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Designing games for learning: An investigation of instructional designers, game designers, and teachers design decisions and epistemological beliefs

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DESIGNING GAMES FOR LEARNING:
AN INVESTIGATION OF INSTRUCTIONAL DESIGNERS, GAME DESIGNERS,
AND TEACHERS' DESIGN DECISIONS AND EPISTEMOLOGICAL BELIEFS

by

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ABSTRACT

Fields within education and training have been exploring the use of educational computer-based games, often referred to as serious games (SG), in multiple disciplines of academic research including the affective, cognitive, and psychomotor domains. Traditionally, game designers tend to represent a different viewpoint about learning than instructional designers, or even teachers. More so, one of the fundamental roles designers play in making decisions is based on multiple factors, which include personal assumptions about constraints and perceived constraints in instructional practice. In order for games to be successful in classroom environments, classroom teachers need to be involved in the design process to help identify and assist in mitigating the classroom-based challenges that will be faced during implementation. The study sought to extend research on serious game attributes by examining the instructional design decisions and beliefs of individuals involved in the design, development, or implementation of serious games in education or training environments, through a web-based survey. Within the serious game community there are multiple approaches to designing learning environments; some view serious games as virtual environments explicitly for education or training, while others include digital games, simulations, and virtual worlds. While there is debate over the type of games that are most effective for learning, researchers have provided guiding qualifications and lists of characteristics that effective games should possess to improve current practice and implementation. Two central aims guided the study: (a) to identify relationships between the mental models put forth by each discipline when selecting serious game attributes, and (b) to provide insight into each subpopulation's beliefs about learning. Suggested implications for the study extend to educational practice, policy, and future research on designing, developing, and implementing serious games in learning environments. Findings suggest that the sample portrayed similar epistemological beliefs between all subgroups. Participants had the most sophisticated beliefs toward quick learning. Limited relationships were evident between participant's epistemological beliefs and selection of serious game attributes (SGA). However, findings indicated that each discipline has unique models and frameworks for designing serious games and perspectives on serious game implementation.

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LIST OF ABBREVIATIONS/ACRONYMS

AECT	Association for Educational Communications and Technology
EBI	Epistemological Belief Inventory
GBL	Game-Based Learning
SG	Serious Games
SGA	Serious Game Attributes
SME	Subject Matter Expert
UCF	University of Central Florida

CHAPTER 1
INTRODUCTION

Introduction

Today's learners are accustomed to one-to-one access to computer-based devices for information seeking purposes, including learning environments like K-12 schools and institutions of higher education (Pew Research, 2014). Computers and mobile devices have afforded opportunities for unique learning environments that can be designed to be motivating, personalized, and adaptive (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Cook et al., 2013; Gee, 2007; Procci & Bowers, 2014; Squire, 2008). Fields within education and training have been exploring the use of educational computer-based games, often referred to as serious games (SG) in several disciplines of academic research including the affective, cognitive, and psychomotor domains (Connolly et al., 2012; Marsh, 2011; Mayer et al., 2014). While there is debate over what type of games are the most effective for learning (e.g., complex game, serious game, simulation, etc.), researchers have provided guiding qualifications and lists of properties that effective games will contain to help current practice and implementation (Arnab et al., 2015; Gunter, Kenny, & Vick, 2008).

Tim Marsh (2011) provided a description of a serious game that aligns with the researcher's perspective, which was used to inform the current study.

> Serious games are digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being,

> and/or experience to convey meaning. The quality or success of serious games is characterized by the degree to which purpose has been fulfilled. Serious games are identified along a continuum from games for purpose at one end, through to experiential environments with minimal or no gaming characteristics for experience at the other end. (p. 63)

Within the serious game community there are multiple approaches to designing learning environments; some view serious games as virtual environments "explicitly" for education or training (Shute, Ventura, Bauer, & Zapata-Rivera, 2009), while others include digital games, simulations, and virtual worlds (Merchant, Goetz, Cifuentes, Keeney-Kinnicutt, & Davis, 2014). No matter what type, a commonality between all games is the high amount of factors that attribute to game features; of those, factors that were supportive of learning outcomes are serious game attributes (e.g., communication), which are in-turn designed to interact with each other to create the features of the game, such as types and levels of social interaction required. If patterns of serious game attributes can be identified and linked to learning outcomes through serious game play, games can be better designed and implemented in K-12 classrooms. The current study seeks to extend current research on serious game attributes by examining the instructional design decisions and beliefs of the individuals involved in the design, development, or implementation of serious games in educational or training environments.

Background

Since gaming technology emerged in the market, corporations and entities have worked toward utilizing the technology as a resource for training, teaching, and practice for complex and high stakes learning (Djaouti, Alvarez, Jessel, & Rampnoux, 2011). Behind the scenes, researchers have been working toward identifying and designing recommendations of best practice to provide empirical evidence to support SG as an instructional tool that could be accessible to learners in K-12 schools (Barzilai & Blau, 2014; Cook et al., 2013; Gee, 2007; Kenny & Gunter, 2011). Design recommendations have also been put forth providing recommendations toward design features that constitute components of the game, targeting learning outcomes (Gunter, Kenny, & Vick, 2008; Hirumi, Appelman, Rieber, & Van Eck, 2010a, 2010b, 2010c).

Initially, research on SG was focused on *what* the tool could do to support learning, but since has shifted from *what*, to *how* and *when* the tool is the most appropriate for improving learning outcomes (Squire, 2008). Building on what features have been found to be effective for promoting positive learning outcomes, is research in simulation and gaming, specifically the examination of serious game mechanics and attributes (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012; Wilson et al., 2009). Within SG, game attributes are characterized as the individual components of the game (Marsh, 2011). Game mechanics and attributes have previously been identified as key features within games for learning (Garris, Ahlers, & Driskell, 2002) and were later narrowed to the term serious game attributes (SGA), with each being linked to empirical evidence of positive learning outcomes (Wilson et al., 2009).

It as been posited that further research is needed connecting serious game attributes with instructional objectives, and the process must integrate knowledge from training, education, and high-quality game design (Hays, 2005; Procci & Bowers, 2014). A central issue in developing high quality SG is establishing a balance between instructional content and quality of game play to support the most effective experience (Procci & Bowers, 2014). Researchers Tang and Hanneghan (2014) captured the essence of the central issue, stating

> Designing games with good game-play is not a science or an art, but often quoted as a 'craft' requiring skills to engage and immerse game players in a realistic setting while also encouraging replayability. Game designers are brilliant at creating 'hooks' to engage gamers, but in the context of game-based learning it is important to emphasize the aspects of academic value that can develop skills that are useful to the learner. (p.109)

Each profession (game designers, instructional designers, and teachers) holds valuable perspectives and insights in exploring SG as a learning environment. Game designers are trained to create high quality interactive engaging games, while teachers are trained to create learning environments focused around structured curriculum and students individual leaning needs (Gee, 2007). Similarly, instructional designers are typically tasked with designing and developing instructional activities that balance the instructional content and interaction to keep learners on task and are targeted to specific learning outcomes. In order to have engaging, meaningful learning through game-play, a combination of each disciplines' skill sets are needed to create an effective learning environment within the game (Procci & Bowers, 2014).

Statement of the Problem

In order for games to be successful in classroom environments, classroom teachers' perspectives need to be considered in the design process to help identify and assist in mitigating the classroom-based challenges that were faced (Kenny & Gunter, 2011). Within K-12 classrooms, there are a high number of instructional constraints that may be imposed on teachers, requiring them to plan accommodations at the individual level, including differentiation for multicultural instruction, English as a second language (ESL) learners, and varied levels of cognitive capabilities in core content area (Honebein & Honebein, 2014; Parrish & Linder-VanBerschot, 2010).

While teachers have a sound understanding of the classroom environment, little is known about their ability to design instruction that is inclusive of game-based learning environments. Conversely, little is also known about game designer's ability to design games that are conducive to classroom-based instruction. However, it has been posited that game designers tend to represent a different viewpoint about learning than instructional designers, or even teachers (Siemens, 2008). This could be attributed to the notion that one of the essential roles instructional designers play is making decisions based on multiple factors, including personal assumptions, and perceived constraints in instructional practice (Jonassen, 2008; Siemens, 2008).

In consideration of the information that is needed to inform practice, the researcher recognized that examining existing games and practice of either population would indicate if they are proficient that their roles in each discipline, when the issue that needs to be examined is more hypothetical in in the role they could play in serious game design. For example, examination of models or designs that were practically implemented by any population may be influenced by the needs of the client (student or recreational player), or limitations within the medium (e.g., capabilities of the gaming engine); whereas an open organizational exercise may shed light on design decisions that are viable but not traditionally available based on unique constraints.

In addition to differences in design decisions between populations, it can be argued that the beliefs of an individual are influenced by their personal epistemology, or belief about knowledge and knowledge acquisition (Hofer & Pintrich, 2002; Hofer & Sinatra, 2010). Each subpopulation may have different perspectives of beliefs on how learning occurs, so measurement of the contributing factors would help support and add credibility to the study.

The study argues that by capturing and analyzing the mental models surrounding beliefs about knowledge acquisition (Schraw, Bendixen, & Dunkle, 2002) and association between game attributes (Bedwell et al., 2012) along a scale of levels of teaching (Hokanson & Hooper, 2004), for individuals that design, develop, and implement SG, differences between design decisions of subpopulations were identified, clarifying and informing key roles for future serious game design and research. The resulting data will aid in providing a clearer understanding of the foundational factors that contribute to people's beliefs about how we learn with SG and how those factors are correlated with each discipline and the mental models of SG attributes. The potential findings can be used to help guide the development of serious game design teams, implementation strategies, and future research and practice.

Purpose of the Study

While research continues to develop on relationships between learning outcomes and SG, there are no current models or frameworks for classroom implementation in regard to instructional levels of game attributes; resulting in a potential barrier for curriculum alignment. In order for serious games to be adopted by K-12 teachers and be effective in classroom environments, barriers (such as models of gaming implementation) need to be addressed (Hew & Brush, 2007). Also, as Jonassen (2008) indicated instructional designers often base their design decisions off their beliefs rather than instructional theory and it has also been noted in cognitive psychology and teacher education research, that beliefs are an important factor in the instructional decisions teachers make (Gill & Hoffman, 2009). To this end, I posit that teachers, instructional designers, and game designers all need to be included in the process of implementation, evaluation and designing models for SG if the ultimate goal is classroom integration.

The current study has two aims: (a) to identify relationships between the mental models put forth by each discipline when selecting serious game attributes, and (b) to provide insight into each subpopulation's beliefs about learning (i.e., epistemology). Building on prior work of SG attributes (Bedwell et al., 2012; Procci & Bowers, 2014; Wilson et al., 2009), the study seeks to align serious game attributes to levels of instructional outcomes in a meaningful way that could be used by teachers in traditional and dynamic classroom settings. To capture the mental models of the design decisions, recommendations from Honebein and Honebein (2014) were adopted, which suggest "content level has a statistically- significant influence on a designer's judgments regarding the usefulness of an instructional method" (p. 53). To this end, the organizational activity in this study will seek to capture each subpopulation's perception of each SGA in relation to instructional levels. The central aim of the study, though, is to explore and quantify the selection of SG attributes by instructional level (Hokanson & Hooper, 2004) and discipline (game designers, instructional designers, and teachers). In additional to instructional levels, the study seeks to identify any existing relationships between epistemic beliefs, subpopulation, and moderating variables (i.e., serious game attributes) in an effort to further align research on SG attributes between the disciplines of simulation, education, training and development, and game production. Capturing participants' perceptions of their own epistemology we better inform the field on the potential differences between subpopulations.

Research Questions

To capture the design decisions, models, and beliefs of the subpopulations, three research questions were crafted to target each variable of interest. The following research questions were used to guide this study:

1. What serious game attributes are most frequently selected for the sample and each subgroup (game designers, instructional designer, higher

education instructors, and K-12 teachers) for each level of teaching?

2. How do the epistemological beliefs of instructional designers compare to those of game designers and teachers (higher education and K-12)?
3. What differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?

Significance of the Study

The integration of dynamic, interactive multimedia into mainstream culture has become the norm during the 21st century for many regions of the globe, especially in the United States (Pew Research. 2014). Educational researchers have since been examining the use and effects of the integration of serious games within instructional settings (Goldman et al., 2012; Hess & Gunter, 2013; Jenson & de Castell, 2010; Kebritchi, Hirumi, & Bai, 2010). As more options become available for individualized learning environments, many classrooms are shifting from traditional to online or hybrid formats, and from structured whole class-based to flexible personalized environments in K-12 and higher education institutions (Annetta, Minogue, Holmes, & Cheng, 2009; Barzilai & Blau, 2014; Shaffer & Gee, 2012; Squire, 2008). As noted in cognitive psychology and teacher education research, beliefs are an important factor in the decisions individuals make. As relayed in teacher education research, “beliefs shape teacher’s epistemological perspectives and strongly influence learning, teaching practice and classroom management" (Gill & Hoffman, 2009, p. 1243), and therefore should be examined in relation to educational design decisions.

Research has indicated that games can support learning outcomes in multiple contexts (Ke, 2009), as well as specific disciplines (Merchant et al., 2014). Reviews of serious games also report inconsistent results on the effectiveness of serious games as an instructional tool based on population, environment, and design, leaving unclear indicators on how educators should select and align learning outcomes in classroom environments (McClarty et al., 2012). With national technological goals of creating authentic personalized learning (Johnson, Adams Becker, Estrada, & Freeman, 2015), serious games provide open opportunities for multiple types of curriculum and outcomes (Cook et al., 2013; Merchant et al., 2014), while having collaborative capabilities that can be adjusted for individual needs. Early examinations of SG (Vogel et al., 2006) also indicate that games are more effective than traditional instruction, when measuring cognitive gain outcomes. Further reviews of serious games have also identified opportunities for utilizing the tool (serious game) as a means for alternative assessment reporting for learners with disabilities. However, as the technology and game attributes continue to advance, research needs to be attributed to aligning instructional outcomes with game attributes to create pathways to effective classroom implementation.

Limitations

Survey research presents inherent threats to internal and external validity, so limitations need to be identified and addressed to mitigate as many issues as possible

(Shadish, Cook, & Campbell, 2002). Sampling limitations were also considered when designing the study and steps were taken to address potential bias, however some issues could not be overcome. The study was subject to nonresponse bias, potential lowered completion rate due to access and sampling bias due to accessibility of subpopulations. In an effort to limit sampling bias, the desired population was targeting through means of identifying a range of job functions through prior research (Procci & Bowers, 2014) as potential individuals that could work with serious game design or implementation.

The following limitations are recognized and apply to this research study:

1. Survey research has limited generalizability and correlational research is further limited in that finding cannot be asserted toward the whole population.

2. Validity is limited to the voluntary participants in the study and their honesty when responding to the survey items.

3. Internal and external validity are limited to the reliability of the Epistemic Belief Inventory (Schraw et al., 2002) and the researcher created organizational activity used in the study.

Assumptions

The following assumptions were made while investigating the research questions:

1. The participants' were able to access the Web-based online survey.

2. The participants' in the study responded honestly to the survey items.

3. The participants' answers were based on their own perceptions and beliefs.

4. The participants' answered the survey without the help of other individuals.

Operational Definitions

For this dissertation, a brief list of definitions is provided.

Epistemological beliefs: the study of knowledge and beliefs about knowledge (Schraw, 2013, p. 3).

Tacit Knowledge: Knowledge individuals' possess that is characterized as difficult to describe, examine, and use (Ford & Sterman, 1998).

Taxonomy: the organization of information by systematic classification or schemata.

Serious Games: digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning (Marsh, 2011, p. 63).

Serious Game Attributes: The mechanisms or characteristics that are used to describe components of serious games (Bedwell et al., 2012).

Summary

Chapter one sought to provide an overview of the study and insight to the philosophical underpinnings of serious game research, highlighting the significance and rationale for serious games in K-12 educational environments. In today's open access learning environments, digital systems that support learning and education have been posited to be key drivers in how individuals learn and how they are assessed (Sampson, Ifenthaler, & Spector, 2014). Provided serious games are being used for learning in educational environments, more research needs to be conducted on the connections between the game features (attributes) and learning outcomes with respect to how they are designed, developed, and implemented. Furthermore, capturing the epistemological beliefs of each subpopulation being investigated, can aid in providing rationale to the instructional design decisions made and allow opportunities for examination of the beliefs of each subpopulation involved in the serious game design, development, and implementation process.

To work toward designing games that maximize learning potential, games should be designed to optimize levels of cognitive load during instructional practice. In an effort toward improving serious game learning outcomes through serious game attribute optimization, the study seeks to identify the levels of instructional outcomes game designers, instructional designers, and tech savvy teachers identify for each serious game attribute. To this end, the researcher proposes investigating the alignment between selection of game attributes and levels of instruction using Hokanson and Hooper's (2004) *Levels of Teaching: A Taxonomy for Instructional Design.* The taxonomy put forth by Hokanson and Hooper (2004) utilizes the cognitive levels of Bloom's revised taxonomy (Krathwohl, 2002) in terms of instructional levels. The five levels of instruction in the *Levels of Teaching: A Taxonomy for Instructional Design*: include increasing levels in instructional complexity as you move from left to right in the taxonomy, from the lowest level (1) to the highest level (5). The specific categories include: Level 1, reception; Level 2, application; Level 3, extension; Level 4, generation; Level 5, challenge. Just as Krathwohl (2002) made revisions to a pre-existing taxonomy, this study seeks to add five instructional levels to the pre-existing list of serious game attributes, in an effort to add instructional guides and supports for teaching how to integrate serious games in classrooms.

CHAPTER 2
LITERATURE REVIEW

Introduction

Chapter two aims to provide a detailed overview of the main constructs of the study, the individuals involved in designing serious games (SG), and a theoretical alignment for the study. The chapter begins with an overview to the science of learning, orienting the reader to major theories of thought about learning, grounding game-based learning research in domains of learning theory. Prior research on serious games within the last five years (2010 – 2015) will also be discussed in an effort to identify the gap within the literature on serious game attributes, epistemological beliefs, and any relationships between design decisions and beliefs. In an effort to conduct a rigorous review of the current literature, a best-evidence synthesis methodology (Cooper, 2003) was employed from relevant meta-analysis, systematic reviews, and primary research, to identify the current state of the literature in regard to serious game design and implementation in education and training environments. Key constructs investigated include serious games, serious game attributes, and beliefs about knowledge acquisition.

Science of Learning

Within the field of instructional design and cognitive psychology, there is a shared knowledge domain often referred to as the science of learning. Simply stated, the science of learning is the ecosystem in which learning theories, instructional theories, instructional strategies, and design models co-exist. Within the major views of learning theory, there are four perspectives that have influenced serious game research, including behaviorism, constructivism, cognitivist, and neurobiological.

Historically, the field of instructional design has emerged from objectivist traditions that support the idea that reality is external to the learner (Cooper, 1993), aligning with both behaviorist and cognitive perspectives (Duffy & Jonassen, 1991). Behaviorists view learning as a change in observable behavior through stimuli and response systems (Driscoll, 1994) and is situated in a school of psychology that focuses on the role of experience in behavior, specifically the consequences of the behavior. Learning is said to take place when there are changes in either the form or frequency of the observable behavior (Ertmer & Newby, 2013). Thorndike's *Connectionism* (1913a, 1913b, 1914) emphasis on stimulus-response bonds is an example of an observable behavior changing over time and has been accounted as the original stimulus response psychology of learning (Mowrer & Klein, 2001). Guthrie's research on *Contiguity* (1942, 1952, 1959) built on Thorndike's stimulus-response work and posited that rewards are not necessary to create an association. Additionally, the reward could prevent further associations to the stimulus. Whereas, Skinner's Behaviorism (1957) argues that individuals do not have a natural capacity for expressing ideas but that verbal behavior is "similar to any other operant response" in that it is "controlled by reinforcement and punishment" (Mowrer & Klein, p. 13). Overall, the linking attribute to behaviorism is that transfer of knowledge is recognized when the learner is able to demonstrate or apply information acquired in new ways or situations (Ertmer & Newby, 2013).

