (agreement statements or application) represent higher levels of SCK that occur in a constructivist-learning environment (Gunawardena, et al., 1997; Marra, et al., 2004). Knowledge at this level is generated, analyzed, tested, and acknowledged. Scavenger hunt, because of its initial unknown outcomes and need for teams to coordinate ideas and decision-making, generated the greatest incidence of the higher phases of the IAM.

An example of how teams negotiated the structure of the scavenger hunt is as follows: "The second option seems fun to me in the fact that we can give a lot of options to pull from. I vote for that one." This message was coded as containing Phase I (sharing and comparing) and Phase III (knowledge construction), as evidenced by the team negotiating meaning on the second option (i.e. the scavenger hunt step).

Once the teams had a general layout of the topics or locations they wished to cover, they tested their understanding of the game. An example: "This will be a general orientation for learning/training. Due to multiple departments within the organization it needs to be covered in one umbrella of learning." Another participant wrote:

> *Wow, I am lost, to say the least. I guess I could go either way. If we are to create a game to teach something, we could create a game to teach how to create a game. I also like the first idea that was mentioned about creating a game for Political Science.*
>
> *I have no experience with gaming, lots of experience with the virtual world of Second Life.*
>
> *It is intriguing to me to create a game to teach someone how to create a game, since this is the situation we are in. I am thinking as I am typing here, so I feel my vote would be to create a game to teach educational professionals how to create a game.*
>
> *We could use the Scavenger Game set-up to take them through the steps of what they need to do, step-by-step, to create the game.*

This message was coded as containing Phase I (sharing and comparing), Phase III (negotiation of meaning), and Phase IV (testing proposed synthesis). The team was in the midst of determining what the scavenger hunt should cover regarding educational simulations.

Using the previous example, Phase III, negotiation of meaning, is evident in the participants' desire to make sense of the activity. Phase IV, testing and modification of proposed synthesis or co-construction, is based on the statement: "If we are to create a game to teach something, we could create a game to teach how to create a game." The participant is modifying the proposed synthesis of "creating a scavenger hunt game to teach" to be more specific – teaching how to create an education simulation. Interviewees spoke of the back-and-forth dialogue among teammates when refining ideas.

In order to reach consensus and proceed with creating each game, participants negotiated meaning and constructed knowledge using all three templates as shown by the messages for each team coded at the Phase III (negotiation of meaning) level. Other studies that attempted to measure SCK using the IAM model (Hou, et al., 2009; Want, et al., 2009; Zhao, 2009; Lucas & Moreira, 2010) used variable sizes of groups, and/or too broad of a topic, to discuss and reach consensus using a blank wiki and message board. In this study, small teams were given clear directives and timelines to create games using the tools provided by the system. Teams were cooperating and trying to accomplish research goals. Participants were forced to compromise on intentions and combine information to help move the activity along.

Finally, the IAM Model's Phase V - where the highest level of SCK is coded as agreement statements or applications of the newly constructed meaning – occurred frequently in scavenger hunt. An example of this type of message is as follows:

> *I definitely agree that this is a rudimentary view. Something that someone taking a course in Educational Games might run through as preparatory material each week, or something that would be enhanced through specific readings. Or it might work for an undergraduate survey.*

Another participant, at the end of completing the scavenger hunt and expressing relief that the experiment was finished wrote in a message, "I really do like our final product. I am so glad you all are feeling the same way." Interviews and game completion surveys confirmed the fact that teams genuinely felt that the games were high quality and worth sharing with others – a reference to IAM's Phase V (agreement statements or application).

Comparing the incidences of higher levels of SCK that took place within the templates, scavenger hunt generated the most incidences (110 incidences), whereas higher levels of SCK still occurred within role-play (78 incidences) and trivia (50 incidences) (see Table 19). The conclusion is that higher levels of SCK occurred in all three templates. The system provided environments for teams to negotiate meaning, test ideas, and acknowledge the fact that they accomplished designing a complex activity within each game template.

Interviews showed that participants genuinely felt that they could use the system to create knowledge games appropriate for sharing with others. Observations confirmed that teams participated at medium rates or better (2.00 out of 3) accessing the system and contributing to game creation (see Table 23). Game completion surveys indicated that participants felt fellow teammates were contributing. All three templates were successful in generating SCK.

It is not an argument about which template generates greater incidences of messages containing higher levels of SCK, but the discovery that higher levels of SCK occurred *at all* within three game creation templates, occurring the least during trivia with 50 incidences.

5.2.5 RQ1d Which game template shows the progression of knowledge creation from Phase I to V? Knowledge creation among people manifests itself from lower to higher phases. According to the IAM Model lower levels of knowledge creation moves from sharing, comparing, and disagreeing, to the higher levels, where co-construction of knowledge occurs and the knowledge is validated. The phases describe how knowledge emerges, is debated, renewed, tested, and finally, accepted.

The IAM model has been in existence for nearly two decades. IAM model developers and researchers who employed it reviewed previous studies that used the model and suggested that the Phases III (knowledge construction), IV (testing proposed synthesis), and V (agreement statements or application) be merged into one phase (Lucas, Gunawardena, & Moriera, 2014). Additionally, Gunawardena (2011) questioned whether or not Phase II (dissonance) is needed during the SCK process. Keeping this in mind, three techniques were used to measure the progression: (1) the original structure of the IAM where all Phases I through V were considered; (2) counting Phase I, III, IV, and V but not counting Phase II; and (3) counting Phases I, III, and combining IV and V but not counting Phase II.

Communication messages generated by teams during game creation were transcribed for incidences of the lower and higher levels SCK according to the IAM Model. Incidences are the IAM Model's five phases as identified by experienced IAM coders contained within a given message. Incidences, or markers of lower and higher levels of SCK occurring, took place predominantly during scavenger hunt with a frequency of 12, followed by role-play (9 incidences), and then trivia (6 incidences) (see Table 21).

The following example represents the second technique mentioned above – all IAM phases, in order, without Phase II (exploration of dissonance). To begin, the first message containing Phase I (sharing and comparing):

> **Phase I: "**What do you think we should include in the stages for this game? If the participants are going on a scavenger hunt we should have them look for items/ideas that will make their tour of SoCo interesting and meaningful. We maybe could begin by thinking about the steps all travelers go through in planning a trip. What do you think?"

The first message demonstrates how a single person initiates the SCK process. In this case, a person shares information, or an idea, for the first of the scavenger hunt: have travellers plan the trip. The message contains IAM's Phase I sharing or comparing of information, or specifically, an opinion statement; asking questions to clarify details, and a definition, description, or identification of a problem are evident a (a subphase of IAM Phase I).

Looking towards Phase III (knowledge construction) and skipping Phase II (dissonance), negotiation of meaning and co-construction of knowledge began.

> **Phase III:** **"**I think these are definitely [what] we can use for the scavenger hunt. We can have people use the internet, also take advantage of the free items that are available at the Chamber of Commerce or purchase some items if they'd like."

A second team member clearly approves of the need for planning the trip and seeks more details, and offers a suggestion for the next step: visit a chamber of commerce and purchase anything needed for the trip. Negotiating of meaning co-construction continues to take place as the scavenger hunt begins to take shape.

Using the knowledge game center to write details of the first few scavenger hunt steps, the team modified the scavenger hunt by adding a fourth step. The following message shows a participant who wanted feedback on the third step and confirmation that the fourth step makes logical sense:

> **Phase IV:** **"**As you can see, I inserted step 3. So, getting information from the chamber of commerce, visiting a local museum, choosing mode of transportation, what should step 4 be? Looking for travel tips on the internet such as packing a suitcase, toiletries, non-perishable food items, first aid necessities (especially depending on the mode of transportation and possible outdoor exposure to nature such as sun, bugs, wildlife, etc). Is that a logical next step? We have to remember that this is a Scavenger Hunt and participants will be searching for this stuff......"

This message demonstrates how teams generate SCK using the knowledge game center and refine their scavenger hunt game during the process. IAM Phase IV (testing proposed synthesis) occurred when teammates were in the process of the game and making sure that the knowledge construction, in this case the scavenger hunt, is acceptable and makes sense.

Nearing the end of the activity, a teammate summarized their work while clarifying a few last details, coded as Phase V (agreement statements or application):

> **Phase V:** "If the team agrees, I will suggest adding travel by train to end the trip. This would be via the Cumbres/Toltec train. Also, dune buggy at the Sand Dunes. So, the modes of travel in combination would be dune buggy on the Dunes, horseback at Zapata Ranch, by car to Fort Garland, on to San Luis by car, and ending at Chama by train????"

The participant recapped the overall scavenger hunt, an indication of IAM Phase V, where implied agreement statements are made; in this case, a summary of the scavenger hunt.

The scavenger hunt created for exploring Southern Colorado - where road trippers visit the Sand Dunes, Zapata ranch, Fort Garland, San Luis, and end on a train to Chama – is an example of how SCK propagates among team members within the scavenger hunt template. In the first phase (sharing and comparing), a participant initiated dialogue among fellow teammates and shared an idea for starting the trip. More messages were exchanged until the third phase (knowledge construction), the first indication of higher levels of SCK, was achieved. In the case of the road trippers, they wanted to clarify details of a stop along the way and figure what they wanted participants to perform. The team then reached the fourth phase of SCK (testing proposed synthesis) when a team member restated the scavenger hunt and adjusted it by adding an extra step to adjust. Finally, a participant typed the agreed upon order of the scavenger hunt as the team reached the highest level of the IAM - Phase V, sub phase a: summarization of agreement.

The scavenger hunt template supported teams as they explored ideas, formulated a general plan of game creation, checked their understanding of the progression of the hunt, and summarized the final activity. Scavenger hunt, as compared to trivia and role-play, required more coordination and testing of ideas due to the complexity of each step and the need to keep the goal in mind. Trivia took the least amount of time to create, role-play the second most amount of time, and scavenger hunt the most as determined by system usage data. As the participant said “We have to remember that this is a Scavenger Hunt and participants will be searching for this stuff”.