Mid-nineteenth century learning theories began to shift from behaviorist-centered models to cognitive models focusing on the complex cognitive processes of the learner. Cognitivism generally views learning as a change in knowledge states rather than a change in behavior (Ertmer & Newby, 2013). Beliefs align with Jonassen's (1991) notion that learning is not as concerned with what learners *do* but with *what* they know and *how* they acquire it. Additionally, learner's thoughts, beliefs, attitudes and values are considered influential in the learning process (Winne, 1985). Two prominent branches of theories exist within the cognitive literature: cognitive information-processing and cognitive-constructivist, the latter of which were discussed under constructivism. Cognitive information-processing (CIP) theories include Atkinson and Shiffrin's (1968) multistage theory of memory, which is said to receive information through a processing system to undergo transformation before being stored in memory. Major components of the CIP model (Atkinson & Shiffrin, 1968) include sensory memory, selection attention, pattern recognition, short-term memory, rehearsal and retrieval, encoding, long-term memory, and retrieval; showing the emphasis on the processes. Additional cognitive theories include Schema Theory (Anderson, Spiro, & Anderson, 1978) and Attribution Theory (Weiner, 1985, 1986), which indicate transfer of learning by how information is stored in memory (Schunk, 2004).

While constructivism is considered a branch of cognitivism, constructivist theories focus on the meaning learners create from an experience and the influence on the individual's understanding and perception of the material or event. Behaviorism and cognitivism rely on objectivist assumptions, which view reality as external to the learner, whereas constructivists view reality as determined by the experiences of the learner (Jonassen, 1991). Simply stated, constructivists believe that humans create meaning as opposed to acquiring it (Ertmer & Newby, 2013). Constructivist views are considered the predominant learning theory in educational environments today. Learning theories that adhere to this school of thought include *Social Development Theory* (Vygotsky, 1980), *Situated Learning Theory* (Lave & Wenger, 1990), and *Gestalt theories of perception* (Bower & Hilgard, 1981), which are tied to instructional methods such as problem-based learning, authentic instruction and computer-supported collaborative learning (Ertmer & Newby, 2013).

In addition to the three major views of learning previously presented, a final classification, neuro-biological, has emerged from the hard sciences. Within the instructional design community, frameworks have recently emerged that consider neuro-biological research in learning theory, such as the taxonomy Hirumi (2013) presented for *e*learning interactions which bridged educational research with neurobiological research on learning. The research is still in its early stages but has recently contributed significant research findings to the learning sciences (Kelly, 2011).

Within each field of thought, there are associated models and procedures testing the theory through the design and implementation. For instance, an instructional design model, often referred to as a plan, applies instructional theory to create an effective lesson or unit (Morrison, Ross & Kemp, 2004). The instructional design process is a composition of instructional strategies and events that are linked to learning theory through instructional theory. Instructional events are sometimes referred to as elements

(Morrison et al., 2004) and are labeled to represent each part of the instructional strategy (Dick, Carey, & Carey, 2009). Gagne referred to instructional events as being "designed to make it possible for learners to proceed from where they are to the achievement of the capability identified as the target objective" (p. 189). Each instructional strategy can be comprised of one or more instructional events to assist the learner with integrating new information to what they already know. Instructional strategies are often considered the creative step in designing instruction (Morrison, Ross & Kemp, 2007). The current study seeks to examine the feasibility of SG as an instructional strategy.

Serious Games (SG)

Within education, a game specifically designed for education or training is referred to as a *serious game* (Shute, Ventura, Bauer, & Zapata-Rivera, 2009). The mechanisms or characteristics that are used to describe components of video games are referred to as game attributes, and attributes identified as being linked to empirically derived learning outcomes were defined as *serious game attributes* (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012; Wilson et al., 2009) within the current study. Reviewing findings pertinent to effective game design helped inform the researcher of known connections between serious games, learning outcomes, and design characteristics. Serious games are an example of an instructional tool that can be used as a strategy for targeting learning outcomes.

Educational games have faced numerous challenges in the design in development processes, some of which are attributed to overlap of research constructs on serious games and gamification (Landers, 2015). Gamification, defined as "the use of video game elements in non-gaming systems to improve user experience and user engagement" (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011, p. 1) differs some serious games from an instructional standpoint, but with the advancement of graphics and other computer-based instruction, the two tools many not be distinguishable to learners or the teachers that implement them. There are indications that the field has a gross amount of overlap within the research, which may be, in part, based on the fact that multiple disciplines (with corresponding design methodologies) are utilizing the tool under discipline specific frameworks, or fields of thought (e.g., cognitivist versus behaviorist principles). The law of parsimony indicates that multiple theoretical constructs should not be used when a single construct would suffice, so more research needs to be conducted on teacher's perceptions of implementation of each tool, gamification and serious games.

Ke's (2009) meta-analysis (n=89) on computer games as learning tools suggest learning outcomes achieved through educational game play largely depend on the alignment of learner and game characteristics. Related research supports the notion that digital games, simulations, and virtual worlds are effective in improving learning outcomes in educational environments (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), but information presented is not specific enough to indicate what traits or attributes are leading to specific learning outcomes.

A meta-analysis focused on examining the overall effect of learning, as well as the impact of selected instructional design principles, serves as a recent overview of the processes and techniques used in designing serious games (Merchant et al., 2014).

Merchant and colleagues' (2014) analysis included studies (*n*=69) conducted in K-12 and higher education settings. Several key findings from the empirical evidence suggest games, simulations, and virtual worlds were effective in improving learning outcome gains. Digital education games were found to show higher learning gains than simulations and virtual worlds, and a distinction in simulation studies emerged, indicating elaborate "explanation feedback was found to be more suitable for declarative tasks whereas knowledge of correct response is more appropriate for procedural tasks" (p. 29). Findings also indicated that performance in virtual worlds improved when students worked individually, and performance decreased when participants were repeatedly assessed (Merchant et al., 2014). While the findings are of use to the field, there is room for more detailed alignment of the learning outcomes with instructional levels (Procci & Bowers, 2014). For instance, data supports that learner performance goes down when learners are repeatedly assessed, however data collected is currently not detailed enough to make guidelines for each type (e.g., cognitive, psychomotor) of content and targeted instructional levels (Krathwohl, 2002; Hokanson & Hooper, 2004) to reach each desired learning outcome.

Research specific to educational assessments has also blossomed through the use of digital games (Shute, Ventura, Bauer, & Zapata-Rivera, 2009). It has been argued that digital games are good for learning because they are good at assessing knowledge and skills through practical play (Shaffer & Gee, 2012). In one study, digital assessment researchers (Shute, Ventura, & Kim, 2013) posited that students who played the game improved in their "qualitative, conceptual physics understanding" (p. 428). The conceptual physics game, *Newton's Playground,* was implemented with middle school science students in a single session (less than two hours). However the limited exposure to the instructional tool help portray it's potential power, in that findings indicate transferability of knowledge from the game to a traditional assessment through pre-test and post-test scores and have supporting evidence linking students with high engagement to significant instructional gains, indicating the importance of engagement in game-based learning within an educational context (Shute, Ventura, & Kim, 2013).

A key finding among the data indicated that instructional gaming may be better suited to certain levels of cognitive skills (higher order and affective outcomes) or certain leaners (e.g., exceptional education students) than others (Ke, 2009). Researchers are now beginning to be able to identify interactions in SG that are more effective than others, such as aligning the type of feedback (e.g., elaborate explanation) to specific tasks that were found to be effective (Merchant et al., 2014).

Issues in Serious Games

While there are many positive findings tied to serious game research, some view one of the fallacies as a decrease in the user experience or enjoyment when educational interventions are included in the game (Gobel, Wendel, Ritter, & Steinmetz, 2010). James Paul Gee (2007), a prominent research in utilizing games for learning, indicated that games need to be interesting, suspenseful, contain an entertaining story, while being challenging, but not too stressful to keep the players motivated to continue to play. To continue the advancement of Gee's vision and education and training outcomes from serious games, efforts should be focused on identifying effective guidance and support strategies that can be embedded into the game itself (Fiorella, Vogel-Walcutt, & Fiore, 2012). In military simulation-based studies, metacognitive prompting techniques are being explored and findings have indicated overall positive results in decision making when metacognitive prompting is integrated into the training (Fiorella et al., 2012).

Additional recommendations have also been published to orient instructional designers in game-based learning, gamification and components thereof (Hirumi, Appelman, Rieber, & Van Eck, 2010a, 2010b, 2010c). Additional research and publications on serious game design, including attributes, and recommendations for implication should be available for individuals that design serious games.

For individuals that focus on the integration of SG in the classroom, frameworks have emerged within the last 5-10 years, such as Gunter, Kenny, and Vick's (2008) RETAIN model for design and evaluation; Yusoff, Crowder, Gilbert, and Wills's (2009) conceptual framework for SG; and Obikwelu and Read's (2012) constructivist framework for children's learning. However, recommendations for implementation of SG are less prevalent in the literature (Procci & Bowers, 2014). Cannon-Bowers and Bowers (2009) noted that inconsistent outcomes can be attributed to too much focus on the effectiveness of the training system rather than the examining the individual features in the systems (i.e., game attributes).

A more subtle Another issue that has emerged in the last 5 years is the lack of interdisciplinary collaboration on serious game research (Procci & Bowers, 2014). Recommendations for the advancement of instructional models, strategies, and areas of future research on optimization of SG are available within specific domains (e.g., simulation, education), however recommendations toward implementation and practice are limited though the impact factors of the publications, which in-turn may not reach instructional designers (Hirumi, Appelman, Rieber, & Van Eck, 2010a, 2010b, 2010c). More so, publications are acutely focused on design and evaluation, leaving little room for discussion on methods of implementation and delivery (Gunter, Kenny, & Vick, 2008).

Some research has begun to approach the SG from a top down methodology rather than bottom up (Squire, 2008). Questions have since shifted from seeing if SG can be effective, to *how* should it be used, *when* should it be used and *where* should it be used (Squire, 2008). Schrader and Bastiaens (2012) reiterated the point that "it is not possible to define one optimal solution path for designing effective educational computer games based on their diversity" (p. 253), therefore the characteristics of game attributes must be examined to accurately identify connections between serious games and learning outcomes.

Additional studies on instructional levels and specific strategies have been published (Tan, Johnston-Wilder, & Neill, 2010) to guide research, however few reviews of literature examine primary research outside of their field (e.g., medicine reviews medical research only); in turn, stunting the growth of the interdisciplinary field of SG. Others (e.g., Cook et al., 2013) have also made recommendations to guide practice and future research; however there is still a disconnect between research and practice, possibly due to the lack of integration between game design, instructional design, and education. A lack of empirical evidence from studies with rigorous methodologies also may lead experts to question the effectiveness of the tool (SG). Currently, there is a need for more research on the design variables used in SG that could be potentially effective for producing learning outcomes (Bedwell et al., 2012).

Serious Game Attributes

A limited number of empirical studies have aimed to identify game attributes linked to statistically significant differences in learning outcomes (Wilson et al., 2009). Bedwell and colleagues (2012) sought to examine serious games that indicated positive learning outcomes to identify and linguistically bridge specific game attributes across multiple disciplines including the cognitive sciences (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Lorant-Royer, Munch, Mescle, Lieury, 2010); academia (Annetta, Minogue, Holmes, & Cheng, 2009; Kebritchi, Hirumi, & Bai, 2010; Wrzesien & Raya 2010; Hainey, Connolly, Stansfield, & Boyle, 2011); medicine (Beale, Kato, Marin-Bowling, Guthrie, & Cole, 2007; Knight et al., 2010), and social sciences (Tanes & Cemalcilar, 2010). The review included studies that indicated evidence of positive learning outcomes from SG based on randomized empirical trials, and pre-test and post-test quantitative design methodologies. Results identified 19 common attributes stemming from nine categories across the qualifying research. Each of the 19 game attributes identified (Appendix A: Serious Game Attribute Definitions) were utilized in this study.

Each of the serious game attributes identified in prior research stem from nine game categories; action language, assessment, conflict and challenge, control, environment, game fiction, human interaction, immersion, and rules and goals (Bedwell et al., 2012; Wilson et al, 2009). Each category yields one or more game attribute that can be used in designing game environments. The taxonomy was created using a card sort technique to balance theoretical and practical concerns from multiple disciplines empirically investigating serious games (Wilson et al., 2009). Each of the game attributes categories are present in all serious games, but to what extent and level is still unknown (Bedwell et al., 2012; Landers, 2014).

Instructional Designers' Role in Serious Game Design

The role of instructional designers is to provide guidance to the process and components, which is essentially optimizing the learning process. Learning processes are what drive instructional designers' way of thinking, but research has supported the development of systematically derived models which elicit targeted learning outcomes through instructional strategies that are supported through sound methodological and statistically empirical evidence. Recommendations for collaboration between instructional designers and game designers have previously been suggested, but have not been inclusive of educators that implement the game (Charsky, 2010).

To discuss the optimization and deconstruction of learning, definition of the term must first be established. Several definitions of learning have emerged in the last 25 years, ranging from a change in response due to direct influence, to a process that changes permanent capacity not linked to natural maturation (Illeris, 2012; Mowrer &

Klein, 2001). While definitions tend to shed light on the similarities in perceptions of learning, there are many divisions in major theories of thought. Main assumptions or beliefs about learning have also emerged from classical and contemporary learning theories. Learning theory is defined as a "scientifically acceptable set(s) of principles offered to explain a phenomenon" (Schunk, 2004, p. 3), so each will project philosophical assumptions within related models and framework that align with the field of thought. Until the last few years, three distinct epistemologies governed the majority of the learning theories in use, which were: behaviorist, cognitivist, and constructivist views.

By trade, instructional designers are known for a variety of skillsets including creating, analyzing, and refining instructional processes and practices in addition to being able to adapt methods and tools to align with theory and clientele beliefs. Researchers, Reigeluth (1983) and Smith and Ragan (1993), have suggested that the field of instructional design and instructional designers have been assigned with translating theory and research on learning into optimal instructional actions, materials, and activities (Ertmer & Newby, 2013).

Mental Models

Translating theory to practice is a difficult task, and many times illustrated models or organizational frameworks are developed to aid in global understanding and interactions between components in the model. Finalized instructional models often stem from revised models of tacit knowledge, such Benjamin Bloom's (1956) original taxonomy. Tacit knowledge is referred to as knowledge individuals' possess that is characterized as difficult to describe, examine, and use (Ford & Sterman, 1998).

Researchers Reigeluth (1983) and Smith and Ragan (1993), have suggested that the field of instructional design (and therefore instructional designers), have been assigned with translating theory and research on learning into optimal instructional actions, materials, and activities (Ertmer & Newby, 2013). In an effort to optimize instructional strategies for serious games, this study seeks to capture the mental models of individuals that design SG. However when working in a relatively new domain the content is more understandable when related to something that is already established. One method of developing organizational models is through capturing mental models, characterized as methods "to identify relationships within an unknown domain with the help of the relationships within a known domain" (Seel, 1999, p. 157).

In an effort towards extending the connections between serious game attributes and levels of instruction, the study seeks to utilize a card sort activity as a means to capture expert mental models (Bedwell et al., 2012; Wilson et al., 2009). To identify the current organizational frameworks and mental models of those that design SG, frequency counts can be used to align SG attributes with instructional levels. Data resulting from the study will extend current research on serious game attributes according to beliefs and experts in each domain, which in turn will aid in extending current taxonomies on instructional strategies in the profession.

Theoretical and Conceptual Framework

The conceptual framework for the study is grounded in three fields of study; game design, instructional design and teacher education. In an effort to tie prior research from the range of disciplines, cognitive load theory and a multidimensional construct oriented approach to learning were selected as foundational theoretical frameworks (Chandler & Sweller, 1991; Hutchins, Wickens, Carolan, & Cumming, 2013; Kraiger, Ford, & Salas, 1993). The foundational literature linking serious game attributes and learning outcomes was built on the theoretically based model of multidimensional, construct oriented approach to learning (a) cognitive, (b) skill based, and (c) affective learning outcomes (Kraiger, Ford, & Salas, 1993; Wilson, et al., 2009). Kraiger, Ford, & Salas' (1993) model of multidimensional, construct oriented approach to learning built on the prior work of Bloom's (1956) and Gagne's (1984) taxonomies, providing a link between theoretical models of cognition and instructional practice. Bloom's revised taxonomy of educational objectives (Krathwohl, 2002) integrated a multi dimensional component to each level of the updated taxonomy (remember, understand, apply, analyze, evaluate, and create) to distinguish between four distinct knowledge dimensions of cognitive learning (factual, conceptual, procedural, and metacognitive). For the purpose of this study, the researcher sought to identify the levels of complexity rather than the dimensions of complexity.

While serious games can have multiple purposes, the current study focuses on cognitive outcomes rather than skill based or affective outcomes, therefore foundational literature built off the theory of cognitive load (Chandler & Sweller, 1991). Cognitive

Load Theory [CLT] (Chandler & Sweller, 1991), assumes that cognitive processes during learning are influenced by the load imposed on the cognitive resources of learners, which in turn are limited in capacity and duration. Schrader and Bastiaens (2012) identified three types of cognitive load as intrinsic, extraneous, and germane. Schrader and Bastiaens (2012) stated:

> *Intrinsic cognitive load* depends on the complexity of the given learning task in relation to the learners' level of expertise. *Extraneous cognitive load* is caused by unnecessary cognitive demands imposed by the instructional design that hinder learning. Finally, *germane load* is the load that results from the learners' engagement in learning activities. (p. 259)

It has been posited that learning can occur "from active engagement in a gaming environment" but emphasis on gaming experiences with appropriate design elements have been noted to "enhance optimal levels of emotion and motivation and decrease extraneous cognitive load," which extends the notion that reducing extraneous cognitive load will allow for intrinsic and germane load, both of which are needed to ensure educational quality (Schrader & Bastiaens, 2012, p. 261).

Epistemological Beliefs & Pedagogy

Scholars have been clear in indicating that there is a need for more research on teachers' beliefs in relation to how they believe students acquire knowledge and effective pedagogy (Gill, Ashton, & Algina, 2004; Pajares, 1992; Schraw, & Olafson, 2014). To this end, recommendations for extending research on teacher's beliefs about learning (i.e., epistemology) have been hypothesized to lead to a better understanding of comprehension (Ertmer & Ottenbreit-Leftwich, 2010; Schommer, 1990). Epistemology has been defined as being "concerned with the origin, nature, limits, methods, and justification of human knowledge" (Hofer & Pintrich, 2002, p. 4). Pajares (1992) indicated the importance of examining teacher's beliefs including epistemology due to the influence beliefs may have on instructional practice. Moreover, he supported researchers whose "findings suggest strong relationships between teachers' educational beliefs and their planning, instructional decisions, and classroom practices" (p. 326). Individual beliefs about learning have been posited to influence the instructional decisions and priorities teachers make (Pajares, 1992; Rimm-Kaufmann, Storm, Sawyer, Pianta, LaParo, 2006). Factors that influence teacher and student beliefs in relationship to adopting educational tools for instruction have been examined in other areas (e.g., Ajjan & Hartshorne, 2008; Kepple, Campbell, Hartshorne, & Herlihy, 2015); however the influence or correlation between design decisions and beliefs has yet to be extended to innovative strategies, such as serious games.

One-dimensional versus Multidimensional Belief Models

Epistemological beliefs are often written from two perspectives: supporters of one-dimensional models and advocates of multidimensional models (Hofer, 2008; Hofer & Pintrich, 2002). One-dimensional models can be described as stages of development, where each stage has variation along a linear scale. Conversely, multidimensional models are fabricated under the assumption that there are several dimensions to a construct, such as epistemology, and each facet is independent, allowing detection of unique relationships (Buehl & Alexander, 2006). Schommer's (1990) model of epistemology is a primary example of a multidimensional model, containing five dimensions or factors (source, certainty, structure of knowledge, control, and speed of knowledge acquisition) to the construct of beliefs about the nature of knowledge and acquisition of knowledge (Müller, Rebmann, & Liebsch, 2008).

The five dimensions represent influences that affect an individual's belief in how to acquire knowledge, influencing perceptions and judgments, which in-turn can be said to influence methods of instruction (Pajares, 1992). Measuring each epistemic factor that contributes to epistemology better informs the researcher of the strength of the individual's belief in regard to acquiring knowledge through each construct than a total score. Each factor can then be correlated with multiple variables (e.g., group affiliation, instructional level, demographic information) in the organizational activity (card sort).

Conclusion

In summary, chapter two sought to review pertinent literature around serious games, attributes, and associated theories of thought to provide a background to the constructs being investigated in the study. As instructional tools continue to advance, evidence points toward serious games as a highly potential tool for learning. Research of well designed games in multiple areas provide evidence of transferability of knowledge from in game to real world applications when serious games designed for specific learning outcomes (Dormann, Whiteson, & Biddle, 2011). Recommendations for future research include organizing the types of game and associated strategies (serious game attributes).