Trivia and role-play were both unique in their own ways, but did not require the same level of coordination and feedback from peers as scavenger hunt. Interviewees confirmed that trivia was straight-forward and easy to begin creating knowledge. Role-play led some teams to reflect on each other’s ideas and recognize the potential for including more. Role-play’s For example, a participant wrote:

> *Thank you for bringing this together [Participant 1]. I was having a hard time following [Participant 2]'s line of thinking, but in a crazy way, maybe we could ask for restaurants, gift shops, and discounted tickets for entry…*

Progression through the phases occurred during role-play and trivia, but not at the same amount as scavenger hunt. Role-play discussions helped teammates focus topics despite having a simple design, whereas trivia was more structured and orderly due to its straight-forwardness and chance for all participants to work on their own set of trivia questions.

5.2.6 RQ2 What factors influence SCK as participants engage in constructing games? The 12 three person teams came from a broad range of work, technology, and years of experience within work, school, and hobbies pursuits to design knowledge games (see Section 4.1). Teams struggled using the system at first, but became familiar with the design by the second and third games.

All the games produced in this study contained interesting, relevant, and properly edited knowledge games for each game template. The project was completely open-ended; there were no right or wrong answers and teams had to decide when they were finished. All three game templates generated higher levels of SCK as groups co-edited knowledge within the game templates (see Table 19).

Teams were given a space to communicate and construct each game. Strategies came into realization as teams learned ways to work together within each template. The diverse set of teams and varying creativities involved in each template gave the researcher insight into the process of co-creating knowledge games. Unique factors such as the familiarity of teammates with each other, the complexity of the activity, collaboration, contributions, and communication tendencies within each template, and limitations of the technology used to create the system helped the researcher understand how SCK occurs.

The first clue lies in the overall incidences of higher levels of SCK across all three game templates for all teams (see Table 19). Table 38 displays the incidences SCK, or IAM Phases III (knowledge construction), IV (testing proposed synthesis), and V (agreement statements or application) per team for all templates.

Table 38

Overall Incidences of Higher Levels SCK Across All Templates, All Teams

Team	Total SCK All Game Templates
1	37
2	12
3	17
4	35
5	2
6	12
7	58
8	11
9	10
10	2
11	1
12	41

Teams 1, 4, 7, and 12 were teams with a professional relationship. The teams were teachers who worked together in educational settings, or in the case of the last group, a tight-knit team of road-trippers who have spent time together. Table 3 reports descriptions of all teams; successful teams generally were tight-knit groups who had previous experience working together and were ambitious and dedicated teams that were willing to do anything in order to finish the game. These teams would share as much information as possible, provide constructive criticism to one another without fear, report individual progress, and ask questions of teammates who were struggling to contribute. Teams should have a strong relationship in order to engage and construct SCK.

A second consideration that influences SCK during game construction is the complexity of the activity. Scavenger hunt, the template that contained the most input fields and required teams to be creative in designing their activity, caused teams to ask more questions and guide one another to a common ground. Trivia, with its clear directives for generating as many questions and answers as possible, caused teams to divide the work and create trivia items with little need for help from others. Role-play shared similar traits to trivia and scavenger hunt; even though the activity was short in written length, it required dialogue among the teams. Therefore the challenge level of the template activity influences the amount of SCK that can occur.

Collaboration, contribution, and communication are the third factors that supported SCK generated within each template. Using game completion survey results (see Table 30) and trends uncovered from IAM coding, observations, interviews, and system usage data, unique traits for each template emerged. The first survey question asked participants if they felt that their team collaborated with each other to create each game - and scavenger hunt had the highest mean score (6.60 out of 10), followed by trivia (6.52 out of 10), and last role-play (6.33 out of 10). Scavenger hunt required teammates to create a new scavenger hunt step, check with their team if it fit the order of the activity, and finalize writing the scavenger hunt details. Trivia required teams to divide workloads and check with one another if the questions they created were enough to finalize the activity. Role-play called for each team to discuss and reach a consensus decision on how to design the activity. Teams had to use varying forms of collaboration to create each knowledge game.

The second survey question concerned perceived contribution by teammates to creating the games. The question asked if all team members contributed to creating the game and scavenger hunt had the greatest score (7.10 out of 10), trivia second highest (6.96 out of 10), and role-play the least (6.82 out of 10). In scavenger hunt, the amount of detail in each step called for all teammates to make contributions, usually with one person writing the main sequence of the scavenger hunt and teammates adding detail. Trivia naturally called for dividing the workload and teammates writing all the questions for each category. Role-play called for input from all teammates before the main description of the scenario was written by an individual and then approved by all three teammates. Each template called for contributions from all participants; usually in the form of sharing workloads and/or reviewing each other's work and providing feedback.

Responses to the third survey question, asking participants if they felt that they communicated with teammates to create the game, showed that role-play received the highest score of 7.18 out of 10, scavenger hunt the second highest at 7.03 out of 10, and trivia the third highest with 7.00 out of 10. Role-play called for communication among teammates to share ideas, critique proposals for the scenario, and refine the final form of role-play. Role-play had the least amount of words used to write the activity and description of resources (Figure 12), but dialogue was needed to reach consensus on clear and concise descriptions of the role-play's description and descriptions of resources. During scavenger hunt, teammates had to periodically discuss thoughts, ideas, and reasoning for the sequence of the scavenger hunt. Teams would communicate during scavenger hunt to work out any confusing details coming through in their writing and refine each step of the hunt as the overall picture became clearer. During trivia, communication involved teammates double-checking facts and information and reporting the progress each other's part. The unique communication techniques used within each game template helped to facilitate the SCK process.

Fourth, an additional factor that influenced SCK during participation was the limitation in the design of the knowledge game center. This had a negative effect on teams grasping what to do when they first logged on to the system. Interviews relayed dissatisfaction with the design of the system and even more disdain for the message system. Due to the limitations of FileMaker and the fact that the researcher designed the system without the perspective of another developer, it was bound to contain limitations and opportunity for improvement.

Participants would log in, on average, for 30 minutes at a time (Table 33) and go from six hour to 209 hours in-between sections (Table 35) – therefore participation was high on certain days and low during certain weeks. Participants were leading busy lives and had to find time to use the knowledge game templates. For example, a participant would log on, read and respond to messages, create game items, write details of each game component, and log-off. The next time they would log in, they would check if teammates provided feedback and asked questions. This process would continue until the team agreed that they were finished. Therefore, familiarity with and comfort using the system positively influenced SCK.

Despite the challenges, participants still produced SCK. Taking all into consideration, a variety of factors either helped or hindered SCK. How well the team knew each other, the difficulty of designing the game and using the template at hand, collaboration, contributions, and communication, and interaction required to complete a game template increased SCK (as evidenced in scavenger hunt). On the other hand, the design of the system and limitations of FileMaker limited SCK. However, all teams played a part in identifying common strategies for working together and identifying factors that support SCK.

5.2.7 RQ3 What are participants' perceptions of their ability to construct the games? As in any group situation, communication styles and working with team members presents challenges. Reasons for constructing games went beyond technology support. One participant reflected on the team's ability to construct games during an interview:

> *I think in these games it's difficult when you have the people on your team, and not only do you have to sometimes wait for other people, there might be times when it can actually limit some of your knowledge. For myself, there were a lot of things that I wanted to expand upon, but when other people are involved, you don't want to step on anyone's toes*

Group work is difficult and can cause conflict, especially online. An and Kim (2009) spoke of the following difficulties encountered during online collaborative tasks: (1) cognitive conflicts; (2) individual differences; (3) difficulties adapting to a non-differentiated grading system; (4) time zone scheduling problems; and (5) challenges because of not being able to communicate face-to-face. Each group likely experienced a combination of the aforementioned factors.

It was clear that those with the confidence to create knowledge persevered and managed to create the games even though they were not familiar with the game templates. Participants without a background in creating instructional material struggled to contribute to their team's efforts.

Participants recognized the potential of using the system to construct knowledge games. Interviewees reported positive impressions of the games. A veteran elementary and middle school teacher reported "It would be something that I would readily, without hesitation, use … to get away from the mundane lecture and the textbook driven teaching" Educators with a background in leading professional development looked beyond the limitations of the system and honed in on the benefits.

Overall, participants spoke of the challenges in working with others. The complexities of scheduling, work commitments, and enthusiasm among busy professionals did not lend to creating knowledge games and feeling satisfied with the final design. Additionally, one participant spoke of a lack of confidence in being creative and contributing to the team.

Beyond participants' frustrations working in a group, and any self-doubt of being creative and contributing to their team's efforts, perseverance and a desire to share the games with others shone through. Teams were able to learn the system and persist with creating the games. Despite the limitations placed on participants by the system, the games that the teams constructed were recognized as worthy for sharing with others.

5.2.8 RQ4 What information is revealed by system usage statistics of how teams construct games? Statistics were presented in chapter 4 and here salient findings are discussed. Overall, the knowledge game center captured connection records, navigation activity records, and authoring history for every game's input fields. The data assists understanding how participants used the system to create knowledge games.

Comparing overall completion times, scavenger hunt took the most amount of time to construct, whereas trivia the shortest (Table 31). Scavenger hunt required more input from participants in terms of data fields required (3 fields for the overall scavenger hunt and 5 inputs for each step), whereas trivia contained less (1 field for the trivia game's instructions and 4 inputs for each question and answer). Of particular interest is that role-play, the second longest template on average to create, only had 2 inputs (one field for the entire activity and one for each resource). Each game template had it's own unique takeaways.

As revealed during interviews, trivia came through as the easiest to grasp and most straightforward to generate knowledge among the team. This is reflected in the overall completion times with scavenger hunt taking 11.50 days and trivia taking 6.99 days to complete (Table 31). Scavenger hunt and role-play required more thought and coordination among the team. The amount of messages generated within each template (see Table 11) - scavenger hunt the most (313 messages), role-play second (202 messages), and trivia third (178 messages) - backed up the notion that it took more time and communication to generate the more open-ended scavenger and role-play games.

Recognizing the actual hours invested in constructing all the games, individuals spent on average 8 hours and 39 minutes constructing the games - a little more than a full working day (Table 32). The total combined hours for all three members of a team was an average 25 hours and 57 minutes - nearly triple the average time spent per participant.

This system usage statistic revealed that the length of time the average person could realistically spend tackling three major assignments are eight hours. One participant contributed only 45 minutes helping their teammates construct the three games, whereas another person spent almost 22 hours on a computer constructing the games (see Table 32). Overall, people who contain the most knowledge are likely the busiest; with little time to sit down, be creative, and work in a group to create knowledge games.