CHAPTER 3
METHODOLOGY

Introduction

Chapter three aims to provide a detailed description of the methods and procedures utilized to conduct this study. Major sections include a restatement of the purpose of the study, research questions that will guide the study, the design of the study, descriptions of the population and sample, methods of data collection, instrumentation, and methods of analysis. To date, there has been no national survey study conducted on individuals' beliefs about learning and organization of serious game attributes that include key stakeholders (i.e, game designers, instructional designers, higher education instructors, and K-12 teachers). The purpose of the proposed study is to explore and quantify the selection of serious game attributes when designing a game for learning using *Levels of Teaching: A Taxonomy for Instructional Designers* and identify any relationships between beliefs about knowledge acquisition, expertise in field, and domain of field (e.g., education, game design, instructional design) (Hokanson & Hooper, 2004). Building on prior work of serious game (SG) attributes and the connection to learning outcomes (Bedwell et al., 2012), the proposed study has two central aims: (a) to identify the mental models put forth by each participant group when selecting serious game attributes on an instructional taxonomy, and (b) to provide insight into each subpopulations's beliefs about learning (i.e., epistemology).

Research Questions

The following research questions were used to guide this study:

1. What serious game attributes are most frequently selected for the sample and each subgroup (game designers, instructional designer, higher education instructors, and K-12 teachers) for each level of teaching?
2. How do the epistemological beliefs of instructional designers compare to those of game designers and teachers (higher education and K-12)?
3. What differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?

Design of the Study

The first stage in instructional design processes and methods, such as curriculum analysis, curriculum design or organizational change, is a detailed analysis of the key players in the ecosystem being investigated (Hays, 2006; Posner, 2004). To collect data on the key players in designing, developing and implementing serious games, a survey-based research design utilizing an expert-expert quantitative comparison was employed for the study. Survey research is defined as an approach to conducting research on potentially large groups of people by collecting questionnaire data through a representative sample (Gall et al., 2006; Mertler & Charles, 2011). In an aim to identify experts in each domain of interest (instructional design, game design, higher education, and teach savvy K-12 teachers), a flexible design was sought to be reach each subpopulation. Online survey research has several affordances that can help with reaching specific groups. Online surveys allow unique and specific groups of individuals access to the survey who would otherwise be challenging to reach (Wright, 2005); for example, individuals in serious game design communities would most likely yield higher levels of interest and domain knowledge in serious games as compared to all game designers. Specifically, an online survey allows access to virtual communities "who share specific interests, attitudes, beliefs, and values regarding an issue, problem, or activity" (Wright, 2005, 2.3). Given that that study is investigating individuals with a shared interest, online communities were identified as the best method of access to the population and subgroups.

Online Likert style survey research had been credited with potential issues in sampling bias and validity of results due to methods in the survey development and deployment (Jamieson, 2004). To mitigate issues toward sampling bias, an expert-expert comparison was identified as the most appropriate method of data analysis to make comparisons between groups. Further validating the sample, sample demographics are reported to disclose sample size and normality of data (Norman, 2010).

The survey sought to capture four sets of data through a web-based survey; EBI scores, organization of SGAs, models and frameworks being used, and participant demographics. Each data set was analyzed through statistical methods appropriate for each research question and type of data (e.g., ordinal). Participants' mental models of five factors of epistemological beliefs (simple knowledge, certain knowledge, innate ability, quick learning, and omniscient authority) were captured through factor analysis. Next, participants' mental models of SGA along an instructional scale were captured through an online card sort activity. Participants were then asked to identify any models or frameworks they use to design game through an open-ended question. To relate the information captured back to each participant subpopulation, participants were also asked demographic information to identify their relationship to each subpopulation, level of expertise, years in each field, and gender.

Operationalization of Epistemological Beliefs & Pedagogy

To capture participant's epistemological beliefs, questionnaires measuring epistemology or epistemic beliefs were identified through prior research (DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008; Schraw & Olafson, 2014). Prior recommendations for data collection on beliefs include assessments of individuals' statements, intentions, actions, verbal expressions, predispositions to action, and teaching behaviors (Gill et al., 2004; Pajares, 1992). However, data collection for each of these on a large national sample will not be attempted in this study to keep a centralized focus on game attributes rather than beliefs of designers and teachers. For the purposes of this study, three self-report measures were reviewed; the Epistemological Questionnaire (EQ; Schommer, 1990; N=935), the Epistemic Belief Inventory (EBI; Schraw, Bendixen, & Dunkle, 2002; N=795), and the Epistemological Belief Survey (EBS; Wood & Kardash, 2002; N=795).

Within educational research, specifically teacher education, Schommer's (1990)

Epistemological Questionnaire (EQ) was found to have the highest reliability based on the length of the instrument. During the selection process, reports and reviews of three self-report measures on epistemic beliefs were conducted and findings indicating minimal differences in factor loading across the instruments (Debacker et al., 2008). Validity and reliability scores had some variance in all three instruments when tested on the desired populations; however, the EBI was reported to have the highest level of internal validity and reliability when proper factor loading exists on the sample population. Though authors noted issues with reliability when measuring epistemic beliefs (EB) through self-report paper-pencil techniques, recommendations indicated that only in-depth interviews and qualitative analysis could indicate an individual's epistemic beliefs accurately, which is outside the realm of the current study.

The EQ was the most highly utilized instrument in education research of the three instruments reviewed and consists of 63 items representing 4 factors; simple knowledge, certain knowledge, innate ability, and quick learning with reported reliability coefficients ranging from .51-.78, indicating poor to good overall reliability (Debacker et al., 2008). However, replication studies failed to find the same reliabilities and only 3 of the 4 factors had proper loading in those studies (Duell & Schommer-Aikins, 2001; Schommer-Aikins, 2002).

Multiple iterations of the EBI have been put forth in an effort to increase the validity of the instrument and reduce the number of items. For this study the 32 item version was adopted which consists of 5 dimensions of epistemic beliefs; simple knowledge, certain knowledge, innate ability, omniscient authority, and quick learning, which held an overall internal consistency of .67, ranging from .67 - .87 for each factor in lieu of the 28 item version, which held low reliability (.58-.68) (Bendixen, Schraw, & Dunkle, 1998).

The EBI was adapted by the researcher for the current study from Schraw, Bendixen and Dunkle (2002), which is comprised of 32-Likert-type scale items ranging from strongly disagree to strongly agree and has a reported reliability ranging from .58 to .68 and elicits information regarding five dimensions of beliefs: structure of knowledge, certainty of knowledge, source of knowledge, beliefs about nature of ability, and learning (Debacker et al., 2008; Schraw et al., 2002). Identifying a scale that was developed and tested on almost identical participant groups (teachers) was ideal for the study because no pilot test was given. While instrument reliability could be considered low, there were other factors that were important in administration of the survey; these included the length of the survey and cost of assessment. For these reasons, the EBI was selected as the most appropriate measurement scale for the study.

The EBI was adapted from Schommer's (1990) Epistemological Questionnaire (EQ), a 63-item instrument designed to capture data regarding five dimensions of beliefs (structure of knowledge, certainty of knowledge, source of knowledge, beliefs about nature of ability, and learning). The dimensions represented in unique factors via factor analysis were developed by Schommer (1990). The Epistemic Belief Inventory (EBI; Schraw et al., 2002) was recrafted after Schommer's (1990) work but sought to "better capture" the five dimensions of epistemic beliefs originally suggested by Schommer (1990) (DeBacker et al., 2008, p. 287). Overall, the final version of the EBI reported having a Cronbach's alpha score of 0.71 indicating good internal consistency of the instrument (Schraw et al., 2002).

Factor Analysis

To identify epistemological beliefs, participants were asked to respond with their level of agreement on a five point Likert scale to a 32 item inventory that measures five factors (simple knowledge, certain knowledge, innate ability, omniscient authority, and quick learning). Following the procedures set forth by the Epistemological Belief Inventory (EBI; Schraw, Bendixen, & Dunkle, 2002), items were analyzed according to a five-factor model for the sample as a whole and for each subpopulation. When conducting factor analysis, there are three main steps that should be taken: (a) assessing the suitability of the data, (b) factor extraction, and (c) interpretation (Pallant, 2010). Factor analysis allows multiple iterations of analysis of individual data layers (participant groups) so long as the data is normality distributed. The study sought to examine three layers of participant data to determine normally and explore differences in populations among the sample and each subpopulation.

Card Sorting

A card sort methodology framework was used for the exploration of the selection of game attributes for each of the five levels of instruction identified by Hokanson & Hooper (2004). Card sorting is a methodology established for recording mental models (Seel, 1999) and was previously used to linguistically identify and bridge terminology between types of games and those that design them (Bedwell et al., 2012; Wilson et al., 2009). Card sorting is a categorization method most commonly used in game design and user-centered design research to investigate mental models (Bedwell et. al, 2012; Jonassen, 2006; Seel, 1999). A variation of the single criterion sort is the repeated single criterion sort that requires respondents to sort the same entities repeatedly, categorizing in terms of a different single criterion each time (Rugg & McGeorge, 1997). Furthermore, card sorts can be defined as open or closed, in that an open card sort does not have any predetermined categories to organize the items and a closed card sort utilizes predetermined categories. For the study, a closed card sort activity were conducted, where respondents will select each of the applicable levels of instruction for each serious game attribute. Honebein & Honebein's (2014) study on instructional designers use of instructional planning theory to judge the usefulness of instructional methods found that the methods used by participants (56 instructional designer) are very similar to what experts suggest.

Five Levels of Instruction

During the online modified card sort activity, participants were presented with 19 SGAs (Hokanson & Hooper, 2004) and asked to identify what instructional level (level 1-5), if any, the attribute could be used at. Each participant was asked decide if the SGA could be used at each instructional level, referred to as the five levels of instruction; level 1: reception, level 2: application; level 3: extension; level 4: generation; level 5: challenge (Hokanson & Hooper, 2004). The final category (level 5: challenge) was modified to state *personal challenge,* in an effort to mitigate any confusion with game-based goals and challenges that are present in multiplayer games.

Hokanson and Hooper's (2004) *Five Levels of Instruction* was selected based appropriateness of the scale, in that instructional objectives and activities are addressed in the Five levels of Instruction, as compared to other models which focus on cognitive outcomes (i.e., Bloom & Krathwohl, 1956) or thinking levels (Marzano & Kendall, 2006). Consideration was given to other instructional models had been previously used in educational research, such as Marzano & Kendall's taxonomy (2006), which has been utilized in K-12 classrooms. However the taxonomy was not well supported by empirical evidence on populations outside of K-12 classrooms, such as higher education. In an effort to identify the scale most appropriate for the populations involved in designing games, the researcher chose to focus on models that were supported in both higher education and K-12 environments. Therefore, Hokanson and Hooper's (2004) *Five Levels of Instruction* was selected and modified (i.e., changed level 5 from challenge to personal challenge) as a scale for operationalizing the SGA for participants. The *Five Levels of Instruction* are briefly described below as they were listed in the survey for participants.

Level 1: Reception

Level 1: Receiving information. Lowest level of instruction. All analysis, synthesis, and problem solving is done by the instructor.

Level 2: Application

Level 2: Application. Second lowest level of instruction: drill and practice. Knowledge is acquired through repetition, and the learning level may be described as 'near transfer'.

Level 3: Extension

Level 3: Extension. Middle level of instruction. Learners extend that they have learned to a different or authentic task. Knowledge is acquired through applying previous information in new situations and the learning level may be described as 'far transfer'.

Level 4: Generation

Level 4: Generation. Second highest level of instruction. Learners create their own solutions to complex problems. After a problem is presented, learners must recognize, regulate, and marshal the resources needed for a successful solution. The learning level may be described as 'meta-transfer'.

Level 5: Personal Challenge

Level 5: Personal Challenge. Highest level of instruction. Learners challenge themselves and others to learn. Those who seek, find, pose, and eventually resolve exploratory problems fro themselves, challenge their own limits of learning.

Population

The study seeks to identify individuals' beliefs and shared group beliefs about knowledge acquisition (Schraw et al., 2002), mental models of serious game attributes (Bedwell et al., 2012), and any existing relationships between the variables. An examination of the beliefs about knowledge acquisition and selection of game attributes of three distinct groups involved in designing and implementing educational games were selected as the population for the study. The three groups being examined are video game designers, instructional designers, and teachers. Furthermore, teachers were broken down into two subgroups, those that are in K-12 education and those that are in higher education. The distinction was made between the teacher group to better inform the data on the group's beliefs, knowledge of SG and SGA, and participant response rate. Each group was selected based on critical roles in serious game design and implementation (Procci & Bowers, 2014). Due to the variation in job titles of designers (both game and instructional), several demographic questions were included in the survey to clarify participants' affiliation with the subpopulations of interest.

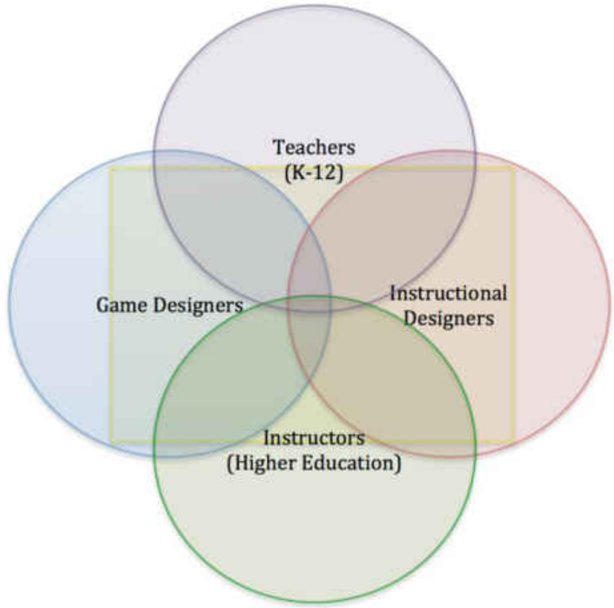


Figure 1: Subpopulations

Identification of an individual's knowledge base of games for learning cannot be predetermined geographically; however, in preparation for the research, the researcher sought to identify the population based on cultural habits. Early meetings with game design and instructional design faculty helped identify cultural components of each subpopulation. Information on each population's communication methods, gatherings, and affiliations were recorded and considered when identifying potential recruitment sites and methods of data collection.

Experts within each respective field were sought through selective criterion, which were identified through demographic questions establishing length of time in field of work, specialization, and self-reported level of expertise (novice, intermediate, expert). Potential participants were recruited through a stratified sampling method including; (a) a national organization for the advancement of learning, containing both instructional designers and teachers; (b) snowball recruitment through higher education faculty and social networks for serious game designers; and (c) visits to University courses in senior level game design and a graduate level Educational Technology course. Participants were offered a five-dollar electronic gift card as a gift of appreciation in an effort to increase overall participation (Dillman, Smyth, & Christian, 2009).

Sample

To best answer each research question, a purposive sample was established based on research recommendations of individuals that should be involved in designing serious games which include instructional designers, game designers and educators (Procci & Bowers, 2014). For the card sort activity findings to be generalizable to the population, a sample size of 35 participants from each discipline was sought. To capture the beliefs and mental models of each field, a purposeful sample (N=105) of game designers (n=35), instructional designers (n=35), and teachers (n=35) was sought to allow for identification of patterns through an online card sort activity (Tullis & Wood, 2004). The sample were identified based on demographic questions posed in the online survey (Appendix C). To indicate a medium effect, a sample size of 60 must be reached for significance (p=0.05). Minimally, the aim is to have 30 expert participants in each group for a correlational coefficient of 0.98 in numeric similarity scores for the card sort activity (Barnard-Brak & Lan, 2009; Tullis & Wood, 2004).

Minor modifications were made to sampling techniques to reach each target population. The research utilized purposive sampling while applying methods of stratification to account for each subpopulation (Gall et al., 2006). As advocated by Gall et al. (2006) and Barnard-Brak and Lan (2009), purposeful sampling of participants was sought to obtain the desired sample size of 35 participants that identify as members of each pre-determined field of inclusion (game design, instructional design, teachers). Referring to Peers (1996), "Sample size is one of the four inter-related features of a study design that can influence the detection of significant differences, relationships or interactions" therefore steps were taken to obtain an optimal sample size (Bartlett, Kotrlik, & Higgins, 2001, p. 43).

Sampling Procedures

To reach the target population multiple sampling methods were used. To recruit participants from each subpopulation, a combination of sampling methods were selected to reduce sampling bias, including non-proportional stratified sampling, snowball sampling, and convenient cluster sampling (Gall et al., 2006; Shadish et al., 2007). Guidelines for participant recruitment were consistent with multiple components of the Dillman Design Method (Dillman, Smyth, & Christian, 2009), including (a) personalization of contacts, (b) token of appreciation ($5.00 Thank you gift card to Amazon), (c) contacting participants by another mode (i.e., their national associations), (d) length and tone of communication, and (e) clarity of instructions and continuity of online tools. Selective criteria for each participant group was established and included in recruitment messaging, which is detailed in the subsequent section. Participants were asked to self identify as a game designer, instructional designer, higher education instructor or K-12 teacher. Instructional designers and game designers were asked to identify by job title, or affiliation to their primary work role. More specific criterion was identified for teachers in order to select participants that would have some familiarity to the paradigm of using video games in classrooms. Teachers were asked to identify as either higher education instructors or K-12 teachers. To target K-12 teachers that would more likely have experience with using serious games, all recruitment messaging specified 'tech savvy teachers', rather than *teachers* or *K-12 teachers*.

Recruitment Methods

Participants were recruited from three disciplines (instructional design, game design, and teachers) to gain insight into the epistemic beliefs and organization of serious game attributes instructional level. To target instructional designers and teachers with exposure to serious games, inclusion of an international organization in the advancement of computing methods was sought out to increase the diversity of the sample and aid in mitigating external threats to validity (Shadish, Cook, & Cambell, 2002). Participants were recruited through a pre-existing membership association, the Association for Educational Communications and Technology (AECT), which reports having thousands of members in the U.S. and internationally. Pulling member records from the directory, the researcher identified that there are 885 members in the United States alone. Online surveys have been reported to have low response rates (Bartlett, Kotrlik, & Higgins, 2001), therefore the researcher set low estimates (5-10%; *n*=44-88) for online response rate returns from the AECT recruitment.

In adherence with UCF Institutional Review Board (IRB) board and AECT's rules, the partnering institution was sent IRB approval for the study, recruitment messaging, and informed consent, which went through AECT board member approval. Once approval was granted, individualized emails were sent to all AECT members asking for participation and a link describing the purpose of the study was available on the AECT research request page.

Recruitment messaging included a link with a shortened Uniform Resource Locator (URL) to the research study website. All communications included pertinent information on the research investigation including the primary investigator, title of dissertation, IRB approval number, and a linked URL leading to further information about the intentions of the study, access to the survey, thank you gift, and affiliations to UCF. Digital marketing strategies (online poster; Appendix I) were utilized for online populations where no personalization was implemented to increase interest and participation. All digital materials and content were approved by IRB before publication and distribution.

Dillman and colleagues (2009) identify the process for emailing participants as three-fold; (a) establishing trust with participants, (b) increasing benefits for participants, and (c) decreasing costs of administration. In an effort to meet each criteria, Dillman and colleagues suggest that researchers distributing web-based surveys (a) send three emails, (b) personalize emails to each participant, (c) provide specific codes for each participant, and (d) use a uniform source to send emails from to promote trust and increase sample size. In compliance with the suggested guidelines, the researcher tailored the emails to each group of participants by their national association affiliation rather than individual names to respect anonymity, yet personalized invitations to participate by tailoring messages for each group (i.e., game designer, instructional designers, and teachers) and unique codes for each participant. The researcher was not able to facilitate the administration of follow up emails with the partnering organization (i.e., AECT), but prior research suggests that response rates will still remain between 25-30% when previously described recruitment methods are employed (Bartlett, Kotrlik, & Higgins, 2001). As a token of appreciation the researcher gave participants the option of submitting an email address where they would be sent a $5.00 electronic gift card to Amazon.com. All participants that completed the survey in full had the option to receive the token of appreciation. Thus, a limited version of the tailored design method was implemented for distribution and collection of the web-based data through email recruitment.

Snowball Recruiting

Three faculty members from a large southeastern university volunteered to formally assist with recruiting participants for the study. Recruitment strategies were individually tailored to address the personal, professional, and student contacts each faculty member was willing to reach out to. Methods for recruitment with each gatekeeper is described below:

Faculty member 1

The first faculty member was asked if he/she would be interested in allowing his/her students in a *Game Design Workshop course* (4000 level course) to participate in the study. Upon approval, the researcher established dates where an in-person classroom visit could be conducted for the first 5 minutes of class time. The researcher presented an overview of the study, allowing time for questions about participation. All students were verbally notified that participation was voluntary and no consequences will occur for not participating. In addition, all data collected would remain confidential. The researcher attended two course sections with approximately 30 students each on June 9, 2015 and June 10, 2015. Participants that were recruited through this strategy (faculty member and game design course) could not be directly identified, however analytics within Qualtrics allows for identification of the participant location through an IP address.

Faculty member 2

The second faculty member was asked if he/she would be interested in allowing his/her students in a *Multimedia for Education and Training course* (6000 level course) to participate in the study. Upon approval, the researcher presented an overview of the study for potential participants via webinar using video chat (Adobe Connect) for the master's level course, targeting educators and instructional designers. The researcher presented an overview of the study, allowing time for questions about participation. All students were verbally notified that participation was voluntary and no consequences will occur for not participating. They were also told that all data collected would remain confidential. A brief description and link to the study was also posted as a course announcement by the professor in an effort to allow students to consider participating at a later period of time.

Faculty member 3

The third faculty member has a long standing presence in the education and multimedia research community and was asked to recruit other experts who met the inclusion criteria and conducted research in the domain of serious games. The researcher provided an email template that could be personalized to the faculty member who then distributed the participation request via emails to personal and professional contacts within the educational and serious game communities. The number of emails that were sent and recruited through this method are not available and are an inherent limitation to the data collection.

Social Media Recruitment Methods

Social media recruiting methods were employed in an attempt to identify game designers with experience or interest in serious games. One group (Group A) and one page (Group B) was identified as being closely aligned with the target population, Academic gamers (social membership group; *N*=185) and the Serious Game Showcase and Challenge (organization/event page). Recruitment postings were listed on the respective walls on June 2, 2015.

Sampling Limitations

Web surveys have several inherent limitations including issues with both time and space, yet are still an effective method for reaching groups of individuals that are otherwise challenging to connect with (Wright, 2005). Individuals and groups targeted for the research study could not be accessed through physical locations, so membership groups and education settings were identified as the best method of targeting the desired population. However, not being able to connect with participants in real time is an inherent limitation to sampling, as participants that are met in person have a higher response rate (Dillman et al., 2000). Specifically, researchers are not able to fully anticipate when potential participants will have the opportunity (i.e., time available) to review the research participation request, as opposed to a paper-based survey where both parties (the researcher and the participant) would be in the same location at the same point of time to discuss and distribute the survey. To help mitigate the issue, the researcher opted to utilize recommended online survey methods to increase participation by extended the length of time the survey would be available to participants (Dillman et al., 2000).

In addition to limitations with timing, the space in which the research was presented may not be palatable to all individuals in the targeted population. For example, Hudson and colleagues (2005) found that members of an online community deemed research posts on community boards as offensive or rude for posting to the community space. To best mitigate the issue of space or unwanted presence, the researcher sought to match participants' interest in the topic, so specific membership populations that have goals of improving learning and instructional methods (e.g., AECT), or gaming (e.g., Facebook: Academic Gamers) were targeted for participant recruitment.

Data Collection

A web-based survey was identified as the most appropriate method of collecting data for the current study. All contacts and data collection processes began after UCF IRB approval. Participants were asked to complete the online survey, which included the EBI, a one minute video on Hokanson & Hooper's (2004) taxonomy, a modified card sort activity, and demographics questions focused on level of experience in each discipline.

Recruited participants were directed to a website providing information about the research study and an access link to complete the survey. Two secure databases were used to collect participants' data: (a) online data collection software, *Qualtrics,* was used for administration and collection of all data resulting from the online survey, including the EBI (Schraw et al.,2002), card sort (Bedwell et al., 2012), and participants demographic data, and (b) Google Docs, where participants' gift card email addresses were stored. All participants in the study were required to read a statement of informed consent and attest to voluntary agreement of participation in the study approved by UCF's institutional review board (IRB).

Ethical Considerations

Ethical considerations were considered by Institutional Review Board (IRB) committee at the University of Central Florida. Some of these considerations include, but are not limited to:

1. The identity and all data collected were anonymous.
2. Participation in this research project is entirely voluntary.
3. Participants may withdraw from the study at any time without consequence. All respondents were informed of their rights and the above mentioned information through an approved *Informed Consent* form pre-approved by the IRB at the University of Central Florida
4. Permission to use the data instruments were granted by the authors and developers of each instrument.
5. The study will not be conducted without the permission and approval by the dissertation chair, committee members, and IRB of the University of Central Florida.

Instrumentation

Each instrument employed by the study was linked to descriptive statistics on each participant to measure characteristics of a sample on pre-determined variables (Gall et al., 2006). Quantitative statistical methods were used to measure three sections of the survey: (a) descriptive demographic data; (b) factors of epistemic beliefs (Schraw et al., 2002) including simple knowledge, certain knowledge, quick learning, omniscient authority, and innate ability; and (c) selection of serious game attributes by instructional level. All items were distributed through a 56-item survey created using Qualtrics (Appendix A-C).

Access to the survey was established through a Uniform Resource Locator (URL) link distributed to participants by one of the previously identified recruitment methods. Participants were required to review all IRB and consent forms before being granted access to the survey questions. To indicate understanding and agreement to participate each participant was initially asked consent (to agree and continue to the study or disagree and close out of the study), and to provide an email address where a thank you gift could be electronically sent. Finally, before beginning the survey items, each participant was provide with the approximate amount of time it would take to complete the survey, notification that the survey will not work on touch screen devices, and asked to complete all components of the survey including the EBI, card sort, and demographic information before submitting.

Before beginning the survey questions, participants were provided with an overview of each section, including; (a) EBI, (b) 1 minute video, (c) card sort, and (d) demographic data. For each section, a brief one sentence narrative was provided to inform participants on what they are being asked to do. Throughout all sections, participants were provided with a progress bar indicating their percentage toward completion located at the bottom of the screen. Accessibility features available were enabled in the survey including allowing participants to stop the survey and return at a later time with a passcode to login. The survey was designed to take approximately 20 minutes, including time for the 1-minute video.

The first section of the survey was comprised of the 32 items from the EBI (Schraw et al., 2002), used verbatim, in an online medium with permission from the author (Appendix A). Participants were asked to indicate their strength of agreement with each statement, ranging from strongly agree (5) to strongly disagree (1), within a five-point Likert scale. Next, participants were asked to review a 1-minute informational video on the scale they are required to use in the next activity, the card sort. The video reviewed the levels of the scale from least to most complex instructional levels. After reviewing the video, participants were asked to review each of the 19 serious game attributes and indicate the instructional levels (1-5) to which the attribute could be applied. Within each question, the serious game attribute and each of the 5 levels of instruction were enabled with rollovers so participants could review definition of terms at any point in the survey. The last section of the survey consisted of demographic questions. Participants were asked to classify themselves by: (a) affiliation to population being examined, (b) years of experience in each field, (c) level of expertise (novice, intermediate, expert), (d) age group (18-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70+), and gender (male, female, other).

Survey Response Rates

Web-based surveys have several advantages over paper-based surveys, including ease of distribution to unique populations and time and cost savings (Dillman, 2000; Sax, Gilmartin, & Bryant, 2003). However, response rates are generally found to be lower for online or electronic surveys than those that are paper-based (Cook, Heath, & Thompson, 2000; Dillman, 2000). Cook and colleagues'(2000) meta-analysis of 68 online survey's response rates indicated that you can expect a range between 25-38 percent response when no follow-up is used. Furthermore, they found three dominant factors affecting the response rates to be: (a) number of contacts, (b) personalized contacts, and (c) pre-contacts. Conversely, Sax and colleagues (2003) found one moderating factor that affected college student response rate between all methods of collections (e.g., web-only, paper-pencil), which was method of administration.

Factors related to survey construction were also considered when designing the web-based survey and participant recruitment materials. The total length of the instrument was reduced through utilizing an online card-sort within the survey over a paper-based card-sort, reducing the time for task completion on the survey (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004). Dillman (2000) indicated that a respondent friendly design of survey items also increases response rates for mail survey response, so similar strategies were taken when constructing the web-based survey's card sort activity, allowing participants to easily access definitions to serious game attributes and a 1 minute video reviewing the instructional scale they were asked to categorize them into (5 Levels of Teaching; Hokanson & Hooper, 2004). Additionally, a *thank you* incentive was advertised with all recruitment materials using a visual element (i.e., picture of a gift card) to populations not recruited through a membership organization (AECT recruitment materials did not contain any images).

A limitation when surveying individuals that are often asked to complete surveys, such as educators and college students, is total nonresponse bias. "Nonresponse bias refers to a bias that exists when respondents to a survey are different from those who did not respond in terms of demographic or attitudinal variables" (Sax et al., 2003, p. 411). According to Gall and colleagues (2006), participants that volunteer in research typically are different than non-volunteers, introducing sampling bias. Bias that may influence participants in this study, according to prior research on volunteers, which indicates that volunteers tend to be better educated, have a higher social-class status, have more intelligence, have a higher need for social approval, more sociable, more arousal-seeking, more unconventional, less authoritarian, and less conforming than non-volunteers (Gall et al., 2006).

Data Analysis Methods & Procedures

Data analysis methods and procedures were detailed for each research question. Quantitative data analyzes were performed using the Statistical Package for Social Science (SPSS) software package for Mac and Windows Version 22.0 (2014).

Research Question 1

The first research question seeks to answer, *what serious game attributes are most frequently selected for the sample and each subgroup (game designers, instructional designer, higher education instructors, and K-12 teachers) for each level of teaching?*

The researcher used a closed card sort based on Hokanson and Hooper's (2004) five instructional levels as the predetermined hierarchal categories (Hudson, 2013) with a repeated single criterion design (Rugg & McGeorge, 1997). This afforded participants the option to select each game attribute for each level they felt was appropriate. To mitigate statistical error issues, the research design incorporated repeated measures to aid in maintaining the integrity of the forced choice in the card sort. Frequency counts were tallied for each game attribute within each level of the five levels presented. Furthermore, descriptive data analysis was used in the form of frequency counts on participants' affiliation to each discipline. Participant data were separated according to discipline, and factor analysis was run within groups. Data was then analyzed to identify any between group differences for each SGA.

Data is reported for each instructional level, beginning with the SGAs that were selected the most frequently. To "probe more fully the character of these viewpoints, a set of factor scores if computed for each, thereby producing a composite q-sort, one for each factor" (McKeown & Thomas, 2013, p.4). A card sort (i.e., Q-methodology) was used to quantitatively measure the subjectivity of each group's use of SGA. A card sort utilizes the same analysis methods as a q-sort or q-study, "using a form of multivariate analysis, a Q-study is designed to extract the number of viewpoints in a sample while identifying both the distinctions and similarities between each viewpoint" (Roberts, Hargett, Nagler, Lajoi, & Lehrich, 2015, p. 149-150).

Descriptive statistics are reported for each game attribute indicating the frequency of selection in each level of teaching. Additionally, the total frequency of selection of the attribute across all levels of teaching are reported with frequency counts and percentage of total attributes (number for specific attribute/total number of attributes) listed. The number of times selected for each attribute (total possible score of 5) was used to rank the selection of the game attributes from most frequently selected to least selected.

Research Question 2

The second research question seeks to answer, *how do the epistemological beliefs of instructional designers compare to those of game designers and teachers (higher education and K-12)?* Epistemological beliefs were operationalized by the five factors of the Epistemic Beliefs Inventory: simple knowledge, certain knowledge, innate ability, omniscient authority, and quick learning (Schraw, Bendixen, & Dunkle, 2002; Schrommer, 1990). The sample and each subpopulation are correlated with the each of the five factors, indicating a shared or unshared beliefs about learning. To test for validity of the population, the researcher conducted factor analysis on each group to validate the correlation of the items and predefined factors on each subpopulation. The strength of the relationship between each factor and the full population and subpopulations is reported for comparison. For example, instructional designers are subject to analysis to identify if the subgroup's answers covary, and the strength of the relationship. If there is no correlation or a negative correlation, the questions contributing to the factor is reviewed for possible removal from the survey data.

Factor analysis is a method of analysis that allows for patterns among several variables to be explored and assesses construct validity in assessments. Factor analysis involves: (a) finding factors associated with a specific set of variables, (b) discovering what variables load on specific factors, (c) examining the correlations of variables with factors, (e) examining the correlations (if any) among factors, and (f) determining the maximum variance accounted for by the factors. The ultimate goal for factor analysis is to cover a maximum variance with the fewest amount of factors. Due to the exploratory nature of the design, exploratory factor analysis (EFA) is the most appropriate statistical analysis for identification of factors influencing epistemological beliefs. Once the validity of the factors was established, each question was scored according to the guidelines provided in the Epistemic Beliefs Inventory Key (Appendix G).

Research Question 3

The third research question seeks to answer, *what differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?* To best answer the question, the research utilized a case study methodology with ethnographic elements. Participants were asked to identify any models or frameworks they utilize when designing a game through an open-ended question, which does not limit or put forth expectations to the length or detail in participant response. The cases examined are the models and frameworks identified by participants, who were viewed holistically with the sample and then through four lenses, one for each subpopulation. Through qualitative methods, participants' Researchers argue that qualitative methods are based on philosophical assumptions, rather than methods of collecting data. Creswell lays out the five philosophical assumptions that lead to an individual choice of qualitative research which include: ontology, epistemology, axiology, rhetorical, and methodological assumptions (2007).

Within qualitative research, a set of procedures are viewed as guidelines rather than hard and fast rules, allowing researchers to adapt methodologies to study their specific variables. A researcher could use a case study methodology and compliment this with ethnography. Case study methodology is defined by several researchers including Stake (1995), Merriam (2009), and Patton (2002) as the study of a case (e.g., person, place, or event), selected for its particularity, and bounded by physical, temporal, social/cultural, and conceptual features. Case study research is not defined by use of a particular set of methods, although selection of the case should inform the process of inquiry (i.e., use the methods from areas of qualitative research that best align with the case).

Case-based methods have three distinct attitudes in social science, which are linked to loosely based philosophies of education (e.g., standard scholars, social philosophers, or conceptualists), commonly referred to by the direction they are oriented, such as “from above” and “from below”, or “upwards” and “downwards”, (Byrne & Ragin, 2009, p. 40-41) where ethnographers are required to have elements of each. In a case study the phenomenon being investigated is unique to the case, so generalizations or validity to populations cannot be made, whereas an ethnography seeks to examine the values and beliefs of a cultural group, not the individual or unique phenomenon.

The data analysis methods between the two types of methodologies discussed have few differences as described by Creswell (2007). Creswell’s recommendation for ethnography to use three aspects of analysis as advanced by Wolcott (1994), which include: "description, analysis, and interpretation of the culture-sharing group" (p. 161), further recommending the analysis be conducted throughout the study allowing for natural patterns and behaviors to emerge, while still allowing for the design of the questions to be reflective of the data collected. Furthermore, Creswell suggests use of a template for coding an ethnography to analyze the emerging patterns, allowing neutrality to participants identified sex or socioeconomic status. The recommendations for a analysis and interpretation of case study, as posited by Creswell (2007) is nearly identical to the ethnography regarding data management, reading and memoing, describing the data, classifying the data and representation of the data. The major difference in analysis between the two methodologies lies in the interpretation of the findings, one to the case and the other to the cultural group.

Summary

In summary, the study aims to identify any preexisting relationships between epistemic beliefs of serious games between game designers, instructional designers, and teachers in an effort to extend research on the game attributes selected when designing a game for learning. Chapter three sought to delineate the design methodologies, population and sample, recruitment strategies, methods of data collection and analysis, and any foreseen limitations to the procedures of the study. Game designers, instructional designer, K-12 teachers and higher education professionals were identified as the sample population. Each subpopulation will be recruited through methods of stratified sampling, snowball recruiting, and convenient cluster sampling asking for participation in a 15 minute online survey. Four types of data were collected from the survey to inform the study, (a) EBI scores, (b) SGA organization, (c) models and frameworks being used to design serious games, and (d) demographic information. Subpopulations' EBI scores for each factor (simple knowledge, certain knowledge, innate ability, omniscient authority, and quick learning) are reported to identify the level of sophistication or naïvety of the sample and each subpopulation. Serious game attributes will be analyzed in accordance to the levels of instruction (Hokanson & Hooper, 2004) the sample and each subpopulation identified for each attribute. The models and frameworks identified will be subject to a case study analysis with an ethnographic focus for each culture sharing group (subpopulation).

CHAPTER 4
ANALYSIS

Introduction

Chapter four aims to provide an overview of the data findings including the sampling frame, procedures taken to clean the data and the findings for each research question. The three research questions posed for the study sought to examine the instructional design patterns and epistemological beliefs of game designers, instructional designers, and teachers (higher education and K-12). Specifically, what serious game attributes (SGA) are useful at each instructional level (Hokanson & Hopper, 2004). The study included the development, distribution and analysis of a web-based survey exploring the epistemological beliefs and mental models of each subpopulation.

Sampling Frame

A sampling frame is provided as an overview of the characteristics of participants that completed the survey and that were either removed or dropped out of the study. A sampling frame is provided based on reporting recommendations for studies using a Q methodology (Roberts, Hargett, Nagler, Jakoi & Lehrich, 2015). It has been stated that "the purpose of a q-study is not to estimate population statistics, but rather to identify and explore the various perspectives on a given topic present in a group" (Roberts et al., 2015, p. 155), so identification of participant demographics is warranted.

Participant responses were collected through Qualtrics, an online cloud–based survey development and distribution software. The software has several affordances including collecting participant IP addresses, which were used to identify participant's location at time of survey completion. An unsponsored, free web-based service was selected to decode participant's location (*https://www.iplocation.net*) that provided city, state, and country information for provided IP addresses across the globe. Specifically, the service pulls geolocation data from 6 different Internet providers, including mobile services. Data reports indicate that the sample population (N=171) completed the survey in 16 countries. Minor discrepancies between the geolocation of the participant was identified in the data within the cities and township that the user accessed the survey, however results unanimously reported the same state and country for each IP address. Therefore, participant locations are reported in terms of country and state of survey access for all participants.

IP Address Access Locations

Participants from the United States attributed to 88.9% of individuals that made up the sample population (N=171). Specifically, U.S. participants (n=152) came from 35 states and 1 district; predominantly from Florida (n_{FL}=48; 28%) and Illinois (n_{IL}=9; 5.2%) and the remainder accessed the survey from unique locations across the US (AL, AZ, CA, CO, CT, D.C., GA, ID, IN, IA, KS, KY, MA, MD, MI, MS, MO, MT, NV, NH, NC, OK, PA, RI, SC, TN, TX, UT, VA, WA, WI, WY) representing less than 5 percent of the sample population. The remainder of the sample population (n=19; 11.1%)

came from countries (*n*=15) outside of the U.S., including Canada, Mexico, China, Hong Kong, Taiwan, Germany, Brussels, Hungary, Oman, Armenia, Belize, Greece, Netherlands, Singapore, and Korea. A total of 171 surveys were started from unique participants as identified by Internet Protocol (IP) addresses. However, only 84 percent (n=150) of those participants completed the survey (dropout rate: 16%, *n*=21). An additional 9 participants were also removed from the sample due to incomplete data, leaving the final sample at 142 participants.

Data Cleaning

The process of data cleaning is considered an important component in the analysis process and if omitted, findings could be subject to additional bias; with the current research methodology data cleaning is stated to be "critical" to the validity of data (Osborne, 2013, p. 12). Following recommendations of best practices on data cleaning, the researcher followed a systematic process inclusive of removing data sets or variables (*n*=47) that were not viewed, missing participant responses, or were not accurately captured (Osborne, 2013). To facilitate the data cleaning process, minimum criteria were established for exclusion of participant data from the sample and each variable included in the instrument was reviewed for inconsistencies in the instrument or data collection processes. Criteria for inclusion in the study sample consisted of completing all 32 EBI questions, recorded responses to a minimum of 17 of the 19 serious game attributes, identification of the group participants felt most closely aligned, amount of experience in their discipline (i.e., time in field) and gender. In total, 47 participants were removed from the sample population and one variable was removed from analysis.

Participant Dropout

When requiring participants to complete surveys through web-based methods, there are inherent technology threats that cannot be mitigated on the user's side. One such issue arose for 16 percent of the population that accessed the survey. Data indicates that 9 participants that dropped out of the study were accessing the survey through a mobile carrier-based Internet service, therefore they may have dropped due to incompatibility of survey elements with the device (e.g., Netherlands, Singapore, Korea were dropped from analysis). Participants were asked to complete the survey on a computer (desktop or laptop) due to features that would not be enabled with touch screen devices before beginning the survey, but the message may not have displayed properly on mobile devices because popups would not be enabled. A second reoccurring issue was identified around video playback (n=3). Two participants contacted the researcher directly about issues with the video playback and dropped participation in the survey for this reason. One additional participant contacted a professor that was a conduit for snowball recruiting with reports of video playback issues as well. The latter participant was able to complete the survey through a different access point (device) at a later time.