Further analysis of connection patterns revealed more participation trends. On average, participants connected 18 times for half an hour at a time (see Tables 33 $ 34). The average maximum amount of time in-between connections was a little more than 209 hours - or nearly nine days. The minimum time in-between connections was around 6.5 hours (see Table 35). These participation trends show that people were either focused on participating in the study, or would let a week or more pass before recommitting time to accessing the system and building knowledge with their team. A participant's two other teammates were likely managing personal time the same way; thus the ability of the group to quickly make decisions, respond to questions on the system, and write and approve the details of each game lost enthusiasm.

The average percentage of time contributed by each team member was 33.33% of the teams' overall time (see Table 34) - mathematically a near perfect third. Knowing that teams had participants connecting on average of half an hour each time, with as little more than half a day to more than a week in-between connection times, it is impressive that teams accomplished creating the games with success.

Scavenger hunt and trivia generated the most amount of words, 2012 and 1901 respectively, whereas role play generated 1307 words on average (see Table 36). The fact that scavenger hunt and trivia required more words and items to generate a game is not surprising. On the other hand role-play, with the least amount of input fields, required the second most average time to complete the game while using the least amount of words. Teams had to carefully consider and discuss their role-play activity before marking it final.

The TinCan data, as shown in Figure 13, generated a bank of information. The top three actions generated within the system were: "saved" at 24% of all actions, "interacted" at 21%, and "completed" at 11% of all actions. Participant likely to saved work after interacting with the system. Saved occurred whenever a participant would intentionally press the save button. The interacted action was tied to navigation buttons embedded throughout the system - such as when a participant chose to enter the main game construction area, viewed their profile, or clicked the home button. Completed was produced each time a participant finished editing a trivia question, role-play resource, or scavenger hunt item.

5.2.9 Overall Findings This study demonstrated that SCK occurred as participants used three different game templates to create a knowledge game. Knowledge construction occurred in all three game templates even though the incidences were not statistically significant.

The knowledge game center provided structure and guidance for teams to collaborate and co-create knowledge games. A help section, sample knowledge games, the message board, and the templates shared spaces and sources of information to drive interaction among teams. The system enabled an environment conducive to creating knowledge. Von Krough, Ichijo, & Nonaka (2000) describe a "knowledge spiral" of interaction within such an environment where knowledge creation thrives (pg. 180).

The knowledge game center achieves the knowledge spiral's four interactions – originating, conversing, documenting and internalizing. For demonstration, the trivia template will be highlighted. A participant originates an idea by either writing a piece of the game or sharing an idea for how to – such as writing a five star (difficult game). The original author converses with his or her teammates within the messaging system to refine concepts and seek team approval. Any last changes are officially documented and the team marks the game piece as finished and moves onto the next question. Finally, the games can be shared with others so that the knowledge can be internalized and integrated into practice. From here, new teams can form and use the knowledge center for a second time – thus restarting the spiral of interactions producing knowledge.

The templates provided unique takeaways for consideration by future designers of knowledge creation systems: trivia's ease of use, role-play's engaging complexity, scavenger hunt's intrigue, and optimism for the use of games to create knowledge. Trivia allowed teams to get started quickly with little effort – hence it's ease of use. Role-play offered engaging complexity because even though it was short in terms of written length, it called for teammates to interact with one another and craft a role-play activity that was fun to play and provided authentic learning moments. Scavenger hunt was intriguing because despite it's complexity, and amount of detail required for the scavenger hunt, participants communicated, collaborated, and authored the game at the highest levels as compared to the other two. Finally, optimism was expressed by participants towards the possible applications of the technology and knowledge games - activities that can meet the needs of 21st century learners. This subsection summarizes these findings based upon all research questions.

The data were gathered using coding of messages as were created, observations, interviews, game completion surveys, and system usage data. Table 39 is a joint display of qualitative and quantitative findings, as encouraged for mixed-methods design (Creswell & Plano-Clark, 2011).

Trivia's ease of use is the first finding. Trivia was straightforward and easy to use; team members easily split up tasks and experienced no problems writing each trivia question. IAM coding found trivia used the least amount of posts per team (Table 11) – an indication that teams were naturally creating knowledge with little need to communicate. All phases of the IAM occurred during trivia, with the least amount of Phase I (sharing and comparing) and Phases III through V (knowledge construction, testing proposed synthesis, and agreement statements or application) happening during trivia. Additionally, observations found that trivia contained the highest levels of team member participation and authoring rates as compared to the other two templates.

Interviews supported the claim that trivia was uncomplicated and was the preferred template for working with peers. Trivia game completion surveys found that perceived collaboration and contribution among teams was rated at least 6.50 out of 10 in both areas – indicating that participants believed the team was working together to create each game (see Table 30). System usage data supported trivia's ease of use among teams by showing that trivia took the shortest amount of time, on average, to complete (see Table 31).

Table 39

Joint Display of Qualitative and Quantitative Findings

Research Questions	Trivia's Ease of Use	Role-Play's Engaging Complexity	Scavenger Hunt's Intrigue	Optimism
(1) Which game template (trivia, role-play, or scavenger hunt) generates social construction of knowledge (SCK) as participants use each template to create a knowledge game?	SCK occurred in the trivia template	SCK occurred in the role-play template	SCK occurred in the scavenger hunt template.	SCK occurred in all three templates.
(1a) Which game template leads to the highest incidence of the IAM model's Phase I (Sharing and Comparing)?	Coded 136 incidences.	Coded 168 incidences.	Coded 225 incidences.	System makes it easy to share thoughts or ideas.
(1b) Which game template leads to the highest incidence of the IAM model's Phase II (Exploration of Dissonance)?	Coded 6 incidences.	Coded 14 incidences.	Coded 3 incidences.	Dissonance occurred in all three templates.
(1c) Which game template leads to the highest incidence of the IAM model's Phase III, IV, or V (Knowledge Construction, Testing Proposed Synthesis, and Agreement Statements or Application)?	Coded 50 incidences.	Coded 78 incidences.	Coded 110 incidences.	Phase V (agreement statements or application) achieved.
(1d) Which game template shows the progression of knowledge from Phase I to V?	Coded 6 incidences.	Coded 9 incidences.	Coded 12 incidences.	Phase V (agreement statements or application) achieved in each template.
(2) What factors influence SCK as participants engage in constructing games?	Team member participation and authoring rate observed at a high rate. Teamwork spoken of during interviews.	Highest average survey score for liking the game and looking forward to sharing. Highest observation rating for material being interesting and relevant.	Highest observation rating of game creation activities and team communication occurring while creating hunt.	Despite limiting factors of message system, teams still created knowledge in each template.
(3) What are participants' perceptions of their ability to construct the games?	Collaboration and contribution survey scores of at least 6.5. Positive viewpoints from interviews.	Highest levels of required communication to create the game and emergence of leaders reported through surveys.	Intentions to use the activity with others reported in survey free-response. Positive viewpoints from interviews	Overall positive viewpoints of using games to create knowledge reported through interviews and surveys.
(4) What do system usage data show about a team's knowledge construction patterns (time spent on task, system navigation trends, amounts of words used, and game items created)?	Least amount of time, on average, to complete. Least amount of messages generated.	Eight days, on average, to create despite using the least amount of words and items.	Longest average time to complete. Greatest amount of average words used per game.	Games were of recommended format. Teams predominantly saved work, interacted, and completed tasks. Each template took different times to complete.

The second finding was *role-play's engaging complexity*. The role-play games were simple in terms of amount of writing required, but contained complex scenarios and roles to support the activity. IAM coding, observations, and game completion surveys discovered unique outcomes from role-play. IAM Coding found that role-play generated the second most incidences of I, III, IV, and V. This indicates that while SCK was taking place at both lower and higher levels, few messages were created that did directly relate to the creation of the role-play. Participants were engaged while designing the role-play activity.

Additionally, the researcher gave the highest average observation score to role-play for game material being interesting and relevant. The role-play commerce game developed by the computer science team is an example of a game that would be entertaining to play and appropriate for the intentions of a team (see Appendix E). Participants spoke during interviews of role-play's open-endedness and how it could be used in any scenario imaginable.

System usage data supported role-play's engaging complexity; on average, it took the least amount of words and items to complete but took nearly eight days to complete. Due to the busy nature of participants, and desire to have the greatest impact by sharing knowledge with others, role-play is appealing since it takes less writing to create and provides an in-depth activity.

The third finding involves *scavenger hunt's intrigue*. IAM coding discovered the greatest incidences of Phase I (sharing and comparing), III (knowledge construction), and V (agreement statements or application) – evidence of higher levels of SCK. Teams were busy sharing ideas, co-constructing meaning, and acknowledging their work with the greatest frequency in scavenger hunt. Scavenger hunt generated the most communication messages as compared to the other templates.

The researcher observed that teammates were all involved in creating the scavenger hunt and communicating with one another as compared to the other two templates. Despite the activity taking the longest length of time, generating the most amount of words, and requiring high-levels of team coordination, people reported through surveys and interviews a desire to share the scavenger hunt with others. It is intriguing that participants put the most amount of work into scavenger hunt, and were the most excited to share the game with others.

Interviewees and game completion surveys indicated the desire to use a scavenger hunt in practice. Scavenger hunt never had the lowest average score for any game completion survey question and participants responded that they would share the games with others during open-ended questions. Finally, system usage data revealed that scavenger hunt used the most amount of words and took the longest length of time to complete. Despite the perceived amount of effort to create each scavenger hunt, participants thought that the scavenger hunt activities were the best way to share knowledge with others.

Optimism in creating knowledge through game development was the remaining finding. Simply put, because the IAM coding found evidence of Phase V (agreement statements or application) in at least one message in every template, the IAM coders demonstrated that teams could achieve higher levels of SCK through each template. Additionally, dissonance took place in each game’s communication messages - an indication that teams were in thoughtful dialogue negotiating the details of each game.

Teams acknowledged their hard work and talked about how they could use the games in practice to support learning and creating knowledge.

The researcher observed that teams created material appropriate for each game template at a rate of at least 2.75 out of 3.00 in all three templates (Table 27); meaning that the trivia, role-play, and scavenger hunt were true examples of the activity – another reason for optimism. Considering the challenge of placing participants in an experimental system, and providing minimal guidance on how to construct each template, teams created games that were genuine trivia, role-play, or scavenger hunt activities which were complete enough to share with others.