Serious Game Attributes

During the data cleaning process, an abnormality was found within one of the SGAs, sensory stimuli after the survey was live. The 19th attribute on the list had an error in display and there were indications that participants did not view the final attribute, sensory stimuli, so the SGA was removed from analysis. The abnormality was attributed to programming error within the Qualtrics software.

Sample

Data sets that met all sample criteria were included in the analysis, resulting in 142 total participants. The sample (*N*=142) consists of participants that identify as male (*n*=65; 46%), female (*n*=76; 53%) and other (*n*=1; 1%) and from four fields of study, game designers (*n*=21; 15%), instructional designers (*n*=55; 39%), higher education teachers (*n*=35; 24%), and K-12 teachers (*n*=31; 22%). Participants were also asked to disclose their age range, self reported level of expertise in each of the subdomains being investigated (game design, instructional design, and teaching) and years of experience. Data collected indicated a large variance in age groups with the most participants being in their 40s (40-49, n=40; 28%), followed by those in their 30s (30-39, *n*=34; 24%), 50s (50-59, *n*=27; 19%), 20s (20-29, *n*=25; 18%), 60s (60-69, *n*=13; 9%), 70s (70+, *n*=2; 1%), and under 20 (18-19, *n*=1; 1%) respectively.

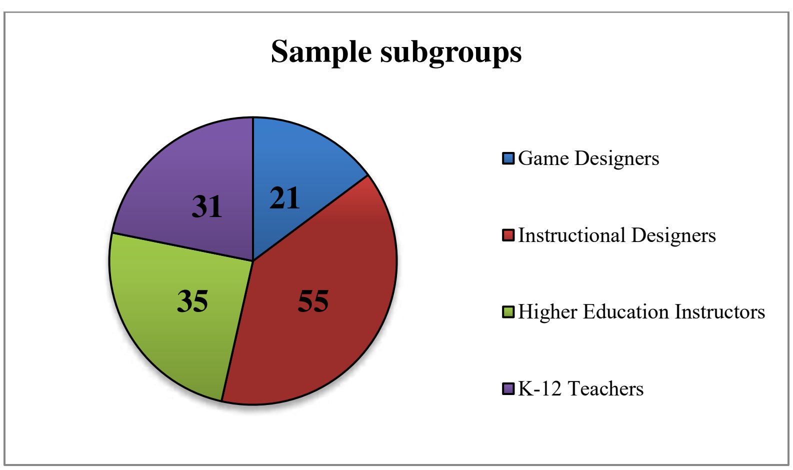


Figure 2: Number of participants in each subpopulation of the sample

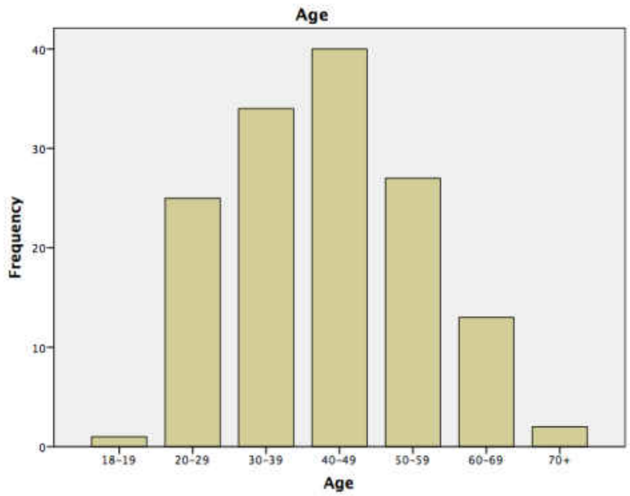


Figure 3: Age of participants in sample

Majority of sample participants identified as being a novice in game design (n_{GDn}=110) but indicated intermediate (n_{IDi}=66; n_{Ti}=37) or expert (n_{IDe}=42; n_{Te}=76) in instructional design or teaching. Specifically, participants self reported as being at the various levels in game design (Novice=110; Intermediate=24; Expert=5; NR=3), instructional design (Novice=29; Intermediate=66; Expert=42; NR=5), and teaching (Novice=23; Intermediate=37; Expert=76; NR=6). To capture a more detailed understanding of participants' experience in each field, they were also asked to indicate the years of experience in each field reported in terms of mean scores and standard deviation; game design (M_{GD}=1.53, SD_{GD}=3.26), instructional design (M_{ID}=6.61, SD_{ID}=6.87), higher education teacher (M_I=6.39, SD_I=6.8) and K-12 teacher (M_T=4.35, SD_T=6.13)

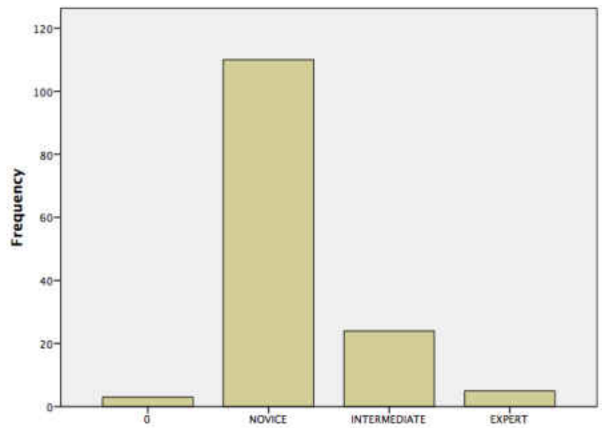


Figure 4: Sample's experience level in Game Design

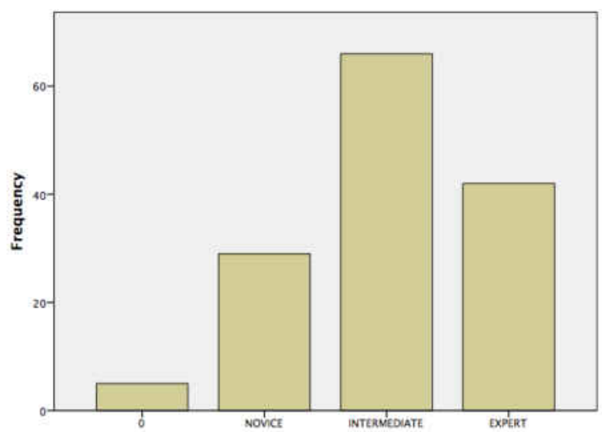


Figure 5: Sample's experience level in Instructional Design

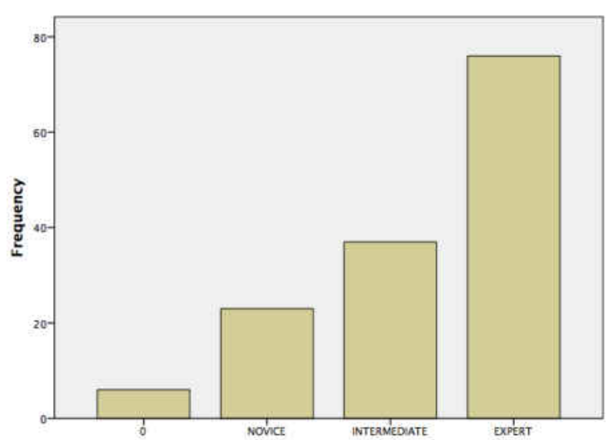


Figure 6: Sample's experience level in Teaching (any level)

Analysis

Research Question One: what serious game attributes are most frequently selected for the sample and each subgroup (game designers, instructional designer, higher education instructors, and K-12 teachers) for each level of teaching?

To answer the first research question, the researcher calculated frequency counts and weighted scores for each SGA and level of instruction for each participant group (game designers, instructional designers, and teachers). Watts and Stenner (2012) suggest presenting data analysis for Q-methodology in three stages; translating data from q-sorts to factors, from factors to factor arrays, and factor arrays to factor interpretations. However, most q-sort participants are forced to make one selection for each item among an evenly distributed scale, but the current study allows for participants to make multiple selections on each item to identify all levels the SGA could be used at, rather than just the top ranked choice. Therefore, a variation on analysis and interpretation must be considered for the data obtained. Factor arrays are found "via the weighted averaging of significantly loading or factor-exemplifying q-sorts", so weighted averages of each SGA is presented for each subpopulation (Watts & Stenner, 2012, p. 180).

Data findings are presented through percentages of the sample (*N*=142) and subpopulation's selection of instructional level for each SGA (Appendix K). Percentage of selection for each SGA was found by identifying the total number of times the attribute could be selected (Sample size x Instructional levels; 142x5=710), and dividing the umber of times selected for each subpopulation by 710.

Results reported include frequency counts for each level and subpopulation, which was then tabulated into total scores for each level on the scale. Total scores were then computed for each participant group (game designers, instructional designers, K-12 teachers, higher education instructors). As reported in *table 5: Subpopulation's frequency of instructional levels for SGA* (Appendix K), level 3 and 4 were the most highly selected among all SGAs.

Analysis of each level for the sample population (*N*=142) is reported in order of levels, beginning with level one, Reception, and concluding with level five, Personal Challenge. Both the raw scores and weighted scores were presented for each SGA (*n*=18) identified the most applicable to the level. To identify which level the SGA should be placed in, data for each SGA was reviewed by instructional levels. The level with the highest percent agreement within the SGA was identified as the attribute the sample perceived to be the most applicable.

<u>Level 1: Reception</u>

Level one of the instructional scale involves organizing information logically and presenting the information in an efficient method, typically presented in a linear or sequential format so learners can later build on the information presented (Hokanson & Hooper, 2004). Participants selected level one the most frequently for one SGA, Language/Communication* (*n*=108; 76%). The SGA Language/Communication yielded an unweighted mean score of 100.4 (SD=9.83) from all participant groups and ranged from a raw score of 84 (level 5) to 108 (level 1 & 2), as supported by 76 percent of the sample. Data can be interpreted to suggest a shared belief among study participants that language/communication in serious games is perceived to be the most useful for receiving information, as compared to the other 17 SGAs. A more detailed synopsis of the implications of level 4 findings is discussed in chapter 5.

Level 2: Application

The second instructional level, Application, is focused on allowing opportunities to apply information without deeper level understanding of the concepts or theories behind the instruction. Drill-and-practice is considered to be on the application level, along with demonstration of knowledge (Hokanson & Hooper, 2004). Application is also included a linear relationship between the learner and the instructor posing simple questions or engaging in low level discussion, such as fact repetition or simple recall.

Participants indicated shared perceptions that eight SGAs would be the most applicable of the 18 attributes available. The SGAs that were the most frequently selected suggest participants' belief that the attribute would be most appropriately applied for the application or demonstration level of instruction. Data findings may suggest a shared belief that use of the SGAs in serious games are most useful for instruction at the application level. The SGAs for the second level held a high level of agreement within the sample, as 82 percent selected Rules/Goals, 77 percent selected Interaction – Equipment, 76 percent selected Language/Communication, 73 percent selected Pieces or Players, 70 percent selected Location, 70 percent selected Assessment, 69 percent selected Safety, and 67 percent selected Control, which are presented in order level of agreement from the of highest to the lowest percent for the sample (*N*=142).

Each SGA reported for the level will include the number of participants that selected the attribute (*n*), the weighted percent of the sample, the unweighted mean, standard deviation, and range. Rules/Goals (n=116; 82%) yielded an unweighted mean score of 99.6 (SD=14.88) from all participant groups and ranged from a score of 85 (level 5) to 116 (level 2). Assessment (*n*=99; 70%) yielded an unweighted mean score of 86.8 (SD=14.82) from all participant groups and ranged from a score of 62 (level 1) to 99 (level 2). Interaction-Equipment (*n*=109; 77%) yielded an unweighted mean score of 91.8 (SD=14.92) from all participant groups and ranged from a score of 71 (level 1) to 109 (level 2). Language/Communication* (*n*=108; 76%) yielded an unweighted mean score of 100.4 (SD=9.83) from all participant groups and ranged from a score of 84 (level 5) to 108 (level 1 & 2). Pieces or Players (*n*=104; 73%) yielded an unweighted mean score of 97.4 (SD=5.41) from all participant groups and ranged from a score of 91 (level 5) to 104 (level 2). Location (*n* =99; 70%) yielded an unweighted mean score of 91.8 (SD=5.71) from all participant groups and ranged from a score of 85 (level 5) to 99 (level 2). Safety (n=98; 69%) yielded an unweighted mean score of 89.2 (SD=5.21) from all participant groups and ranged from a score of 84 (level 5) to 98 (level 2). Control* (*n* =95; 67%) yielded an unweighted mean score of 81.8 (SD=17.62) from all participant groups and ranged from a score of 52 (level 1) to 95 (level 2 & 4). A more detailed synopsis of the implications of level 2 findings is discussed in chapter 5.

Level 3: Extension

Level three, Extension, is focused on extending prior knowledge to new situations or context where learners can recognize similar problems and identify the proper methods of solution. The SGAs identified as most useful for learning to extend to new situation were progress and adaptation (Hokanson & Hooper, 2004).

Participants indicated shared perceptions that two SGAs would be the most applicable of the 18 attributes available. The SGAs for the third level held a high level of agreement within the sample, as 79 percent selected Progress and 72 percent selected Adaptation the most frequently. Data findings for both SGAs are reported in order of highest instructional level to the lowest. Each SGA reported for the level will include the number of participants that selected the attribute (*n*), the weighted percent of the sample, the unweighted mean, standard deviation, and range. Progress (n=112; 79%) yielded an unweighted mean score of 98.2 (SD=18.74) from all participant groups and ranged from a score of 66 (level 1) to 112 (level 3). Adaptation (*n*=102; 72%) yielded an unweighted mean score of 77 (SD=24.8) from all participant groups and ranged from a score of 37 (level 1) to 102 (level 3). A more detailed synopsis of the implications of level 3 findings is discussed in chapter 5.

Level 4: Generation

Level four, Generation, is focused on a problem or question that drives the learning and learners have a flexible environment where they can identify and select the needed resources to solve the problem. As learners become confident in a knowledge domain, they "must eventually learn to generate or create their own solutions to complex problems" (Hokanson & Hooper, 2004, p.5).

Participants in the sample identified the most SGAs as being applicable to level 4, Generation, indicating a shared belief that of the five instructional levels, level four is the most applicable to serious games. Specifically, participants indicated shared perceptions that six SGAs would be the most applicable of the 18 attributes available. The SGAs for the fourth level held a high level of agreement within the sample, as 67 percent selected Control, 69 percent selected Fantasy, 77 percent selected Interaction- Social, 76 percent selected Mystery, 75 percent selected Interaction- Interpersonal and 70 percent selected Representation the most frequently. Data findings are reported in order of highest level to the lowest.

Each SGA reported for the level will include the number of participants that selected the attribute (*n*), the weighted percent of the sample, the unweighted mean, standard deviation, and range. Interaction- Social (*n*=109; 77%) yielded an unweighted mean score of 89.8 (SD=20.26) from all participant groups and ranged from a score of 59 (level 1) to 109 (level 4). Mystery (*n*=108; 76%) yielded an unweighted mean score of 86.2 (SD=17.62) from all participant groups and ranged from a score of 48 (level 1) to 108 (level 4). Interaction- Interpersonal (*n*=107; 75%) yielded an unweighted mean score of 93.2 (SD=17.69) from all participant groups and ranged from a score of 63 (level 1) to 107 (level 4). Representation (*n*=100; 70%) yielded an unweighted mean score of 92.2 (SD=8.55) from all participant groups and ranged from a score of 82 (level 5) to 100 (level 4). Fantasy (*n*=98; 69%) yielded an unweighted mean score of 84.6 (SD=16.19) from all participant groups and ranged from a score of 65 (level 1) to 98 (level 4). Control* (*n*=95; 67%) yielded an unweighted mean score of 81.8 (SD=17.62) from all participant groups and ranged from a score of 52 (level 1) to 95 (level 2 & 4). A more detailed synopsis of the implications of level 4 findings is discussed in chapter 5.

Level 5: Personal Challenge

Level five, Personal Challenge, was adapted from the Challenge level in the original taxonomy (Hokanson & Hooper, 2004) to reduce misinterpretation or bias of the instructional goals. Personal challenge represents the goals that the learners identifies and creates for themselves, elevating their learning to the highest level where self-motivation and self-evaluation take place (Hokanson & Hooper, 2004). Participants indicated shared perceptions that three SGAs would be the most applicable of the 18 attributes available. The SGAs for the fifth level held a high level of agreement within the sample, as 82 percent selected Challenge, 77 percent selected Surprise and 68 percent selected Conflict the most frequently. Each SGA reported for the level will include the number of participants that selected the attribute (*n*), the weighted percent of the sample, the unweighted mean, standard deviation, and range. Challenge (*n*=116; 82%) yielded an unweighted mean score of 80 (SD=31.7) from all participant groups and ranged from a score of 32 (level 1) to 116 (level 5). Surprise (*n*=109; 77%) yielded an unweighted mean score of 87.2 (SD=21.29) from all participant groups and ranged from a score of 59 (level 1) to 109 (level 5). Conflict (*n*=97; 68%) yielded an unweighted mean score of 80.6 (SD=24.8) from all participant groups and ranged from a score of 39 (level 1) to 97 (level

5). Within level five, Personal Challenge, participants narrowed the SGAs to those that are most relevant to designing games that allow learners to create their own unique problem, identified by themselves or others (Hokanson & Hooper, 2004). A more detailed synopsis of the implications of level 5 findings is discussed in chapter 5.

The strength of the relationship between instructional levels and subpopulations could not be determined from the current study due to the limited sample size of each subpopulation. However, when rank scores were applied to the frequency counts of instructional levels by subpopulation, patterns became evident. Three of the four subgroups (Instructional Designers and Teachers – higher education and K-12) ranked the all five levels the same in the same order. As a whole, the sample ranked the use of instructional levels for the 18 SGA as follows:

Rank Order

Level 4: Generation (*n*=1474)

Level 3: Extension (*n*=1455)

Level 5: Personal Challenge (*n*=1401)

Level 2: Application (*n*=1141)

Level 1: Reception (*n*=968)

Research Question Two: How do the epistemological beliefs, as measured by the Epistemic Belief Inventory (EBI; Schraw, Bendixen, & Dunkle, 2002), of instructional designers compare to those of game designers and teachers (higher education and K-12)?

To answer the second research question, the researcher ran correlations between participant subpopulations and each of the five factors in the EBI (simple knowledge, certain knowledge, innate ability, omniscient authority, & quick learning) to determine level of agreement. Findings indicate the strength of agreement the whole population has with each of the five EBI factors and for each participant subpopulation (instructional designers, game designer, K-12 teachers, higher education instructors). Before running correlations between the data, EBI score must be calculated for the suitability of the data, which can be achieved through factor analysis.

<u>EBI Factor Analysis</u>

To conduct factor analysis, there are three main steps: (a) assessing the suitability of the data, (b) factor extraction, and (c) interpretation (Pallant, 2010). To assess the suitability of the data, two considerations should be noted, the sample size and the strength of the relationship among the variables. A suitable sample size is not generally agreed upon among scholars, however recommendations within statistical analysis indicate "factors obtained from small data sets do not generalize as well as those derived from larger samples" (Pallant, 2010, p. 183). In contrast, others suggest a ratio between participants and items, such as 10:1 (Nunnally, 1978) or 5:1 (Tabachnick & Fidell, 2007), when the sample is less than 150 participants. To address the issue of the strength of the correlation among items, inspection of the correlation matrix coefficients was conducted and indicated sampling adequacy table 1 (Tabachnick & Fidell, 2007). Kaiser-Meyer-Olin (KMO) measure of sampling adequacy (ranging from 0-1, with 0.6 minimum) was used to determine if the EBI factors could be considered appropriate for factor analysis and was further supported with inclusion of the p level for Bartlett's test of sphericity (Pallant, 2010) which are detailed in table 1 and table 2. If EBI items that held less than a 0.3 coefficient for the sample were removed from analysis for the factor and subpopulation.

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.694
Bartlett's Test of Sphericity	Approx. Chi-Square	1367.998
	df	496
	Sig.	.000

<u>Assessing the suitability of the data</u>

Data was broken down 3 ways to determine appropriateness of factor analysis for the sample, EBI factors, and each subpopulation. Analysis was conducted for (a) assessing the suitability of the data, (b) factor extraction, and (c) factor rotation by verifying minimum levels of Kaiser-Meyer-Olkin measure of sampling adequacy ($KMO \geq 0.6$) and Bartlett's test of sphericity ($p<0.05$), checking the correlation matrix for values of 0.3 and above across the sample population (Pallant, 2010). Findings suggest sampling is adequate for factor analysis for the sample population (table 1), each EBI factor (table 2), and 2 of the 4 subpopulations (table 3).