Overall, participants persevered and mastered using the system. Participation patterns showed that saving work, interacting with the system, and completing tasks were the top three activities displayed by participants within the system (see Figure 14) – possible signs of that SCK was taking place. The average total time teams spent creating all three games was 26.50 days (see Table 31) while generating a total average amount of 57.74 messages (see Table 11)– an indication of the dedication of participants to the challenge presented by the knowledge game center. Interviews and game completion surveys found similar pieces of optimism reported by participants.

5.3 Implications

The analysis and findings presented in previous chapters makes it clear - experimentation with how learning communities record knowledge so that it is interesting and immediately transferable to others is more than ever. The knowledge game center provided an environment where SCK took place within three game templates. The following two subsections discuss design and research implications for future researchers, educators, and developers.

5.3.1 Design implications. The researcher accepted the challenge of creating an online knowledge creation system and learned several lessons along the way. The researcher envisioned an online knowledge creation system that used games as a format to empower SCK among subject matter experts. Similar experiments were not found, especially systems using FileMaker or Microsoft Access - technologies readily available creating documents. Therefore, a quasi-experimental mixed methods study was deployed to gather both quantitative and qualitative data of how SCK takes place.

This study demonstrated how to examine online knowledge creation across multiple parties interested in collaborating. Others have experimented with connecting experts online to create knowledge. Hills (2015) explored “crowdsourcing” – or using students to develop content according to their own interests. Even though the experiment produced blog postings developed by 98 students, students did not work together nor provide feedback like how the knowledge game center used a team concept, game templates, and a messaging system.

Another study explored knowledge construction by following students playing games (Foster, 2011), but gathered data from an outsider point-of-view – unlike the knowledge game center where data collection was embedded into the SCK experience. Other studies attempted collaborative projects using wikis and a message board but experienced mixed results (Hou, et al., 2009; Judd, Kennedy, & Cropper, 2010; Qian & Johnston, 2012). Providing structure to compose knowledge embodied in a familiar object – like a book, game, or movie – gives researchers another technique for designing learning activities.

Even though this study cannot be generalized, it provides other educational technologists a starting point - a lesson on creating online knowledge creation environments. Despite participants' initial issues becoming comfortable with the system and the limitations of the message board, participants considered the games worthy for sharing with others.

The games themselves offered glimpses into what it takes to create each activity. Trivia was straight-forward and easy to come up with idea. Role-play was simple in the amount of words required to describe it, but required a complex thought process by teammates to craft the perfect activity. Scavenger hunt was the most challenging of three in terms of amount of writing and length of time required, but offered the best opportunity to achieve deep understandings of topics. The templates gives educators an idea of difficulty levels required to create each game –trivia may be best for novices, scavenger hunts for advanced learners, role-play for creative thinkers, etc.

In terms of system design, participation patterns uncovered that saving, interacting, and completing were the primary activity of participants within this study's experimental software system. Participants saved work as much as possible to avoid reconstructing the knowledge if the connection were lost. Also, participants interacted with the system by pressing every button, accessing every section, and clicking every menu as they became comfortable with the system.

In addition to saving and interacting, participants completed tasks presented by the system's scripted navigation menus. The three patterns are an indication that people focus on the task at hand and depend on the system to guide them to the objective; in this study, creating each game.

On a different note, other game types should be explored as templates for creating knowledge. Why not ask participants to create a board or dice game? Or what about creating a jigsaw or scaffolding activity for teachers? Maybe even a charades game? What if the participants were asked to write a song or a movie script? Mad Libs™ - the phrasal word game in existence since 1958 where nouns, adjectives, and adverbs are plugged into sentences - is another format worth exploring. Another idea would be as simple as giving teams a single text box and asking them to describe the game in paragraph form. The possibilities are endless.

Other suggestions, in retrospect, regard whether or not technology is needed in the first place. Would participants be more successful designing the knowledge games without templates and databases? Future researchers should explore the difference of using electronic technology versus a simple paper & pencil. Even though it may seem like an ignorant proposition to not use technology, it might be that gathering participants in a room, with a whiteboard and paper supplies, is the best way to design knowledge games.

5.3.2 Research implications. Coding messages according to the IAM model served as the primary resource for measuring levels of knowledge creation. Analysis via the IAM confirmed that SCK took place, but opportunities to improve the process remain. One of the drawbacks of the IAM model is the complexity and poor consistency of reliability (Marra, 2006). The five major phases and 21 sub phases of the IAM challenges coders to consider every code when examining a unit of analysis. Combining

Phases III through V (knowledge construction, testing proposed synthesis, and agreement statements or application) into a single phase that represents higher orders of knowledge construction is seen as viable adaptation to the model (Lucas, et al., 2014) Because of this, the researcher used a flexible interpretation of the IAM model in order to count all higher phases of the IAM model and the progression of SCK through phases I through V (see Table 21). Future researchers should explore new interpretations of the IAM phases and how they can evolve.

Besides coding the message sent between participants during SCK, the artifact itself – does it not count for something? The first sub phase of the IAM model's Phase V – summarization of agreement (Gunawardena, et al., 1997) - implies a summary of the group's consensus. If the artifact itself - in the case of this study, each game - represents knowledge that was shared, disagreed upon, co-constructed, tested, and finally applied - why not count it for Phase V? Future researchers should include an extra phase to the IAM model called "Artifact Inspection" where the researcher can review the artifact and count it as a Phase V score or assign it a different category as a developed produced due to the the knowledge creation. To make the standards for this new code more stringent, the researcher can consider participation patterns and authoring history if available from the system. By counting the artifact as a representation of the higher orders of SCK, researchers can broaden investigation into to what SCK looks like when it occurs and how do researchers measure it.

The IAM model also presents an opportunity to expand understanding of how participants manage the SCK process. A "no phase" code given by the researcher, or a code given on the unit of analysis indicating no SCK, may represent something opposite of SCK; for example how people deal with online interactions. For example, a participant left a message for a teammate: “I went to the help button and looked at the examples.” Another example of a no phase code for a post would be: “So next time we meet, are we to review what was done today and click on ‘create the game?’” Both examples demonstrate how people communicate in an online virtual environment as they work together to create an artifact. No phase posts, similar to project management questions, polite side-conversations, or blank messages are insights into the social dimension of what’s occurring. How participants share schedules, figure who’s going to write what, pose questions about the system are all clues on the likelihood of collaboration occurring. A future investigation should explore how “no phase” messages, which are not accounted for by the IAM, support social construction of knowledge.

Coders marked no phase of the IAM model on 42 trivia, 34 role-play, and 88 scavenger hunt messages (Figure 11). Further examination of the overall coding (Figure 11) revealed that the amount of no phase messages appear equal to the amount of Phase III (negotiating of meaning / co-construction of knowledge); but both half the amount of IAM Phase I (Sharing & Comparing). Participants were predominantly sharing and discussing information, but spent about equal effort co-constructing knowledge and chatting about things other than the problem.

The other research techniques in this study placed the researcher in the center of data collection activities. Interviews were the most direct interaction with participants, but gave the researcher an opportunity to hear thoughts from participants who either approved or disliked the system. The messages and free-response section of game completion surveys were other areas where opinions of the study were found. The research methods supporting the IAM coding were beneficial tools for measuring SCK and understanding how it took place.

The system data captured access and activity records that revealed participation patterns. Participants of this study were willing to lend eight hours of time to knowledge creation efforts with teammates (see Table 32). System usage data revealed that people tried to contribute as much as possible, but were limited to half-hour blocks of time. These blocks of time must be productive and beneficial for participants to see any value in contributing. The study used an open schedule for organizing participants to create each game. Requiring participants to attend game creation sessions would yield interesting results.

Another challenge facing knowledge creation researchers involves being protective of the design treatments (i.e. the templates). The participants received the general research premise – access a system that contains three activities involving games and knowledge creation - but the researcher chose not to share the exact details of the research task (to create a trivia, role-play, and scavenger hunt activity). Sharing steps of the activity with participants is recommended as much as possible; but not at the expense of revealing the experimental treatment and introducing bias.

Researchers continuing this type of experimentation must decide if exploring differences between the templates is more important than between the teams. This study focused on the difference between templates, not the teams.

5.4 Limitations of the Study

A limiting factor was the required size of each team (three participants). Flexible team sizes would have increased the sample size. Allowing teams to join with as little as two people – to teams consisting of four or more people – would have increased the likelihood of recruiting more people interested in working together.

The participant pool needed further diversification. Recruitment centered on teachers and students teams, with little success obtaining the services of businesses, and hobbyist teams. A wider range of team types could potentially diversify the results. In addition, more male participants are needed to balance the teams. This study had a four to one ratio of female to male participants (Table 4).

The message system frustrated participants and may have hindered the knowledge construction process. The message board did not provide real-time communication and called for a more advanced bulletin board system.

In terms of reliability and validity, each team performed the same activity according to the game template presentation and structure of the system – ensuring consistency of data collection. Surveys and observations were administered within the system as well. Technology performance was staller and few minor bugs were reported. There was no data lost in this study.

The data used for ANOVA testing was not normally distributed, nor did it have homogeneous variances, thus violating the assumptions of ANOVA testing. Non-significance was confirmed even though alternate tests were explored for non-normal and non-homogeneous data. Larger-scale studies and improvements on the design of the knowledge center are the first opportunities to improve data validity. A focused study on a particular type of team - for example, all speech language teachers from a school district – may also decrease the wide range of variances.

Interviews and IAM coding were subject to standards of validity. The researcher transcribed each interview and sent to interviewees for review. Feedback was received and updated in order to confirm the interview transcript. The IAM coding was subject to inter-rater reliability checks as recommended by Chi (1997), such as identifying coding of disagreements, discussing segments of the message representing each code, and either agreeing and changing codes, or disagreeing and not changing the codes. Inter rater reliability checks were performed as described and two Cohen's kappa were calculated: (1) after coding all messages for the first three teams and (2) after coding all messages for the remainder of the teams. The checks yielded a Cohen's kappa of 0.813 and the 0.42, respectively. Both inter rater reliability coefficients were within moderate agreement between the IAM coders.

5.5 Recommendations for Future Research

Mixed methods was a flexible design that enabled administration of surveys, conducting observations, leading interviews, performing interaction analysis, and collect system data. The methods afford researchers the most holistic approach to measure SCK in online knowledge systems. The FileMaker system served as the primary vehicle to gather all such data.