A second relationship was analyzed to determine the strength of the relationship between the sample (N=142) and each belief factor (simple knowledge, certain knowledge, innate ability, omniscient authority, & quick learning) to identify acceptable Kaiser-Meyer-Olkin measure of sampling adequacy scores (KMO$\geq$0.6), and Bartlett's test of sphericity (p>0.05) (Morgan, Reichert & Harrison, 2002). Findings report acceptable KMO and p values for each of the five EBI factors (table 2). Analysis of the two measures provides evidence that the data collected is suitable for factor analysis.

Table 2: Sampling adequacy for EBI factors for sample (N=142)

	Simple Knowledge	Certain Knowledge	Innate Ability	Omniscient Authority	Quick Learning
KMO (*N*=142)	0.663	0.738	0.738	0.740	0.661
Chi square	141.414	149.758	197.807	79.841	98.643
df	28	21	21	10	10
Significance	*p*<.001	*p*<.001	*p*<.001	*p*<.001	*p*<.001

The third relationship the researcher analyzed was to measure the strength of the relationship between each subpopulation (instructional designers, game designers, higher education instructors, and K-12 teachers) and each belief factor (simple knowledge, certain knowledge, innate ability, omniscient authority, & quick learning), identifying alignment of each subpopulation with the EBI's five-dimension belief model based on acceptable Kaiser-Meyer-Olkin measure of sampling adequacy scores ($\geq$0.6), and Bartlett's test of sphericity (p>.05) (Morgan, Reichert & Harrison, 2002).

Results indicate that the data from three of the four subpopulations (instructional designers, higher education instructors, and K-12 teachers) is suitable for factor analysis.

Factor extraction

To determine how many components should be extracted, the initial eigenvalues in the total variance explained table (Appendix J) were examined (Pallant, 2010). For the sample (*N*=142) 10 components were identified as having an eigenvalue of 1 or greater (see Total, Initial Eigenvalue), which explains 64 percent of the variance across the sample (see Cumulative % column). However, inspection of the Scree Plot (figure 7) reveals it is more difficult to discern which items should be included in the findings.
In factor analysis, data is subject to factor rotation, specifically Varimax rotation when performed on statistical software. Rotation was set to yield five factors based on the structure of the EBI. Correlational coefficients above .3 were kept for analysis resulting in items: 2, 6, 23, 25 for Certain knowledge; 10, 11, 13, 18 for Simple knowledge; 5, 12, 17, 26, 32 for Innate ability; 16, 21, 29 for Quick learning; and 4, 7, 20, 27, 28 for Omniscient authority.

Table 3: Sampling adequacy for EBI factors for subpopulations

Simple Knowledge
Game Designers (n=21): Non significant (p=.177)
*Instructional Designers (n=55): Significant (p<.0001)
*Higher Education Instructors (n=35): Significant (p=.009)
*K-12 Teachers (n=31): Significant (p=.017)
Certain Knowledge
Game Designers (n=21): Non significant (p=.328)
*Instructional Designers (n=55): Significant (p<.0001)
*Higher Education Instructors (n=35): Significant (p<.0001)
*K-12 Teachers (n=31): Significant (p=.015)
Innate Ability
Game Designers (n=21): Non significant (p=.104)
*Instructional Designers (n=55): Significant (p<.0001)
*Higher Education Instructors (n=35): Significant (p=.023)
*K-12 Teachers (n=31): Non significant (p<.0001)
Omniscient Authority
Game Designers (n=21): Non significant (p=.134)
*Instructional Designers (n=55): Significant (p<.0001)
*Higher Education Instructors (n=35): Significant (p<.0001)
K-12 Teachers (n=31): Non significant (p=.561)
Quick Learning
Game Designers (n=21): Non significant (p=.479)
*Instructional Designers (n=55): Significant (p<.0001)
*Higher Education Instructors (n=35): Significant (p<.0001)
*K-12 Teachers (n=31): Significant (p=.048)

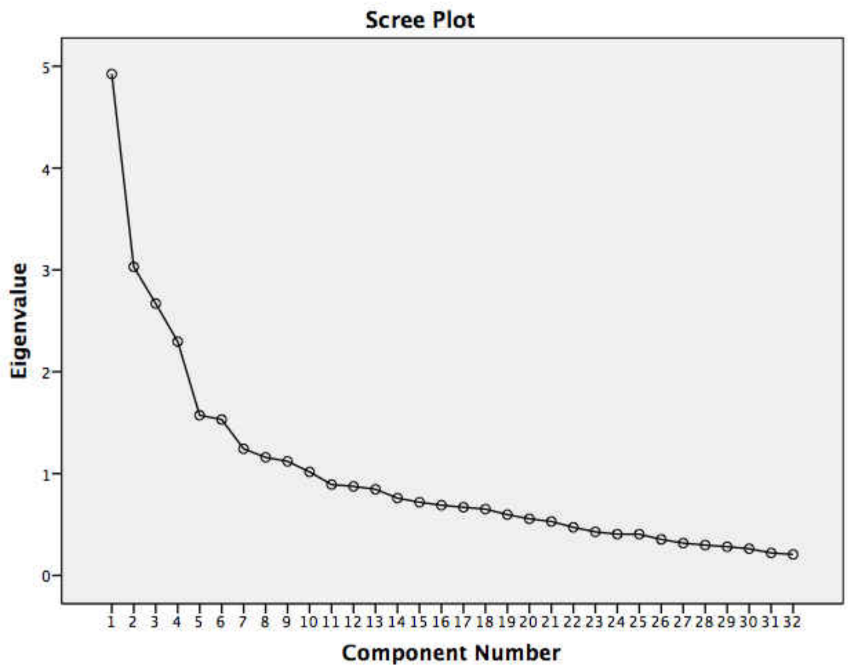


Figure 7: Scree plot of EBI items

EBI findings

To determine the epistemological beliefs for participants, the researcher followed procedures modeled in prior studies (Bays, Ashong, Ward, & Commander, 2014). To determine if the participant's viewpoint is naïve or sophisticated, individual EBI scores were generated by calculating the average of the survey items (n_{EBI}=21) included in the analysis, resulting in a sample mean of 2.434. Next, the sample (*N*=142) was analyzed according to the five factor model (EBI; Schraw, Bendixen & Dunkle, 2002), running separate mean scores for each factor. Findings are listed in order of the most naïve beliefs (high scores) of the sample to the most sophisticated beliefs (low scores). A mean score of 2.82 (*SD*=1.22) was calculated for Innate ability, 2.77 (*SD*=1.09) was calculated for Simple knowledge, and a 2.75 (*SD*=1.09) was calculated for Omniscient authority, indicating participants beliefs are slightly skewed toward naivety on an individual's innate abilities, simple knowledge and omniscient authority. A mean score of 2.43 (*SD*=1.11) was calculated for Certain knowledge. The mean score is right at the cusp of naïve and sophisticated beliefs indicating prominence of both viewpoints in the sample. A mean score of 1.61 (*SD*=0.56) was calculated for Quick learning, indicating a more sophisticated view on individual's quick learning.

Research Question Three: What differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?

To address the qualitative component included in the survey, the researcher analyzed data from the narratives provided by study's participants (*n*=72) to identify the themes, patterns, or other data attributes to emerge. The question and analysis is focused on a single case around research question three; the use of models (instructional design or game design) that participants used when designing games. Furthermore, analysis is embedded within the larger study, in that questions were direct in regard to models, not open to the global experience of designing games. Data was collected through one question at the end of the card sort activity. A large portion of the population made clear indications that they either did not design games or did not use any models. Participants responses on the survey item was limited and consequently ethnographic techniques of analysis could not be conducted because there was not enough narrative evidence to support the method. For those that reported using models or design games, thematic coding was employed to identify patterns and reanalyzed for themes between groups of participants. Data is first presented in terms of narrative responses by each subpopulation and then discussed in relation to epistemological beliefs in chapter five.

Researchers first reviewed data on the sample (*N*=142) as a whole to gain sense of the data more holistically. Once participants that addressed the question were identified, microanalysis was conducted on models identified as being used for game design. Participant responses were then color coded within the data according to themes surrounding the main research question and subpopulation: *What differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?* Once responses were organized by subpopulations, emergent themes were recorded. Patterns of perceptions of learning theories emerged in the form of layers within the data from the 25 models, theories or frameworks participants provided. Each layer was coded and specific instances were recorded to allow for later analysis of any themes that may have appeared across multiple layers. The researcher then examined the data for evidence of patterns between subpopulations to provide a more detailed picture of the models being used in serious gaming. In essence, the researchers sought to identify threads that ran across each layer and to identify any commonalities between layers.

Of the 25 unique responses (removing duplicates, non response), only 3 models were identified by more than one participant subpopulation, ADDIE model, Mayer's Multimedia Principles, and Problem based learning (PBL). The distribution of models, frameworks and theories are presented in figure 8.

Models	**GD**	**ID**	**HE T**	**K-12 T**
ADDIE	◆	◆	◆	◆
ARCS		◆		
Bartle's Test	◆			
CCAF matrix		◆		
Component Display Theory		◆		
Cognitive Load Theory		◆		
Crawl, Run, Walk			◆	
CyGaME Metaphysics		◆		
Dick & Carey			◆	
Fullerton's Game Design Suggestions			◆	
Gagne's 9 Events		◆		
Gee's 4C/ID		◆		
Kemp	◆			
Malone's Curiosity, Fantasy, & Challenge		◆		
Mayer's Multimedia	◆	◆		
MDA	◆			
MUD	◆			
PBL	◆	◆		
Pyramid of Learning			◆	
Rapid Prototyping		◆		
Schank's Goal based Scenarios		◆		
Split Attention Affect		◆		
UBD	◆			
Van Merrienboer Complex Steps			◆	
Waterfall	◆			

Figure 8: Responses from participants on models used for serious games

<u>Game designers</u>

Of the game design participants that completed the survey (*n*=21) and responded to the qualitative question (*n*=12), 2 participants indicated that they did not use any game design or instructional design models to design games. Several models (*n*=9) were identified (ADDIE, Kemp, MDA Framework, MUD, Bartle Test, Mayer's multimedia principles, User Based Design (UBD), PBL and the Waterfall with sub-projects model). Narratives were provided from two game design participants and portray similar points of view in that both individuals indicate the importance of embracing flexibility in the game environment. Participant 135 is clear in his narrative,

> "In my opinion the biggest flaw in current educational games and tools is lack of adaptive difficulty and modes of instruction. When a player is forced to deal with a disagreeable system, they will learn to cheat rather than give an honest effort" (part 135). Not one model fits all "I don't think there is any one model that will work for all player types (http://en.wikipedia.org/wiki/Bartle_Test)" (Participant 135).

Where as, Participant 31, went into the nuances of the processes and procedures of designing an educational game.

> "…Games are very good at one thing: teaching people how to play them. That means if your game and learning objectives are properly aligned, you can more easily move students closer to the target skill/content using the game's mechanics as leverage. When advising others on how to build their own game-based learning tool, I recommend starting with a UBD design model (i.e., a top-down approach built out of the target learning objectives). Many educational game designers mistakenly neglect the alignment of game and learning objectives, which mean learners aren't being guided to perform the actions or demonstrating the skills we want them to transfer to the real world. The most effective way to encourage that transfer is to pair game and learning objectives at a 1:1 ratio, have students fulfill

the objective(s), and then reflect on it/them with the help of a more knowledgeable other (e.g., instructor) … Once we're confident in our answers, we begin structuring course objective(s) above unit objectives above individual lesson objectives. This gives us an idea of how everything should fit together and serves as a backbone for the game narrative (NOTE: we most frequently build text-based games, so the following recommendations are tailored around that approach over a digital/virtual environment, but I'd argue the two only really differ in terms of presentation/modality). It often helps to view things from the student perspective: if you're a student in the class, what's the story you're going to tell about school when you go home at night? … [W]e start building a story and characters to provide the students with the scaffolding necessary to meet the learning objectives … The key is to make sure you never lose sight of your learning objectives… I can't overstate the importance of this 1:1 alignment enough--it's the single-biggest missing element I find when evaluating educational game mechanics (despite how obvious it might seem)… You won't be able (and shouldn't try) to predict how students will control their characters, but you should consider how you might respond to positive, negative, and neutral behaviors. If a student gets off track, how will you re-engage them? … We call this a "sandbox-on-rails" system: students can act freely within an individual immersion session, but we continue pressing ahead to meet the linchpin moments/learning objectives/prompts described above (i.e., the equivalent of riding in a sandbox traveling on a train track--you can do what you like in the sandbox, but you'll

> always be moving ahead to the next station stop). Finally, we try to outline reflective discussion that follows play. What questions will you ask to help students see the invariance between the game experience and the real world? How will they transfer their newly learned skills? What relationship do the ideas/concepts from the story have with their day-to-day lives? This is the make or break moment for a text-based adventure since it determines how and to what extent meaningful learning has unfolded" (Participant 31).

Instructional designers

Of the instructional design participants that completed the survey (*n*=55) and responded to the qualitative question (*n*=32), 10 participants indicated that they did not use any game design or instructional design models to design games. Several models (*n*=14) were identified (ADDIE model, ARCS model, CCAF matrix, Component Display Theory, Cognitive load Theory, CyGaME Metaphysics, Gagne's 9 Events, Gee's 4C/ID model, Malone's curiosity, fantasy & challenge, Mayer's principles of multimedia design, Problem based learning, Rapid prototyping, Schank's goal-based scenarios, and Split attention affect), indicating the varied viewpoints within the instructional design community. Within the subgroup, the model that was put forth the most frequently was ADDIE (Analyze, Design, Develop, Implement, Evaluate), however many of the theories and models presented by the subgroup contain elements of the ADDIE model, so further analysis was conducted on the elements within the models. Each model put forth was categorized into one of the domains of learning theory discussed in chapter two (e.g., cognitive, behavioral) or other. Narratives are not presented in this section because participants chose to list models and theories rather than include narratives on the processes and procedures that influence their design decisions.

<u>Higher education instructors</u>

Of the higher education instructor participants that completed the survey (*n*=31) and responded to the qualitative question (*n*=18), 7 participants indicated that they did not use any game design or instructional design models to design games. Two participant responses could not be coded based on the information provided and one stated "yes" without providing any further information (participant 68), but failed to elaborate on the models used, and the other participants did not state if they did not did not use models, rather stating that they could not think of one "in particular" (101). One narrative was provided, stating "I use role-playing games to design specific classroom experiences, based on the unique learning outcomes intended for each class. I tweak existing games or design my own games for these purposes with an eye to maximum flexibility in application" (49). Remaining qualitative data provided insight around the question but did not specifically identify any models, tools, or frame works; as stated by one response, "I use various tools, like Hot Potatoes, to create games" (34). An additional 3 participants stated that they have not designed a game before.

The 6 participants that put forth models, frameworks, or theories used when designing games produced additional responses not yet captured by the other participants subpopulations, with the exceptions for the ADDIE (*n*=2) model being the only example provided more than once for the subpopulation. Higher education instructors identified as using Van Merrienboer's Complex Steps, Dick and Carey's model, Crawl, walk, run, Pyramid of learning, and Fullerton's game design workshop suggestions.

K-12 teachers

Of the K-12 teacher participants that completed the survey (*n*=31) and responded to the qualitative question (*n*=14), 12 participants indicated that they did not use any game design or instructional design models to design games. Of the two responses that contained information, one participant indicated that they use the ADDIE model, which is an instructional design model, while other participant indicated that they use games and technology that are readily available online. Some insight was shared by one individual that stated, "… my thinking about game models have been shaped by the book "Finite and Infinite Games: A Vision of Life as Play and Possibility" by James Carse" (18).

Summary

Chapter four sought to describe the findings of the study through analysis procedures deemed appropriate for each research question. Analysis indicates that the factors contributing toward epistemological beliefs of the participants were skewed toward naivety with the exception of Quick learning, where the sample mean portrayed more sophisticated viewpoints. The subpopulations surveyed viewed SGAs differently from each other as represented by frequency counts and weighted means. However, the qualitative analysis served to me the most revealing in that 25 models, frameworks, or theories were identified from all subgroups, generally unique to each subpopulation. The next chapter aims to provide a more global discussion on the findings of the study in relation to current and future implications of the serious games for learning and the fields that implement, evaluate and design them.

CHAPTER 5
DISCUSSION

Introduction

Chapter five seeks to provide a review of the study, a discussion of findings and implications for practice, policy, and future research. Specifically, the chapter will summarize the components that informed the study including the purpose, sample, research design, and research questions before providing a discussion around the study's implications and recommendations. The study sought to examine individuals that design, develop, and integrate serious games to inform current practice and future research in regard to using serious games as an instructional strategy in classroom environments.

The central purpose of the study was twofold; to better understand how instructional designers, game designers and teachers perceive serious game attributes in terms of instructional capabilities, and to gain insight into the epistemological beliefs (beliefs about learning) of each subpopulation. Each subpopulation was selected based on their role in implementing, evaluating or designing serious games (SG) for learning environments. The researcher employed an online survey on participants' beliefs about learning (EBI; Schraw, Bendixen & Dunkle, 2002) and a forced card sort activity, where participants identify each instructional level (Hokanson & Hooper, 2004) for which the SGA could be used. Card sort findings were analyzed using a q methodology through an online forced card sort on serious game attributes (SGA) and the instructional levels, in which they could be utilized for learning. Participants' included instructional designers, game designers, higher education instructors and K-12 teachers. Participants epistemological beliefs were also analyzed according to a five factor model (EBI; Schraw, Bendixen & Dunkle, 2002), to determine suitability of data for analysis and EBI items that were significant for the sample. Correlational coefficients above 0.3 were kept for analysis resulting in items: 2, 6, 23, 25 for Certain knowledge (*M*=2.43); 10, 11, 13, 18 for Simple knowledge (*M*=2.77); 5, 12, 17, 26, 32 for Innate ability (*M*=2.82); 16, 21, 29 for Quick learning (*M*=1.61); and 4, 7, 20, 27, 28 for Omniscient authority (*M*=2.74). Data findings indicate that overall, the participants in the sample hold naïve beliefs about learning on three of the five factors measured in the EBI; Simple knowledge, Innate ability, and Omniscient authority. The mean score for Certain knowledge was at the population average, indicating neither naïve or sophisticated beliefs for the sample. Quick learning was the only epistemological factor for which participants held a sophisticated viewpoint.

Three research questions provided a framework for the study, focusing on the connections between instructional decisions and beliefs about learning. Each was revisited with a synopsis of the findings.

Research Question 1:What serious game attributes are most frequently selected for the sample and each subgroup (game designers, instructional designer, higher education instructors, and K-12 teachers) for each level of teaching?

The first research question sought to capture and quantify the instructional decisions made by each subpopulation. For each SGA, participants were asked to indicate what instructional level the attribute could be used at. To identify any emergent patterns within instructional levels (Hokanson & Hooper, 2004) or participant groups, frequencies and weighted means were calculated for each SGA and grouped by subpopulation. Across participant subpopulations (*N*=142), two SGAs were identified as being perceived as useful at lower instructional levels (Interaction/Equipment and Rules/Goals) and seven were identified as being perceived as useful for higher instructional levels (Challenge, Fantasy, Interaction-Interpersonal, Interaction-Social, Mystery, Conflict and Surprise).

The remaining SGAs had less consistent patterns between subpopulations on the instructional level. Data from four SGAs (Adaption, Assessment, Progress and Representation) resembled a normal bell curve when instructional levels were examined from level one to level five, indicating a perceived need for each attributes at all levels, but with varied systematic use. Unique patterns of selection were also found in five SGAs (Language/Communication, Safety, Pieces & Players, Location and Control), which cannot be explained. There are multiple reasons why participants may have selected different instructional levels for each SGA, including participants' level of understanding of serious game attribute functionality or purpose, or participants' may have perceived that attributes are needed to support major views of thought, as expressed in the models and frameworks put forth.