Despite the challenges of becoming accustomed to the FileMaker layouts, participants learned the system and generated knowledge using the game templates. Collecting data from both the user and system's perspective gave the researcher a comprehensive view of what the study achieved. The observations, interviews, and game completion surveys offered a unique perspective on what factors supported SCK and what were the participants' opinions of the experience. The interaction analysis approach for measuring SCK verified that knowledge creation took place. Future researchers should continue to apply similar mixed-method research approaches to understand the nuances of knowledge creation systems. Observations, interviews, coding, and compilation of survey data should be conducted as close together as possible in order to capture the full breadth of the experience.

A larger scale study is the first recommendation for future research. By increasing the amount of participants, variance would become more homogeneous for ANOVA testing while at the same time broadening the data collection for the various types of participants. One possible way of achieving larger pools of participants would be to target an innovative and technologically advanced organization willing to offer complete support for the knowledge creation efforts. The researcher in this study did not have success advertising the study on bulletin boards, online advertisements, or social media. Future researchers must pinpoint a large school district, higher education institution, a massive open online course (MOOC), or a small to medium business willing to make participation mandatory.

Along those same lines, better incentives should be explored for participants. This study revealed that people were willing to dedicate, on average, eight hours of their attention to constructing all three games. If incentives were to be used, and participation was mandatory, more participation and social construction of knowledge would likely increase.

The size of teams offers another opportunity for further research. This study explored teams of strictly three people. Recruitment likely would improve if the size of teams can fluctuate. Team size may reveal intriguing insights - such as how small and large teams manage to create knowledge in different ways. Questions to explore would be: Would team size impact SCK? What type of teams engage in game development? How many and what types of messages do small and large teams generate? Do team members access the system differently as teams of two versus larger teams? Are contributions equally shared or do leader emerge?

In terms of improving the layout of the system, participants suggested several ideas. A participant reported a desire for a more visual experience during the knowledge creation process. The system was primarily a text-based environment and future designs should integrate more graphics. Other recommendations included making examples more prominent, integrating a team vote function, and changing auto-notifications to include the progress of other teammates' work. Future developers should decide if messaging systems built within database programs like Microsoft Access or FileMaker are worth the effort, or if importing message board systems via web portals is the more convenient choice.

5.6 Conclusion

Human spirit guarantees perseverance. In both the researcher and participants' viewpoints, perseverance was required to complete this study. Designing technology to support complex human thinking and the activities that ensue is no easy feat. Neither is performing online group work. Despite the challenges, both a system for creating knowledge games was designed and teams were successful in generating knowledge in the form of a trivia, role-play, and scavenger hunt games. All-in-all, technology must remain adaptable and open to change.

Through a pragmatic quasi-experimental mixed methods approach, the researcher explored the possibility of using games as a template for generating social construction of knowledge in this study. Thirty-six participants forming 12 teams were recruited from teacher, student, business, and hobbyist perspectives. Interviews, analysis of computer messages using the IAM Model, observations, game completion surveys, and review of system usage helped construct the findings. The mixed-methods framework used in this study provides a blueprint for future researchers to study how people connect within interactive knowledge creation systems.

Overall, participants created knowledge within each template and expressed optimism about using games to spread knowledge. Unique traits for each template were revealed through research constructs. Trivia was the fastest and most straightforward of the three to complete as a team. Role-play offered engaging complexity, an indication of its open-endedness and tendency to engage teammates in dialogue on how to design the activity. Scavenger hunt was intriguing because despite having the most requirements and taking the longest average time to complete, the activities were creative and participants most looked forward to sharing the hunts with others.

The study calls for further investigation into using databases and the Internet to provide a captivating and unique approach to creating and sharing knowledge with others. Implications for other designers and researchers will guide potential new studies. Future researchers will continue to push the boundaries of collaboration and knowledge creation - based on the lessons learned from this research - through a foundation of collaborative game creation.

Appendix

Appendix A

Knowledge Game Center
Observation Protocol

Cover Sheet

Team Name: ______________________________

Observer: __________________ Location: __________________

Date: ______________________ Time: ______________________

Type of Game Being Created by the Team:

____

How Participants Are Accessing the System (i.e. smart phone, tablet):

____

Rubric for Assessing Knowledge Game Construction

Observation Evidence Scale

Not Observed	0
Low (up to 33%)	1
Mid (up to 66%)	2
High (over 67%)	3

(mark each item and provide a rating)

I. Process of Knowledge Creation

A. Game Creation

1. Evidence of breakdown in understanding, collaboration, realignment of understanding, and cross leveling of knowledge among tea.…… ☐ __
2. Team has created an adequate amount of items within the game. ☐ __
3. Likelihood the team will complete the game by the deadline ..… ☐ __

B. Team Member Participation

1. The game contains contributions from all members …………... ☐ __
2. All members logged onto the system during the game building phase ………..………………………………………………… ☐ __
3. All members authored at least one portion of the game ………... ☐ __

C. Team Communication

1. Team members are using the message system to socialize ……... ☐ __
3. Team members are asking questions regarding the game creation ☐ __
4. Team members are replying to each other's questions ………..... ☐ __

II. Quality of Knowledge Creation

A. Quality of Games Created

1. Game material is interesting and relevant ………………………. ☐ __
2. Game material has minor grammatical errors …………….…..…. ☐ __
3. Team wrote clear instructions/overview of the game ……..….…... ☐ __
4. Teams achieved creating the recommended amount of game items
    a. Trivia questions/answers (at least 25 questions) ….......…. ☐ __
    b. Role play resources (2-4 resources) …...……………..……. ☐ __
    c. Scavenger hunt steps (5-7 steps) ...………...……………. ☐ __

B. Team’s Understanding of the Game Template

1. Team has little or no questions about the game ...……………… ☐ __
2. Team created material appropriate for the type of game template ☐ __

III. Technology Performance

A. System Performance

1. Knowledge game center is experiencing no server issues ……..... ☐ __
2. Knowledge game center website is online with no errors ……..... ☐ __
3. Knowledge game center displays no lag time navigating the system ……………………………………………………….. ☐ __

D. Need for Technical Assistance

1. Users are able to access the database without assistance ……….. ☐ __
2. No errors or bugs reported by users ………………….…………. ☐ __

III. Other (open notes)

Appendix B

Interview Protocol

Interview Project: Knowledge Game Center Study
Time of Interview:
Date:
Place:
Interviewer:
Interviewee Number:

Questions:

1. How did your team form?

2. Talk about how you shared ideas with your team to create each game.

3. How did your team communicate using the message system to create each game?

4. What were some of your team's challenges to collaborate and develop each game?

5. Describe how your team decided when a game was finished and ready to submit.

6. Which game do you think is ideal for creating knowledge in your profession? Why?

7. Which game do you prefer to construct knowledge with your teammates? Why?

8. How can you use these games in your profession?

9. How can the knowledge game center be improved upon to create better knowledge games?

10. What are the system's strengths for creating knowledge games?

11. Do you have anything else to share?

(Reminder: Thank the individual for participating in the study. Assure him or her of confidentiality of responses.)

Appendix C

Game Completion Surveys

Game Completion Survey: Trivia

Please answer all questions!

1 (low) - 10 (high)

1) Your team collaborated with each other to create this game.

○1 ○2 ○3 ○4 ○5 ○6 ●7 ○8 ○9 ○10

2) All team members contributed to creating this game.

○1 ○2 ○3 ○4 ○5 ●6 ○7 ○8 ○9 ○10

3) You communicated with your team to create this game.

○1 ○2 ○3 ○4 ○5 ○6 ●7 ○8 ○9 ○10

4) Leaders naturally emerged for your team.

○1 ○2 ○3 ○4 ○5 ○6 ●7 ○8 ○9 ○10

5) You like the game your team just created and look forward to sharing it.

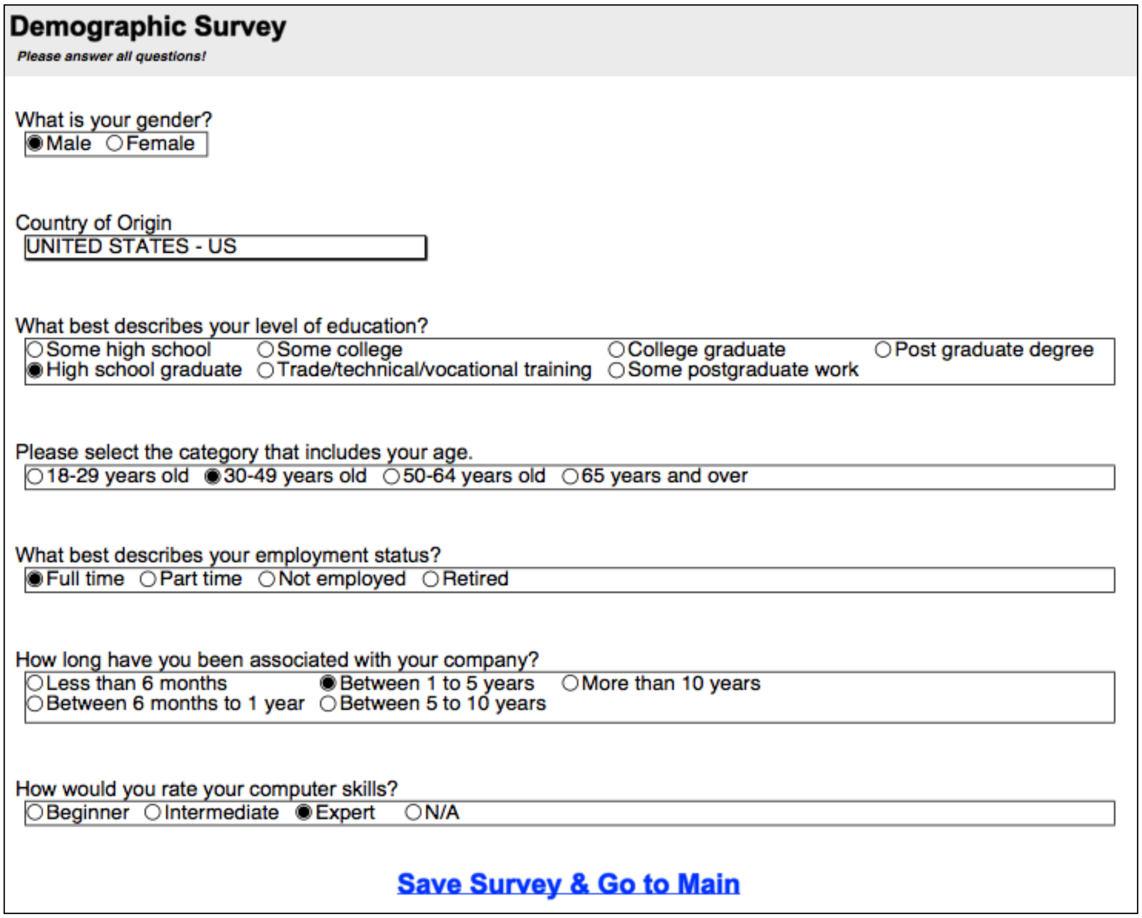
○1 ○2 ○3 ○4 ○5 ○6 ○7 ●8 ○9 ○10

Other Comments

test response

Appendix D

Demographic Surveys



Demographic Survey

Please answer all questions!

What is your gender?

(●) Male ( ) Female

Country of Origin

UNITED STATES - US

What best describes your level of education?

( ) Some high school ( ) Some college ( ) College graduate ( ) Post graduate degree

(●) High school graduate ( ) Trade/technical/vocational training ( ) Some postgraduate work

Please select the category that includes your age.

( ) 18-29 years old (●) 30-49 years old ( ) 50-64 years old ( ) 65 years and over

What best describes your employment status?

(●) Full time ( ) Part time ( ) Not employed ( ) Retired

How long have you been associated with your company?

( ) Less than 6 months (●) Between 1 to 5 years ( ) More than 10 years

( ) Between 6 months to 1 year ( ) Between 5 to 10 years

How would you rate your computer skills?

( ) Beginner ( ) Intermediate (●) Expert ( ) N/A

Save Survey & Go to Main

Appendix E

Sample Knowledge Games

Appendix E highlights knowledge games produced by participant teams. The games were created from September 2014 to April 2015. Teams created trivia, role-play, and scavenger hunt knowledge games. This appendix provides two examples of each game template.

Participants were English teachers, speech therapists, undergraduate computer science students, graduate students interested in educational technology, community college faculty, and an aromatherapy small team. Teams were coworkers and colleagues from a particular field or subject matter experts meeting other experts.

The first trivia game is for educators interested in preschool language development. The second trivia game is for educators attempting to “flip” their classrooms. The first role-play activity is a mercantile game to teach mathematics in a real-world setting. The second role-play is for incoming freshman at a local community college. The first scavenger hunt activity is a literacy unit for middle-school students. The second scavenger hunt activity is an overview of how to start an aromatherapy business.

These examples were less than or met the recommended amount of details to complete each game.

Trivia Example #1

Instructions: Hey Educators! How knowledgeable are you in the subject of preschool language development? Play our game with your staff and see if you are as proficient as you think!

Place all the cards face-down on a table. Take turns reading each card. Game can be played by appointing a specific person (giving an order) to answer the question, or by allowing the first person to raise their hand to answer. 1 point will be given for a correct answer. The person with the most points at the end of the game wins!

Question #1

Subject: DEVELOPING EXPESSIVE LANGAUGE
Difficulty: *** (3 stars)
Question: What difficulties can a preschooler have with expressive language?
Answer: -asking questions, naming objects, using gestures, putting words together into sentences, learning songs and rhymes, using correct pronouns, like "he" or "they", knowing how to start a conversation and keep it going
-ASHA
http://www.asha.org/public/speech/disorders/Preschool-Language-Disorders/

Question #2

Subject: DEVELOPING EXPRESSIVE LANGUAGE
Difficulty: ** (2 stars)
Question: What is expressive language?
Answer: Is how an individual expresses their wants and needs by verbal and nonverbal communication skills and how an individual uses language. These skills include: facial expressions, gestures, intentionality, vocabulary, semantics (word/sentence meaning), morphology, and syntax (grammar rules).

http://www.pediatrictherapynetwork.org/services/speech_language_definitions.cfm

Question #3

Subject: DEVELOPING EXPRESSIVE LANGUAGE
Difficulty: **** (4 stars)
Question: How does a Speech Language Pathologist aid in the development of expressive language?
Answer: In order to develop language skills, children must be able to see, hear, understand, and retain information. Speech therapy focuses on testing and strengthening these skills and on helping your child increase his or her vocabulary. A speech therapist can use word repetition, images, tailored reading materials, and other tools to help nurture your child's communication skills.

Question #4

Subject: DEVELOPING EXPRESSIVE LANGUAGE
Difficulty: ***** (5 stars)
Question: How many words are typical for a 3 year old to have in their expressive vocabulary?
Answer: At 3 years, children can have anywhere from 500-1,100 words in their vocabulary.

Question #5

Subject: DEVELOPING RECEPTIVE LANGUAGE
Difficulty: * (1 star)
Question: Do preschool children have a higher vocabulary in expressive or receptive language?
Answer: Preschool children have a higher vocabulary in receptive language.

Question #6

Subject: DEVELOPING RECEPTIVE LANGUAGE
Difficulty: ** (2 stars)
Question: What is receptive language?
Answer: Is the comprehension of language. It involves attention, listening, and processing the message to gain information. These skills include: attention, receptive vocabulary, following directions, and understanding questions.

http://www.pediatrictherapynetwork.org/services/speech_language_definitions.cfm

Question #7

Subject: DEVELOPING RECEPTIVE LANGUAGE
Difficulty: *** (3 stars)
Question: What strategies can be implemented in the general education classroom for students who have greater abilities in receptive language rather than expressive?
Answer: General education teachers can use visuals and communication devices to help children communicate. Children can gesture, point, and model after teacher to communicate needs and wants.

Question #8

Subject: DEVELOPING RECEPTIVE LANGUAGE
Difficulty: *** (3 stars)
Question: What difficulties does a child have with receptive language?
Answer: understanding what gestures mean, following directions, answering questions, identifying objects and pictures, taking turns when talking with others

ASHA
http://www.asha.org/public/speech/disorders/Preschool-Language-Disorders/

Question #9

Subject: DEVELOPING RECEPTIVE LANGUAGE
Difficulty: **** (4 stars)
Question: At what age is it most beneficial to begin reading with children?
Answer: Studies have shown that reading to babies starting at 8 months old has a significant impact on early language development. Theses studies have shown that reading to 4 month old babies does not appear to have as much of an impact.

Question #10

Subject: LANGUAGE DELAYED PRECHOOL CHILDREN
Difficulty: ** (2 stars)
Question: What can you do as a preschool teacher if you suspect a language delay in one or more of your students?
Answer: Preschool teacher can make a referral to the Speech Language Pathologist or RtI team (depending on school procedure).

Question #11

Subject: LANGUAGE DELAYED PRECHOOL CHILDREN
Difficulty: *** (3 stars)
Question: What are causes of a language delay?
Answer: The cause of a language delay is poorly understood. It is usually not related to the child's level of intelligence. The condition may run in a family or be caused by a brain injury or malnutrition. Some language disorders are accompanied (and worsened) by other issues, such as autism and hearing impairment. If your child's central nervous system is damaged (a condition called aphasia), he or she may be more likely to develop a language disorder.

Question #12

Subject: LANGUAGE DELAYED PRECHOOL CHILDREN
Difficulty: *** (3 stars)
Question: Types of preschool language disorders may include problems with:
Answer: *Understanding basic concepts, questions, and directions
*Learning new words
*Saying words in the right order
*Having conversations and telling stories

Question #13

Subject: LANGUAGE DELAYED PRECHOOL CHILDREN

Difficulty: ***** (5 stars)
Question: Why is it so important to read books with children?
Answer: Reading often with your child will help to build his/her expressive and receptive vocabulary. Research has shown that children learn words when they are interested in and books spark the child's interest. This motivates children to communicate and, when parents /teachers respond to what the child is interested in, it helps the child learn new words. Reading promotes repetition of words in a variety of sentences throughout the book, which helps children understand unfamiliar words. The interactive communication between the child and the reader also assists in the desire to communicate.

Question #14

Subject: LANGUAGE DELAYED PRESCHOOL CHILDREN
Difficulty: ** (2 stars)
Question: What are language delays in preschoolers?
Answer: "Preschool children (3 to 5 years old) with language disorders may have trouble understanding and talking."

http://www.asha.org/public/speech/disorders/preschool-language-disorders/

Question #15

Subject: LANGUAGE DELAYED PRESCHOOL CHILDREN
Difficulty: *** (3 stars)
Question: Can a child with a language delay, have trouble with early literacy and writing skills?
Answer: Yes. The following are a list of skills a child with a language delay can have difficulty with: holding a book right side up, looking at pictures in a book and turning pages, telling a story with a beginning, a middle, and an end, naming letters and numbers, learning the alphabet.

http://www.asha.org/public/speech/disorders/preschool-language-disorders/

Question #16

Subject: LANGUAGE DELAYED PRESCHOOL CHILDREN
Difficulty: **** (4 stars)
Question: Will a language delayed preschool child "catch up" to the expected language development level?
Answer: Yes, a preschool child with a language delay do eventually 'catch up' to their expected language development level. Although, if a child continues to show the language delay, there could possibly be additional impairments that the child may have.

Question #17

Subject: LANGUAGE DELAYED PRESCHOOL CHILDREN
Difficulty: **** (4 stars)
Question: If a child is bilingual, will it cause the child to have a language delay?
Answer: "A child does not get a language disorder from learning a second language. It won't confuse your child to speak more than one language in the home. Speak to your child in the language that you know best. Children with language disorders will have problems with both languages."

http://www.asha.org/public/speech/disorders/preschool-language-disorders/

Question #18

Subject: PRACTICE SCENARIOS
Difficulty: * (1 star)
Question: Anna Stejuh makes her needs known by pointing and using simple utterances. She is in preschool and is starting to exhibit behavioral problems. Her mother is concerned and has asked for your help. What do you do?
Answer: Depending on school policy, you would either initially refer to the RtI team or make a referral to the Speech Language Pathologist. After providing interventions, the team will decide if formal testing should take place. If this happens, results will be shared with the IEP team and appropriate actions will take place (start on IEP, provide family support, etc.).