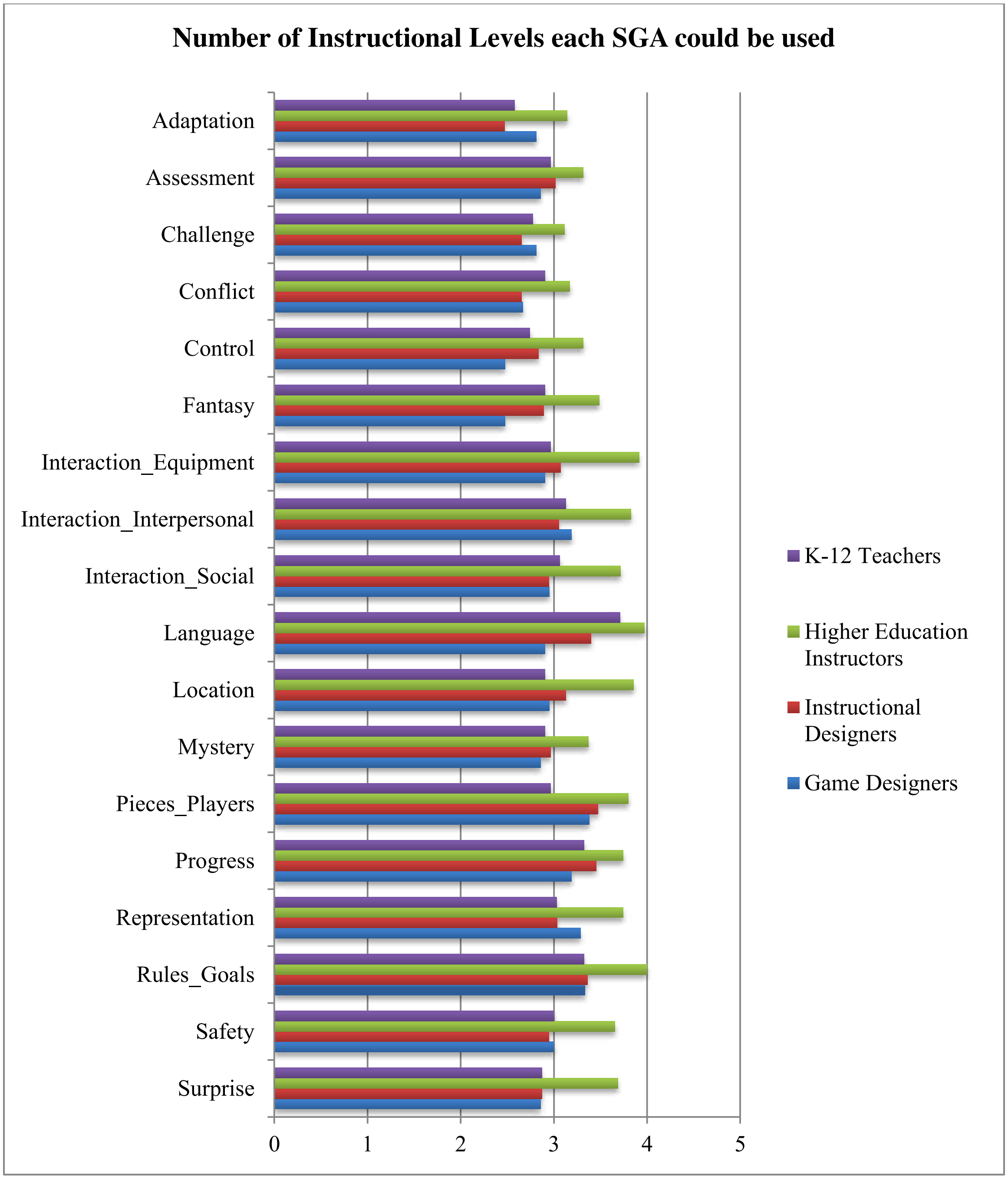


Figure 9: Average number of instructional levels selected by each subpopulation

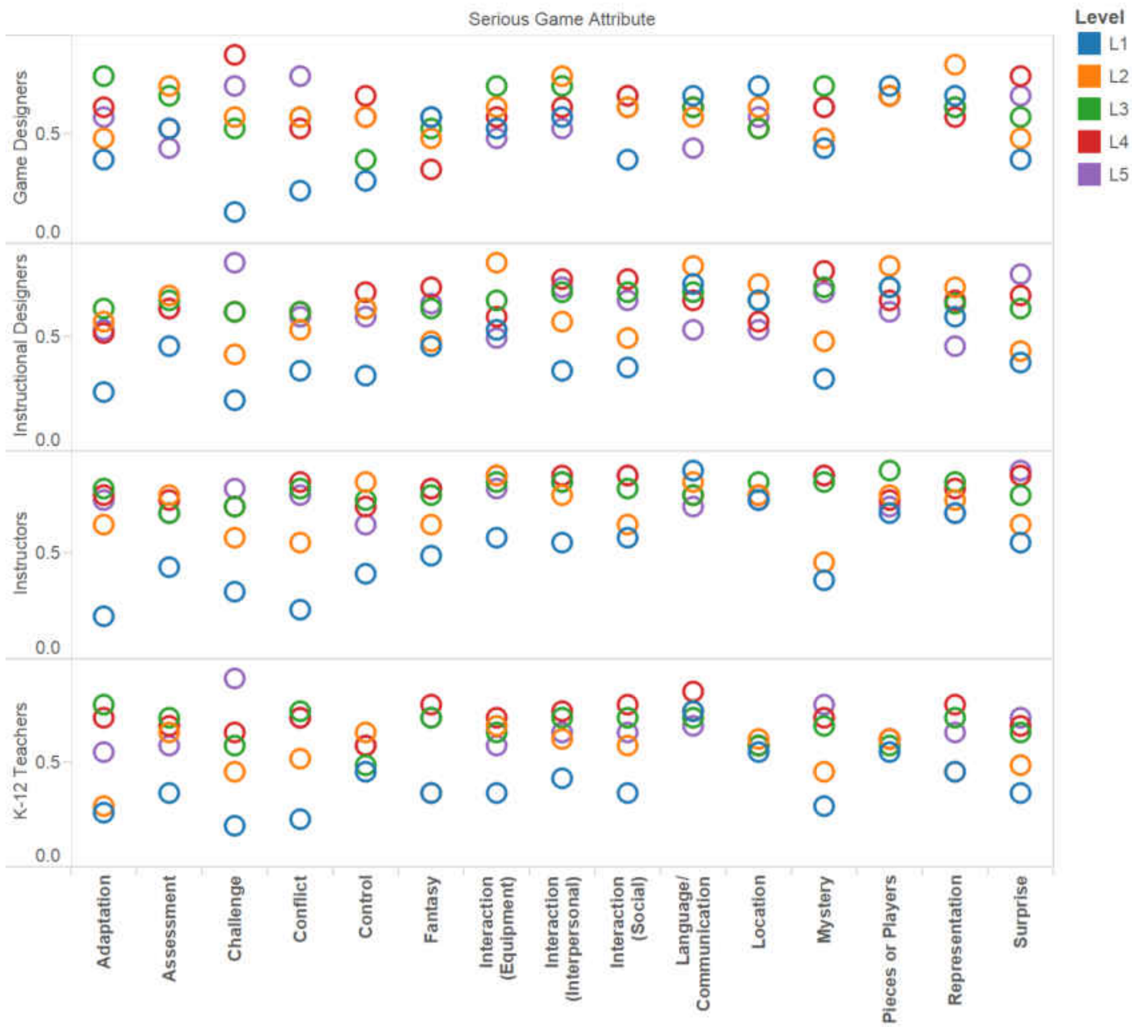


Figure 10: Graph of weighted subpopulation's selection of SGA by instructional level

Figure 5 and 6 portray the weighted frequency counts for number of instructional levels selected (figure 5) and percent of subpopulation that selected each instructional level for each SGA (figure 6). The first of the two charts shows indications of the variance between the group means for each SGA. Instructional designers have a higher mean on all SGAs, indicating an overall belief within the subpopulation that SGAs can be used at more levels of instructional than the other subpopulations captured. Furthermore, all subpopulations indicated that rules and goals, progress, and language/communication are the most versatile SGAs of those presented.

Figure 11 shows patterns of perceptions that the SGA are more appropriately used at higher instructional levels (levels 3-5), than lower levels (level 1-2).

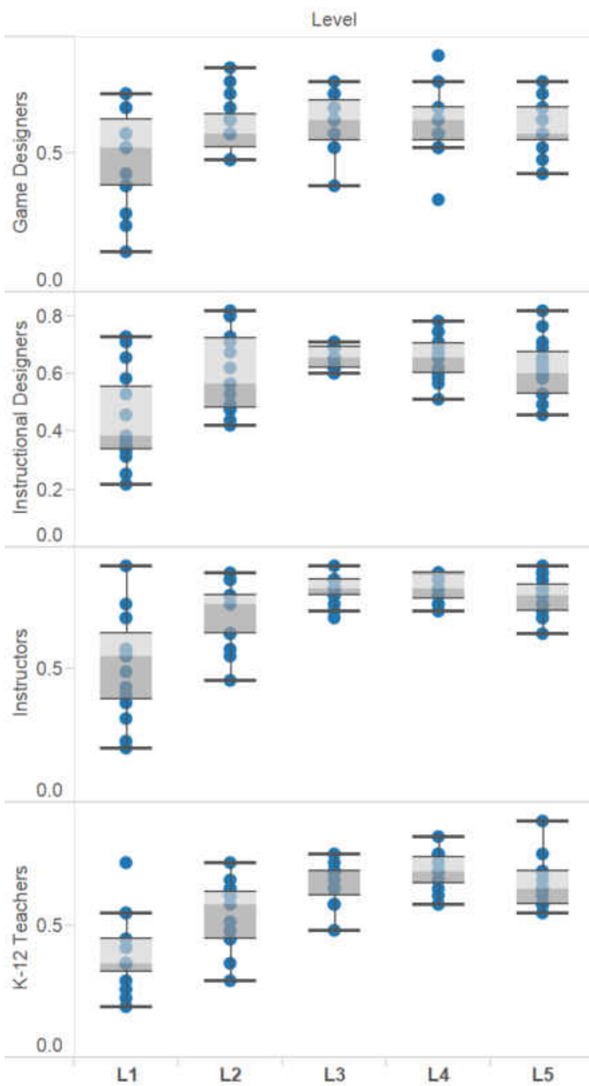


Figure 11: Histogram of each subpopulation's selection of instructional levels

Research Question 2: How do the epistemological beliefs of instructional designers compare to those of game designers and teachers (higher education and K-12)?

The second research question sought to examine the five factors of epistemological beliefs related to structure of knowledge, certainty of knowledge, source of knowledge, and beliefs about nature of ability and learning, which translate to five factors (a) simple knowledge, (b) certain knowledge, (c) innate ability, (d) omniscient authority, and (e) quick learning (Schraw, Bendixen, & Dunkle, 2002; Schrommer, 1990;).

Participants' epistemological beliefs varied between subpopulations; however all subgroups were comprised of individuals possessing naïve beliefs and sophisticated beliefs about learning. Overall, the beliefs of the sample population were skewed toward more naïve beliefs in all EBI factors with the exception of Quick learning. It is also notable that the professions that each individual felt most closely related to, within the given choices, organized each subpopulation. There may be factors outside of participants' profession that contribute to how each participant view learning, which were not measured in the current study. Summaries of the total EBI scores (all 5 factors) are presented for each group with sampling adequacy. Each subpopulation will be compared to the sample (*N*=142) because results are note generalizable to populations outside of the sample examined.

Instructional Designers

Instructional designers (n=55) made up the largest subpopulation within the study and had significant agreement ($p \geq 0.05$) with all five factors in the EBI (simple knowledge, certain knowledge, innate ability, omniscient authority, & quick learning). Overall the instructional designers' EBI factors scores were consistent with the other subpopulations examined (figure 12). Individual EBI scores were calculated for each participant, and instructional designers' scores ranged from 1.59 – 3.03, with a Mean of 2.37. The EBI scores are on a five point scale, with 1 indicating sophisticated beliefs and 5 indicating naïve beliefs. Examining the subpopulation by two groups, those above the sample mean (M_{EBI}=2.434), and those below it. Thirty instructional designers (M_{IDs}=2.14, SD_{IDs}=0.25) within the sample portrayed moderately sophisticated beliefs of learning with EBI scores below the sample mean, while twenty-five instructional designers (M_{IDn}=2.64, SD_{IDn}=0.14) portrayed more naïve beliefs of learning. Instructional designers as a whole skewed toward more sophisticated beliefs within the participants' that completed the survey. Within the four subpopulations, instructional designers ranked as having the most sophisticated beliefs about learning.

Game Designers

Game designers (n=21) made up the smallest subpopulation within the study and consequently failed to have ample participants to yield sampling adequacy. Therefore no further statistical analysis or significant relationships should be drawn from game designers' in regard to epistemological beliefs. However, the game designers in the sample did yield similar EBI factor scores and portray related patterns to the other populations investigated as can be seen in figure 12. For discussion scores are reported, but should not be considered significant. Individual EBI scores were calculated for each participant, and game designers' scores ranged from 2.03 – 3.25, with a Mean of 2.48. The EBI scores are on a five point scale, with 1 indicating sophisticated beliefs and 5 indicating naïve beliefs. Examining the subpopulation by two groups, those above the sample mean (M_{EBI}=2.434), and those below it. Nine game designers (M_{GDs}=2.22, SD_{GDs}=0.11) within the sample portrayed moderately sophisticated beliefs of learning with EBI scores below the sample mean, while twelve game designers (M_{GDn}=2.68, SD_{GDn}=0.23) portrayed more naïve beliefs of learning. Of the participants that completed the survey, game designers were ranked third in regard to subpopulations with highest level of sophistication of beliefs about learning.

Higher Education Instructors

Higher education instructors (*n*=35) made up the second largest subpopulation within the study and aligned with all five factors in the EBI (simple knowledge, certain knowledge, innate ability, omniscient authority, & quick learning) for sampling adequacy. Individual EBI scores were calculated for each participant, and higher education instructor's scores ranged from 1.41 – 3.28, with a Mean of 2.45. Examining the subpopulation by two groups, those above the sample mean (M_{EBI}=2.434), and those below it. Fifteen higher education instructors (M_{HE}=2.13, SD_{IDs}=0.29) within the sample portrayed moderately sophisticated beliefs of learning had EBI scores below the sample mean, while twenty higher education instructors (M_{IDn}=2.68, SD_{IDn}=0.23) portrayed more naïve beliefs of learning. Of the participants that completed the survey, higher education instructors ranked second in regard to subpopulations with highest level of sophistication of beliefs about learning.

<u>K-12 Teachers</u>

K-12 teachers (*n*=31) made up the third largest subpopulation within the study and aligned with four of the five factors in the EBI (simple knowledge, certain knowledge, innate ability, & quick learning) for sampling adequacy. Individual EBI scores were calculated for each participant, and K-12 teachers' scores ranged from 1.78 – 3.19, with a Mean of 2.56. Examining the subpopulation by two groups, those above the sample mean (M_{EBI}=2.434), and those below it. Eleven K-12 teachers (M_{HE}=2.19, SD_{IDs}=0.19) within the sample portrayed moderately sophisticated beliefs of learning had EBI scores below the sample mean, while twenty K-12 teachers (M_{IDn}=2.68, SD_{IDn}=0.21) portrayed more naïve beliefs of learning. Of the participants that completed the survey, K-12 teachers ranked fourth in regard to level of sophistication of beliefs about learning.

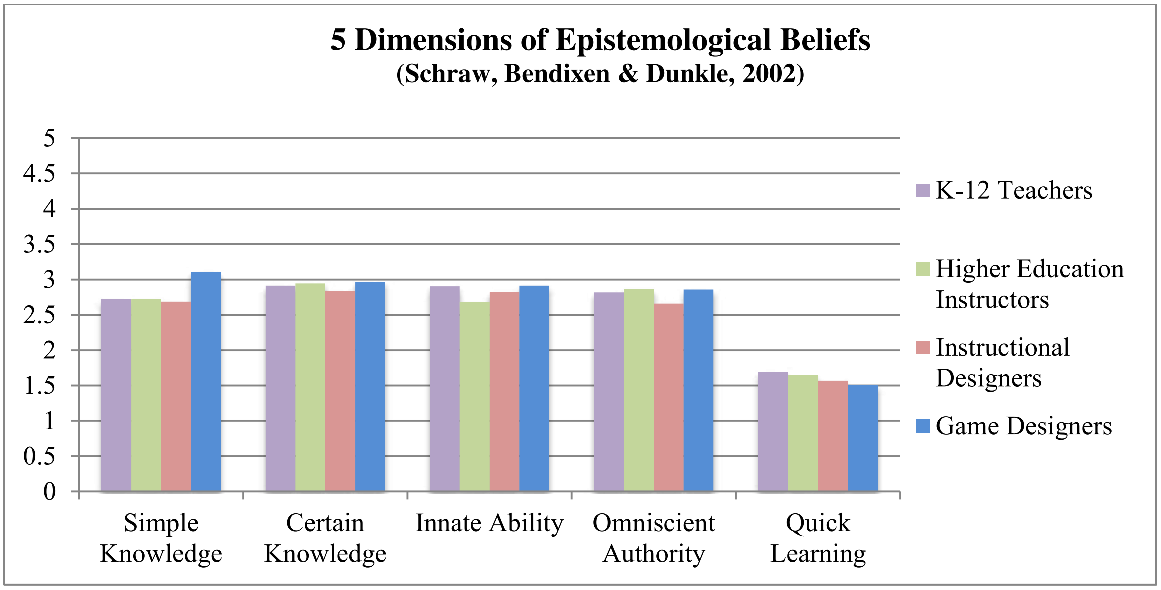


Figure 12: EBI factor scores by subpopulation

Research Question 3: What differences, if any, exist in the instructional models or game models that are being used by instructional designers, game designers and teachers?

A total of 25 models, frameworks or theories were put forth, of which, game designers and instructional designers identified 20, while higher education instructors added 5 unique models (Appendix P). While 80 percent of the models identified where from two subgroups, it should be noted that all populations held similar perspectives on the use of each SGA when scaffolding for learning. While K-12 teachers indicate that they “do not design games” and some go to far to express that they “don’t like video games,” findings support a shared understanding of differentiating SGA by instructional outcome, in relation to the choices made by instructional designers, game designers, and higher education teachers.

The participant responses of models and frameworks could be tied back to multiple paradigms of learning; cognitivist, constructivist, and behaviorist principles. However, responses were interwoven between participant groups, with some participants suggesting multiple models from differing paradigms. The ADDIE model was the only overlapping response that was provided by each subpopulation. The limited overlap between models indicates there is a wide variance of design tactics being employed within the design community. It comes to little surprise that both populations of designers would be best able to identify models and frameworks, but little is still known on what models are best for desired learning outcomes though serious games. Within the current dataset, it is not possible to disentangle participant groups with paradigms of learning, suggesting factors outside of learning paradigms contribute to the decisions to use models and frameworks used when designing games.

Contributions to the Field

The study was guided by two central aims; to identify relationships between the mental models put forth by each subpopulation when selecting serious game attributes and to provide insight into each subpopulation's beliefs about knowledge acquisition. It has been posited that beliefs can be deeply rooted in an individual's persona and be powerful enough to influence instructional practice (Gill & Hoffman, 2009). When designing learning environments, designers and developers make decisions on the instructional habits and norms for the environment. When making those decisions, they rely on multiple factors, one of those being their beliefs about how people learn, i.e., epistemology. Measuring factors that constitute an individual's epistemology help identify commonalities and differences in beliefs about learning, which may support differences in use of SGA by instructional levels. However, all subgroups in the sample held similar viewpoints, as measured by the EBI. Specifically, each subpopulation in the sample included participants with a range of epistemological beliefs, however EBI mean scores indicate participants' belief of Simple knowledge, Certain knowledge, Innate ability, Omniscient authority were on average between 2.5 and 3; indicating all subpopulations hold similar beliefs on four factors. Quick learning was the only factor on the EBI where participants expressed more sophisticated viewpoints. Sophisticated views of Quick learning suggest participants have a deeper understanding of the knowledge acquisition process, in that learners are unique and have individual paces for instruction.

Findings from the current study support the notion that individuals that design, develop, or implement serious games utilize unique mental models of serious game attributes when translating to educational goals, when expressed through instructional levels and serious game design models used. While the research on learner's interactions and experiences with serious games has grown, limited research exists on the design models, processes, and optimal collaboration scenarios for improving serious games through design or implementation. As participant 31 stated, "many educational game designers mistakenly neglect the alignment of the game and learning objective, which mean learners aren't being guided." This narrative evidence suggests that game designers may be employing a form of classroom management techniques through the design of the game, keeping learners focused on the primary objectives of the game, which are in turn correlated with the instructional objectives.

Findings indicate the suitability of each subpopulation as a resource, and recommendations suggest adapting serious game design teams to be inclusive of experts from all fields vested in creating high quality serious games. Teams should hold representation from instructional design, game design and the appropriate level educator (K-12 or higher education) to collaborate on designing serious games. Capturing subgroups' subtle perceptions of instructional use of each SGA opens doors to conversations around factors that can effect adoptions of serious games. Also, comparisons between subgroups' perceptions and EBI factors can better inform educational training and practice in serious game design and K-12 classroom implementation, focusing on designing instruction to be inclusive of learning through game play and tying the objectives back to in class activities that are out of the game environment.