Question #19

Subject: PRACTICE SCENARIOS
Difficulty: *** (3 stars)
Question: Johnny is a preschool student with limited expressive language and has been displaying inappropriate behaviors during circle time and group table tasks. What are reasons for this behavior?
Answer: More than likely, Johnny is exhibiting these behaviors due to his poor language skills. Because it is difficult for him to engage in conversation and answer comprehension questions, he is likely trying to distract from the task in an attempt to leave the situation.

Question #20

Subject: PRACTICE SCENARIOS
Difficulty: *** (3 stars)
Question: A parent comes to you and is concerned about the language development of their child. They have heard of an outside private clinic and want to take their child there. Will the school district pay for these services?
Answer: No. A school district is only responsible for how speech and language development effects academics and qualifies students for school based services under

these conditions. Anything medical or private based is the responsibility of the child's family.

Question #21

Subject: PRACTICE SCENARIOS
Difficulty: ***** (5 stars)
Question: A parent approaches you about concerns related to their 4 year old child producing the /r/ sound. The child replaces the sound with /w/. What do you do? Do you refer to the RtI team?
Answer: Because /r/ is not yet developmentally appropriate, do not take the child to the RtI team or refer for a speech and language evaluation. Discuss developmental milestones with the parents and encourage them to model back the correct /r/ production so the child can hear error.

Question #22

Subject: STRATEGIES FOR PARENTS/GUARDIANS
Difficulty: * (1 star)
Question: Give 2 websites parents can use to find out more information on language delays.
Answer: http://www.hanen.org/Helpful-Info/Parent-Tips.aspx

http://www.playingwithwords365.com

http://www.speechdelay.com/language_development.aspx

(Answer can have various websites)

Question #23

Subject: STRATEGIES FOR PARENTS/GUARDIANS
Difficulty: ** (2 stars)
Question: What parents/guardians do to help assist in language development when reading to their child?
Answer: Parents/Guardians can read to their children and provide a language rich environment. They can model the use of language and have the child try to fill in open ended statements and questions. It is always beneficial when vocabulary and grammar usage is repeated back correctly to the child. For example, if a child says "Her sad" when looking at pictures in the book, parents can say, "You are right, she does look sad. She is crying."

Question #24

Subject: STRATEGIES FOR PARENTS/GUARDIANS
Difficulty: **** (4 stars)

Question: What are some specific strategies parents can use to facilitate language in a 2 to 4 year old?
Answer: Answers may vary, but should be along the following guidelines:
Use good speech that is clear and simple for your child to model.
*Repeat what your child says indicating that you understand. *Build and expand on what was said. "Want juice? I have juice. I have apple juice. Do you want apple juice?"
*Use baby talk only if needed to convey the message and when accompanied by the adult word. "It is time for din-din. We will have dinner now."
*Make a scrapbook of favorite or familiar things by cutting out pictures. Group them into categories, such as things to ride on, things to eat, things for dessert, fruits, things to play with. *Create silly pictures by mixing and matching pictures. Glue a picture of a dog behind the wheel of a car. Talk about what is wrong with the picture and ways to "fix" it. Count items pictured in the book.
*Help your child understand and ask questions. Play the yes-no game. Ask questions such as "Are you a boy?" "Are you Marty?" "Can a pig fly?" Encourage your child to make up questions and try to fool you.
*Ask questions that require a choice. "Do you want an apple or an orange?" "Do you want to wear your red or blue shirt?"
*Expand vocabulary. Name body parts, and identify what you do with them. "This is my nose. I can smell flowers, brownies, popcorn, and soap."
*Sing simple songs and recite nursery rhymes to show the rhythm and pattern of speech.
*Place familiar objects in a container. Have your child remove the object and tell you what it is called and how to use it. "This is my ball. I bounce it. I play with it."
*Use photographs of familiar people and places, and retell what happened or make up a new story.

Question #25

Subject: STRATEGIES FOR PARENTS/GUARDIANS
Difficulty: **** (4 stars)
Question: What can parents discuss with their medical doctor if they suspect a language concern?
Answer: First, parents want to make sure that their child has passed a vision and hearing screening. Many times, children are not screened and have fluid in their ears which distorts what they hear.
If they have, they want to discuss all concerns with the doctor who may refer for medical tests and screenings to see if the delay/impairment is caused by a specific disability.

Trivia Example #2

Instructions: This trivia game is designed to help the player get a better grasp of what a flipped classroom is, how it works and why it works. Players answer trivia questions with increasing difficulty levels. Whoever answers the most questions, wins!

Question #1

Subject: Background information
Difficulty:
Question: How long has this idea been around?
Answer: Since 2007

Question #2

Subject: Background information
Difficulty:
Question: What was it's original purpose?
Answer: The original purpose was for students who missed a class to be able to view the lecture to catch up.

Question #3

Subject: Background information
Difficulty:
Question: What technology was first used?
Answer: You Tube

Question #4

Subject: Background information
Difficulty: ***** (5 stars)
Question: Where did the idea of flipped classrooms start?
Answer: Woodland Park, Colorado by two high school teachers:
Jonathan Bergmann and Aaron Sams

Question #5

Subject: Definitions
Difficulty: ** (2 stars)
Question: What is a Flipped Classroom?
Answer: Students use online technologies to listen to a lecture before class at their own convenience. Homework and learning activities are done in class.

Question #6

Subject: Definitions
Difficulty: ** (2 stars)
Question: What is the teacher's role in a flipped classroom?
Answer: The instructor becomes a facilitator of learning instead of dictating knowledge and information . . . moving from a sage on the stage to a guide on the side.

Question #7

Subject: Definitions
Difficulty: ** (2 stars)
Question: True or False, in a Flipped Classroom the teacher prepares a video for his or her students to watch?
Answer: True

Question #8

Subject: Definitions
Difficulty: **** (4 stars)
Question: Name a second characteristic of a flipped classroom?
Answer: Students are transformed from passive listeners to active learners.

Question #9

Subject: Definitions
Difficulty: **** (4 stars)
Question: Name a characteristic of a flipped classroom?
Answer: Listening to lecture and doing the readings before class encourages discussion to reach higher orders of critical thinking.

Question #10

Subject: Definitions
Difficulty: **** (4 stars)
Question: What style of learning typically occurs in a flipped classroom?
Answer: Learning is collaborative

Question #11

Subject: Definitions / Difficulty: **** (4 stars)
Question: In order to demonstrate a students' mastery of a subject, a student may choose.. Testing, Speaking, Debating, Writing, or Gaming. What is this called?
Answer: Flipped Mastery

Role-Play Example #1

Narrative: The first forms of mathematics, as well as number systems were created to keep track of goods when civilizations first began to stockpile and trade. This game will model basic trade. The model that this game will simulate is supply and demand. The base of this game is that the higher the price is set for goods the less goods will be sold. The owner also has several other options that can change the model. However in this game there is also the aspect of chance. The goal of this game is to try and reach 3000 units of currency. The store initially has a max storage of 50 goods, which can be increased during game play. Also the store has funds of 100 units at the beginning of the game.

Players are encouraged to change goal currency, as well as other values such as D to change the game experience. The values here are merely a suggestion.

There are four roles in this game

Clerk: The clerk works to sell goods. It is the clerks job to role for goods sold and record the amount of goods sold as well as the income made.

Here the Clerk will role for sales each day based on the formula R=D-P.
R is number or roles
P is price per unit of goods.
C is the constant for the slope of this model and starts at 12.
The Clerk is paid 15 units of currency per day

Bookkeeper: The bookkeepers job is to take the information from the clerk and to track total funds as well as total stock.
the bookkeeper should try to summarize the data as much as possible for the success of the shop. The bookkeepers is in this model the business partner of the owner. He or She succeeds or fails with the owner. So it is in the best interest of the bookkeeper to record the data accurately. The clerk should also careful track high stock so that the store does not wast stock any stock over capacity of the store is lost at the time it is generated.

If one of the following conditions occurs then the store is fined 75 units of currency:
1. The store sells goods that it does not currently posses due to a mistake in the recorded quantity of goods.
2. Payment is made to either the Craftsmen or Clerk when such goods do not exist.

Craftsman: the craftsmen will role for goods generated. The craftsmen must also be paid per role.
The craftsman will role each day to create goods. The craftsman must role until the number of goods specified by the owner are made. the Craftsmen must be paid (1/2) P per each role.
P is still the price per unit of goods.

Owner: The owner will look over all the reports from each other player and make decisions based on what he or she finds.
At the end of each day the owner may make any of the following decisions.
1. Change the price of goods
2. Change the amount of goods to be produced by the craftsmen daily.
3. advertise this costs 30 units of currency and adds 2 roles per day to the clerk for 3 days
4. Improve shop. This allows the shop to have a higher maximum capacity for stock which stars at 50, and also permanently raises the value of C for the clerk. each upgrade costs 80 units of currency and increases D by one and Max stock by 5

Resource #1

Description: A six sided die will be used to represent probability. This will add an element of chance into the game

Resource #2

Description: Form or currency:

Again be creative you may choose to use a form of currency you know or create you own. You could use Pounds of silver or gold coins. You may choose to use buttons or other object to represent currency or simply write down the flow of currency.

Resource #3

Description: goods sold at store. These can be physical object or simply a recorded amount of object on paper. Players may decide what item thier store sells. Examples are pottery, shoes, bread, ect. Try to be imaginative and think along the lines of basic needs of a primitive civilization.

Resource #4

Description: Paper to Record sales, prices, goods, wages ect.

Part of this game is for players to try and design there own book keeping methods. There are no rules on how you must record the exchange of money and goods. The only rule is that you may not sell items if you do not have any to sell. Likewise you may not pay for services if you don't have any money.

Role-Play Example #2

Narrative: The video tutorials are produced by CNM's multi-media department. The individual departments collaborate and produce scripts that describe their departments' resources and answers to FAQ's related to the department.

Resource #1

Description: •Career exploration and help with choosing a major
•Creating a realistic educational plan
•Reviewing program and graduation requirements
•Transfer information
•Removal of advisement holds
•Course planning
•Degree evaluations or audits

Resource #2

Description: Do you want to be a successful student? We can help. Connect with achievement coaches who can work with you on academic success planning, financial goals, study skills, accessing community and college resources, and more.
•Community Connections: a strong connection to someone at the college who can help when difficulties arise
•Instruction: academic resources and modes of instruction that promote greater levels of student engagement
•Financial aid: financial support including advisement, resources and aid
•Awareness of and access to resources: promoting access to an awareness of resources so students can use them when needed

Resource #3

Description: Registration is the process of selecting and enrolling in classes. Registration is done online through myCNM, either in person at any CNM location or from any Internet connection.

•Registration Process, Step by Step
•Registration Calendars
•Registration Waitlists

Resource #4
Description: Tutors Will:

•Give you positive feedback.
•Listen closely as you describe the problem.
•Help you identify and correct recurring errors.
•Help you understand the ideas presented in your textbook.
•Demonstrate similar processes and refer you to other sources.
•Ask questions that will help you in the problem solving process.
•Guide you through all steps of a process for solving the problem.
•Provide you with guidance in understanding and solving the problem.

Tutors Will Not:

•Check all homework problems.
•Help with handwritten math problems.
•Help with take-home exams or quizzes.
•Help at a time when the student is scheduled to be in class.
•Teach an entire chapter or lesson that is covered by the instructor.
•Proofread or review papers or assignments the instructor has determined is the student's responsibility.

Scavenger Hunt Example #1

Purpose: The purpose of the scavenger hunt is to use "The Diary of Anne Frank" to create a Plot Diagram that explores important WWII events Anne writes about in her diary.

Start: "There are no walls, there are no bolts, no locks that anyone can put on your mind." You will find events in Anne Frank's life using either a book from the library or online resources.

End: Once the parts of the plot diagram are identified, it will be easier to analyze and understand the life Anne Frank lived being a Jew during World War II; you will also discover the tragic end for most of the people that lived in the secret flat in Mr. Frank's office building.

Step #1

Text: The Diary of Anne Frank
Throughout this book study, we have used various strategies aimed at reading comprehension. The culmination is a more in-depth analysis of the experiences Anne Frank wrote about in her diary. The scavenger hunt will begin with having students secure a hard copy text of her diary.

Directions: Southern Peaks Public Library
You will find a reserved copy at the front desk entitled, "The Diary of a Young Girl"
423 4th Street
Alamosa, CO 81101
719-589-6592
www.alamosalibrary.org

Reflection Prompt: Throughout this book study, you have read an abbreviated version, in the form of a play, highlighting the events in Anne Frank's experiences in the Secret Annex. With the full text, the opportunity to really get into the mind and understand the full scope of her experience is at your fingertips.

Next Step Clue: Using a plot diagram as learned in class, you will use events from the diary to set the stage for understanding. You will begin with Exposition. Read the introduction to describe the setting and characters. In addition, go online and search for a map that shows the Nazi Occupation or German conquests during WWII. Download and print your map to include with your plot diagram.

Step #2

Text: As we discussed in class, the next part of a Plot Diagram starts with Rising Action. Using The Diary of Anne Frank you will fill in the Plot Diagram.

Directions: Read Anne's diary entries from Saturday, 13 June 1942 to Friday, 9 October, 1942. Germans are taking away many of their Jewish friends to concentration camps. Using the internet find out why this is happening. Add this information on the Rising Action part of the Plot Diagram.

Reflection Prompt: Anne and her family are now going into hiding. As you know, they are Jewish and in grave danger.

Next Step Clue: The Franks find out there is some hope. After reading the next few entries you will find out what that hope is.

Step #3

Text: The Franks and van Daan's, are in hiding in the Secret Annexe. Through radio reports they find out about help coming.

Directions: Read Diary entries from Fri., 9 Oct. 1942 to Wed., 13 Jan. 1943. Air raids have begun. Using the internet, find out who the Allied nations are. Print a list of these nations. Add this event to the Rising Action.

Reflection Prompt: Why are the Franks and van Daan's feeling hopeful?

Next Step Clue: The Allied nations are lead by great leaders. How do these leaders help the Jewish people in Europe? The emotions experienced by Anne and the others in hiding, went from feeling hopeful to complete helplessness. In her last diary entry dated Tuesday, 1 August, 1944, there is a sense of foreshadowing about what the future holds. How does this become the beginning of the end for the eight people hiding in the Secret Annex?

Step #4

Text: "That's strange," I said to Margot. "I think we've got burglars."
I was right. They were breaking into the warehouse at that moment. Father, Mr van Daan and Peter went downstairs as quickly as possible. Margot, Mother, Mrs. van Daan and I waited. Four frightened women need to talk, so that's what we did. Then we heard a loud noise, but nobody cam back until ten o'clock.

Directions: Read the diary entry dated Tuesday, 11 April 1944. Find out if the Secret Annexe, the family's hiding place in Amsterdam, is discovered along with the people hiding in it

Reflection Prompt: The families living in the Secret Annexe were living like prisoners because of their religious affiliation. Anne Frank thought she was going to die that night. She said she waited for death like a soldier. Do you believe suffering teaches people something about goodness?

Next Step Clue: From the climax, you will step into the falling action to find out if the occupants were arrested.

Step #5

Text: Concentration Camps

The term concentration camp refers to a camp in which people are detained or confined, usually under very harsh conditions and without regard to human suffering. In Nazi Germany between 1933 and 1945, concentration camps were where Jews were imprisoned after being arrested.

Directions: Auschwitz

The eight people from the Secret Annex were first taken to a prison in Amsterdam. Read the Afterword in your text. Then they were sent to Auschwitz, the concentration camp in Poland. Go online and find an article that describes the conditions in Auschwitz. Among other information, include the Nazi Camp System of forced labor and death marches. This is part of the Falling Action in your Plot Diagram.

Reflection Prompt: The Nazi camp system targeted Jewish people. However, other individuals from a broad range of backgrounds could also be found. Prisoners were required to wear color-coded triangles on their jackets so that the guards and officers of the camps could easily identify each person's background and pit the different groups against each other. Go online and find the color-coded system used by the guards and officers to identify each prisoner. Make a chart of the color-coded system used. Included the colored triangle and the group it depicted.

Next Step Clue: In the Resolution, everything ends. By now you may have some sense of "closure" as to the events that lead to the final entry in Anne's diary datedTuesday, 1 August 1944. Hitler surrendered on May 8, 1945. Compare and contrast his surrender to the surrender and/or bravery of the Jewish people. Use a Venn Diagram.

Step #6

Text: The Diary of Anne Frank - Performance

Using the play script provided, in groups of 11 (as assigned by the teacher) students will act out the play for various audiences in the school.

Directions: In your assigned groups, students will choose roles, including a narrator. Memorize your parts and wait for the live performance for your intended audience.

Reflection Prompt: Knowing the events that occurred in WWII, and Anne Frank's journey, imagine re-living some of those experiences live, before a live audience.

Next Step Clue: What would you say to Anne Frank if you had the opportunity to speak to her? How brave would you be if faced with the same challenges? What did you learn from reading "The Diary of Anne Frank”?

Scavenger Hunt Example #2

Purpose: This scavenger hunt is a skeptic's guide to essential oils: choosing a company - the purity issue.

Start: You are interested in essential oils but confused as to which company from which to buy.

End: After determining from seed to seal or start to finish, how essential oils are distilled, retaining the most therapeutic value, and determining the best buy for your dollar.

Step #1

Text: Research:

Purity
Price
Quality
Reputation and Ethics
Service

Researching your essential oils is crucial to finding the best company. What makes choosing a company difficult is that they sell their products at such widely varying prices, and yet all claim to have superior quality.

Directions: www.younglivingoils.com
www.doTERRA.com
www.rockymountainoils.com.

Reflection Prompt: After researching these companies, how do you feel about the integrity of each company?

Next Step Clue: Research the "play" on names of the three companies and their products. - compare and contrast the essential oils and what they claim to do. What came first, the chicken or the egg? Which company named their essential oil first? Does each company have the same essential oil under a different name?

Step #2

Text: Many people suffer from migraine headaches and are treated with various medications provided by their doctor. However, these medications are pushed through pharmaceutical companies and may have side affects, which can create a new ailment. Essential oils can be overlooked in our society's mentality of treatment options, but

really, should be at the front line. Essential oils help the body as medicinal value without creating side affects, addiction, or further ailments.

Directions: Go to the following websites and explore oils which can be used for migraine headaches. Are there common oils which are used by each manufacturer? What oils do you find?
www.younglivingoils.com
www.doTERRA.com
www.rockymountainoils.com.

Reflection Prompt: Essential oils can help heal ailments. From migraines to fewer side affects of cancer treatments, reflect upon other health conditions which may benefit from the use of essential oils.

Next Step Clue: How can pricing and quality be determined?

Step #3

Text: You want to get a list of essential oils that is to be used like peppermint and lavender. Then go to each website and compare price, purity, and check out any comments about their customer service.

Directions: Make out a list of oils that you would like to buy and price out each essential oil at each of the websites. Check into the purity of the product you plan to purchase. Many companies will say they are pure but are they therapeutic grade? Check out any blogs or comments from people that have purchased from DoTerra, YoungLiving, Rocky Mountain Oils. Get a feel from this how well the product may be.

Reflection Prompt: Check each price point you have and look at the quality of the essential oils that you have found. Decide which essential oil company you would like to go with.

Next Step Clue: Once you have looked into the essential oils companies and have decided on one, check into local distributors from that company and attend an essential oils class. Let your experience begin.

Step #5

Text: After making a decision on which essential oils company you plan to go with, you look for a distributor for that company and sign up to take a free essential oils class to "experiment" with the oils.

Directions: Go out to the distributor to experience each of the essential oils. Learn more about the oils. Smell them, apply them to the skin, blend them together on your skin. Learn about applications and what each can be used for.

Once you've learned about some of the essential oils and have had a chance to experience them, and with all the research into purity and the ethics of the company, make a decision to buy from that company.

Reflection Prompt: Reviewing everything you've gathered about the oils and going to a local distributor, you've made the choice to buy from that company. You like the quality of the oils, the ethics behind the oils, the customer service, and the passion put into the oils.

Next Step Clue: Congratulations! You are finished with the scavenger hunt!

Step #6

Text: You have made your decision about which essential oils company from which you will purchase.

Directions: Plan wisely. Which oils will you purchase monthly, quarterly, bi-annually? Will this be for personal use or for your business? Which oils work for which ailments? Spend your dollar wisely. There are expensive oils that can be used, or one or two others that can be used instead, but their intentions will be the same.

Reflection Prompt: Your essential oils are now in use, and over time, you are seeing and enjoying their benefits. You now begin to share your knowledge with those around you. Those you love, and those with whom they will make a difference.

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