Implications

Implications from research are a means for the researcher to inform research and practice about expected and "unexpected findings or patterns that emerged from the data and report a range of evidence to support assertions or interpretations presented." (Stainback and Stainback, 1988, p. 80-81). Based on the findings, there are multiple implications that can be drawn, including considerations for practice and future research.

Practice

With the proper training, resources, attitude and support serious games could hypothetically be integrated into classrooms as an instructional tool for personalized learning and alternative strategy for assessment reporting for all learners (Gallegos, Kepple, & Bukaty, 2015; Hirumi, 2010; Ketelhut & Schifter, 2011; Taylor & Todd, 1995). In the last few decades, the Department of Education has been supporting research to ensure that all students can learn in an inclusive setting. Since the No Child Left Behind (NCLB) 2001 and the Individuals with Disabilities Education Act (IDEA) 2004 were introduced, federal funds were re-appropriated to support scientific based research of inclusion models, in turn changing implementation tools and techniques in classrooms. Moving forward to the challenges of today, educators' implementation challenges have increased with differentiating curriculum to new standards while accommodating for each learner's personalized needs, at each step of instruction.

Modern techniques in data tracking afford opportunities to examine learner processes though their data trail, logged through mouse clicks. If the strategies and process used to differentiate the instruction for learning goals were tracked and vetted for effectiveness, instructional practices could systematically be improved for design and implementation. For example, within serious games SGAs that are believed to support specific learning outcomes could also be tracked in the game through analytics to further identify what game characteristics are most conducive to learning across populations.

Teachers work to identify sound instructional practices and the implementation of serious game within a classroom to meet the needs of their learners. In order for K-12 teachers to determine if a serious game is a suitable strategy for reaching an instructional objective, they need to be able to have a basic understanding of what SGAs can be used to target each level of instruction. One such approach is to remove barriers and support teachers integrating game play as an instructional strategy to achieve learning objectives, inclusive of instructional pre and post debriefings and feedback, supporting the connections between game play and instructional objectives (Hays, 2006). Instructional designers should also work toward including educators (higher education or K-12 teachers) in the planning phase of the design process for better alignment of the design with implementation.

Alignment of common core curriculum with student serious game play and game development could systematically work toward addressed the technological challenges (Johnson, Adams Becker, Estrada, & Freeman, 2015) faced by the educational community and increase complex understanding. If proper training on using serious games as an instructional strategy was integrated into preservice teacher programs, educators would be more well equipped to handle the disruptions that are associated with classroom integration of games such as subversion of rules, loss of control, and time management (Hirumi, 2010).

Another concern is the amount of instructional time needed to invest into a game to see learning gains. During the instructional time that is accumulated by the serious game, the educator is released from control of the student's learning process (Hirumi, 2010). The release of control and while still holding primary responsibility for students' learning gains could be viewed as risky for teachers due to the impending accountability policies on the horizon that hold teachers personally responsible for annual student learning gains.

Research

Articles on SGA are becoming more prevalent in instructional design research, but limited investigations, empirical or conceptual, include the perceptions of the fields that design the games. To implement change in a system it is important to address several layers of an organization. Within education, administrators need to buy-in to a concept for the change to occur. In 2013, a study was conducted on school leaders, identifying their knowledge, perceptions and current use of a flexible framework, universal design or learning (UDL), which is comprised of three main principles. The researchers used purposeful sampling to identify school leaders (n=15) conceptions, knowledge, and practices held by administrators in regard to the role of the UDL framework supporting all learners. Findings gave “insight into the essence of school leaders beliefs, knowledge and practices about UDL” (Berquist & Sadera, 2013, p. 3038), but no such examination has taken place around associated strategies of implementation, such as serious games. Chita-Tegmark, Gravel, Lourdes B. Serpa, & Domings published an article relating how the Universal Design framework could be extended to “better capture the way that learning is influenced by cultural variations, and illustrate how the UDL framework can be used to create a culturally informed curriculum that is useful to improving education of all learners globally” (2011/2012, pp. 21-22). Other researchers such as Lee and Picanco, have extended the UDL framework on curriculum to include the three principals. They suggest aligning the UDL methods of presentation with the phases of learning, to provide a practical example of how content on multiplication could be placed the UDL framework that breakdown methods of implantation for classroom teachers. If school teachers and administrators could come together on the idea of using UDL framework to culturally support all learners, then there is room for suggestions on how to develop and moderate personalized, flexible environments that are adaptive to learner's needs. Prior findings helped lay the groundwork on buy-in of school administrators toward adaptive frameworks and beliefs, but more research needs to be conducted in this domain and extend to methods of implementation.

Recommendations

The K-12 Horizon Report (Johnson, Adams Becker, Estrada, & Freeman, 2015) identified significant challenges impeding technology adoption in K-12 education that align national curriculum goals based on research, policies, and current practice. The challenges brought to light were organized into three categories; solvable (creating authentic learning opportunities), difficult (personalized learning), and wicked (teaching complex thinking). If the progression of research continues toward building strong connections between game attributes and specific learning outcomes then it is foreseeable that serious games, and individuals that design them, to welcome a viable strategy for classroom instruction. If serious game attributes can be linked with learning outcomes and organized by instructional levels, teachers would be able to best implement games into instructional sequences.

To make serious games a viable option for K-12 schools, games need to be aligned with instructional objectives and have integrated curriculum components that are appropriate for instructional curriculum. In order for the curriculum alignment to take place, several recommendations would have to be put into place. First, policy would have to embrace serious games as an instructional tool and provide guidelines to characteristics of games that are allowed in schools, an approval process, and so forth. On the research side, game designer's instructional design techniques should be more methodically captured to better understand the relationships between serious game attributes, game outcomes, and instructional outcomes. It can also be argued that under the assertion that game designers can best portray the models and techniques used in game design, teachers can similarly portray the effective models and techniques used in classroom learning to collaborate on serious of best practices for implementation, debriefing, and discussions to maximize the instructional potential of serious games.

Findings from the this study indicate educators had more variance or discourse in perceptions of how SGA can be used according to the instructional level presented as compared to the other disciplines surveyed (Hokanson & Hooper, 2004). Having more variance indicates less of a shared understanding of the SGA, so more research on teachers' knowledge and mental models of SGA should be explored. The process of designing instructional environments should be based on theory to continue to support improving serious games and providing evidence-based best practices for teachers. Elevating teachers' foundational knowledge of how serious games can be implemented for classroom practices would enable teachers to join the conversation on the design of game curriculum and further analysis can be run to see if their inclusion is effective.

David RM (Michael), established author in serious game design, foreshadowed the potential role for game designers in developing serious games when discussing the difference between entertainment games and serious games, specifically “the techniques game developers use in entertainment games are quite transferable. In fact, game developers may have a competitive edge because many of the processes and technologies are similar” (Michael & Chen, 2005, p. 29). If effective instructional outcomes can be sequenced, the instructional patterns can be systematically investigated to build instructional programs, which can be personalized for individual student needs. Some serious games have already adopted the notion of embedded formative assessment, dynamic assessments are serious games with embedded codes to collect data trails on learners and analyze their performance (Shute 2011; Shute & Kim, 2014). Using the same strategies and technology as described in the dynamic assessment, similar data analytic strategies could be replicated and reversed to get a more detailed analysis of the serious game at optimal performance. Data would inform teachers, game designers, and instructional designers on game features that compliment each other for an array of instructional objectives, game types, and learner needs. Furthermore, as the connections between SGA and instructional outcomes are refined, a more detailed analysis on the cognitive domains of the outcomes could perpetuate stronger methods of practice for more tailored classroom instruction capabilities.

Summary

Multiple technological challenges are facing K-12 schools (Johnson, Adams Becker, Estrada, & Freeman, 2015). At the school level, technology use policies limit student access to devices that allow for personalized one-to-one instruction, such as serious games. Concerns with integrating serious games into classrooms have multiple considerations that stem from teachers' efficacy, the attitude and norms of the school culture, implementation models available and perceived control of the environment (Hirumi, 2010; Ketelhut & Schifter, 2011; Taylor & Todd, 1995). Provoking the problem even further, some research indicates that ongoing collaboration and assistance on implementing new approaches in schools are provided with little administrative support (Lee & Picanco, 2013). Findings solutions to implementation strategies for serious games can aid bridging the gap between learners' abstract knowledge (e.g., principles) and concrete application of them (e.g., practice) through play for all learners (Gallegos, Kepple, & Bukaty, 2015). The current study was conducted to identify relationships between the mental models put forth by each subpopulation when selecting serious game attributes and to provide insight into each subpopulation's epistemology. Due to limited sample sizes for subpopulations (game designers, higher education instructors and K-12 teachers) and categorical nature of the data collected, limited statistical analysis could be reported in the study. While the current study did not find any statistically significant relationships between participant's epistemological beliefs and level of SGA, findings do support related design patterns between subgroups. Findings indicate that all subgroups examined had relatively similar epistemological beliefs, yet each discipline has unique models and frameworks for designing serious games.

APPENDIX A
SERIOUS GAME ATTRIBUTES

Serious Game Attribute	Definition	Source
Adaptation	Level of difficulty adjusts to the skill level of the player by matching challenges and possible solutions.	Prensky, 2001
Assessment	The measurement of achievement within game (e.g., scoring). Tutorials teach players how to play the game and what aspects are important to achieving the goals. Scoring compares performance among players. Feedback provides a tool for players to learn from pervious actions and adjust accordingly.	Chen & Michael, 2005
Challenge	Ideal amount of difficulty and improbability of obtaining goals. A challenging game possesses multiple, clearly specified goals, progressive difficulty, and informational ambiguity. Challenge also adds fun and competition by creating barriers between current state and goal state.	Garris, Ahlers, & Driskell, 2002; Owen, 2004
Conflict	The presentation of solvable problems within the game and usually drives the game's plot or in-game action by providing interaction. Four types of conflict exist: (a) direct, (b) indirect, (c) violent, and (d) nonviolent.	Crawford, 1984
Control	The player's capacity for power or influence over elements of the game. Learner control occurs when the learner has control over some aspects of the game. Instructional program control determines all elements of the game.	Garris et al., 2002
Fantasy	Make-believe environment, scenarios, or characters. It involves the player in mental imagery and imagination for unusual locations, social situations, and analogies for real-world processes. The player is also required to take on various roles in which he/she is expected to identify. Exogenous fantasy is a direct overlay on learning content. It is dependent on the skill, but the skill does not depend on the fantasy. Endogenous fantasy is related to learning content. It is an essential relationship between the learned skill and the fantasy context (engaging and educational).	Garris et al., 2002; Owen, 2004; Habgood, Alnsworth , & Benford, 2005
Interaction (equipment)	The adaptability and manipulability of a game. The game changes in response to player's actions.	Prensky, 2001
Interaction (interpersonal)	Face-to-face interaction, relationships between players in real space and time. It provides an opportunity for achievements to be acknowledged by others.	Crawford, 1984
Interaction (social)	Interpersonal activity that is mediated by technology, which encourages entertaining communal gatherings by producing a sense of belonging.	Prensky, 2001
Language/ communication	Specific communication rules of the game, and may be a significant part of the game. The two types of communication are verbal and text.	Owen, 2004
Location	The physical or virtual world that the game takes place in. It influences rules, expectations, and solution parameters. The location may be real or fantasy and the space may be bound, unbound, or augmented.	Owen, 2004
Mystery	Gap between existing information and unknown information. It is a product of discrepancies or inconsistencies in knowledge. This attribute is enhanced by information incongruity, complexity, novelty, surprise, expectation violation, idea incompatibility, inability to make predictions, and incomplete or inconsistent information. Sensory curiosity is the interest evoked by novel sensations, and cognitive curiosity is the desire for knowledge related with curiosity (inverse quadratic).	Garris et al., 2002
Pieces or Players	Objects or people (e.g., proxy items, avatars, or human participants) being included in the game narrative or scenario.	Owen, 2004

Progress	How the player progresses toward the goals of the game.	Owen, 2004
Surprise	The random elements of the game.	Owen, 2004
Representation	The player’s perceptions of the game’s reality. It is a subjective feature that makes the game appear psychologically real.	Crawford, 1984
Rules/goals	Rules are the goal makeup of game and establish criteria for how to win. Specific, well-defined rules and guidelines are a necessary component of an effective educational game, as well as feedback on progression toward achieving the goals. Three types of rules exist: (a) system rules (i.e., functional parameters inherent in the game), (b) procedural rules (i.e., actions in game to regulate behavior), and (c) imported rules (i.e., rules originating from real world).	Blunt, 2007; Garris et al., 2002; Owen, 2004
Safety	Disassociation of actions and consequence (i.e., safe way to experience reality). The only consequence is loss of dignity when losing. The results are less harsh than modeled scenarios.	Crawford, 1984
Sensory Stimuli	Visual or auditory stimulations, which distort perception and imply temporary acceptance of an alternate reality.	Garris et al., 2002

APPENDIX B
EPISTEMIC BELIEF INVENTORY (EBI)

EPISTEMOLOGICAL BELIEFS INVENTORY

Directions: *Please indicate how strongly you agree or disagree with each of the statements listed below by circling the number that best corresponds to the strength of your belief.*

1. It bothers me when instructors don't tell students the answers to complicated problems

Strongly 1 2 3 4 5 Strongly
Disagree Agree

2. Truth means different things to different people

Strongly 1 2 3 4 5 Strongly
Disagree Agree

3. Students who learn things quickly are the most successful

Strongly 1 2 3 4 5 Strongly
Disagree Agree

4. People should always obey the law

Strongly 1 2 3 4 5 Strongly
Disagree Agree

5. Some people will never be smart no matter how hard they work

Strongly 1 2 3 4 5 Strongly
Disagree Agree

6. Absolute moral truth does not exist

Strongly 1 2 3 4 5 Strongly
Disagree Agree

7. Parents should teach their children all there is to know about life

Strongly 1 2 3 4 5 Strongly
Disagree Agree

8. Really smart students don't have to work as hard to do well in school

Strongly 1 2 3 4 5 Strongly
Disagree Agree

9. If a person tries too hard to understand a problem, they will most likely end up being confused

Strongly Disagree 1 2 3 4 5 Strongly Agree

10. Too many theories just complicate things

Strongly Disagree 1 2 3 4 5 Strongly Agree

11. The best ideas are often the most simple

Strongly Disagree 1 2 3 4 5 Strongly Agree

12. People can't do too much about how smart they are

Strongly Disagree 1 2 3 4 5 Strongly Agree

13. Instructors should focus on facts instead of theories

Strongly Disagree 1 2 3 4 5 Strongly Agree

14. I like teachers who present several competing theories and let their students decide which is best

Strongly Disagree 1 2 3 4 5 Strongly Agree

15. How well you do in school depends on how smart you are

Strongly Disagree 1 2 3 4 5 Strongly Agree

16. If you don't learn something quickly, you won't ever learn it

Strongly Disagree 1 2 3 4 5 Strongly Agree

17. Some people just have a knack for learning and others don't

Strongly Disagree 1 2 3 4 5 Strongly Agree

18. Things are simpler than most professors would have you believe

Strongly Disagree 1 2 3 4 5 Strongly Agree

19. If two people are arguing about something, at least one of them must be wrong

Strongly Disagree 1 2 3 4 5 Strongly Agree

20. Children should be allowed to question their parents' authority

Strongly Disagree 1 2 3 4 5 Strongly Agree

21. If you haven't understood a chapter the first time through, going back over it won't help

Strongly Disagree 1 2 3 4 5 Strongly Agree

22. Science is easy to understand because it contains so many facts

Strongly Disagree 1 2 3 4 5 Strongly Agree

23. The moral rules I live by apply to everyone

Strongly Disagree 1 2 3 4 5 Strongly Agree

24. The more you know about a topic, the more there is to know

Strongly Disagree 1 2 3 4 5 Strongly Agree

25. What is true today were true tomorrow

Strongly Disagree 1 2 3 4 5 Strongly Agree

26. Smart people are born that way

Strongly 1 2 3 4 5 Strongly
Disagree Agree

27. When someone in authority tells me what to do, I usually do it

Strongly 1 2 3 4 5 Strongly
Disagree Agree

28. People who question authority are trouble makers

Strongly 1 2 3 4 5 Strongly
Disagree Agree

29. Working on a problem with no quick solution is a waste of time

Strongly 1 2 3 4 5 Strongly
Disagree Agree

30. You can study something for years and still not really understand it

Strongly 1 2 3 4 5 Strongly
Disagree Agree

31. Sometimes there are no right answers to life's big problems

Strongly 1 2 3 4 5 Strongly
Disagree Agree

32. Some people are born with special gifts and talents

Strongly 1 2 3 4 5 Strongly
Disagree Agree

APPENDIX C
CARD SORT QUESTIONS

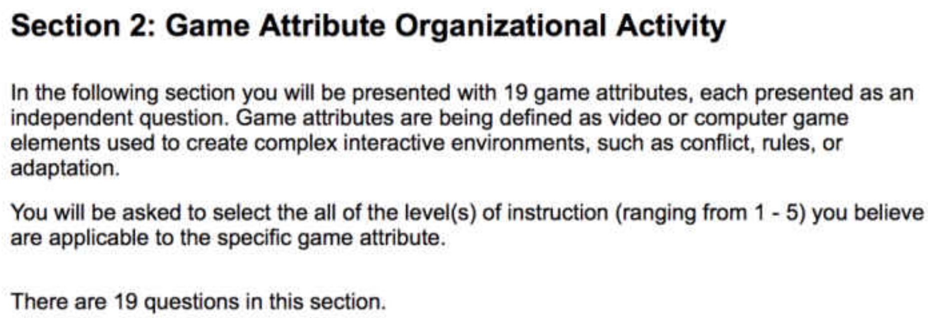


Figure 13: Directions for the card sort activity

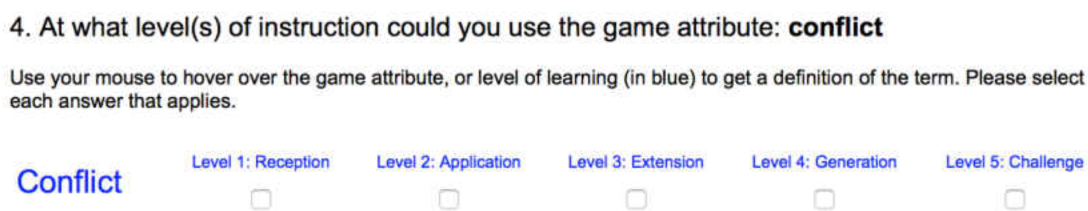


Figure 14: Example question in card sort activity

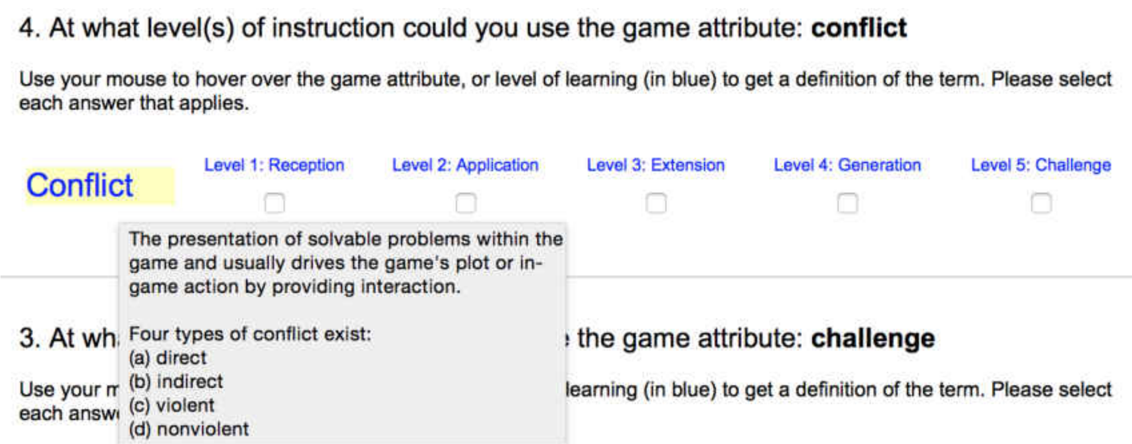
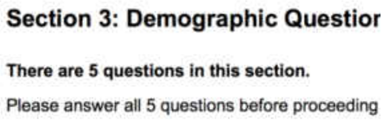


Figure 15: Example question in card sort activity showing hover feature on serious game attributes

APPENDIX D
DEMOGRAPHIC QUESTIONS

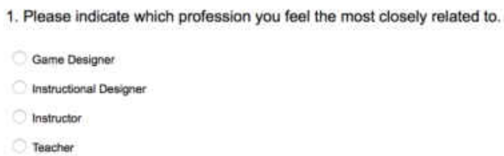


Section 3: Demographic Questior

There are 5 questions in this section.

Please answer all 5 questions before proceeding

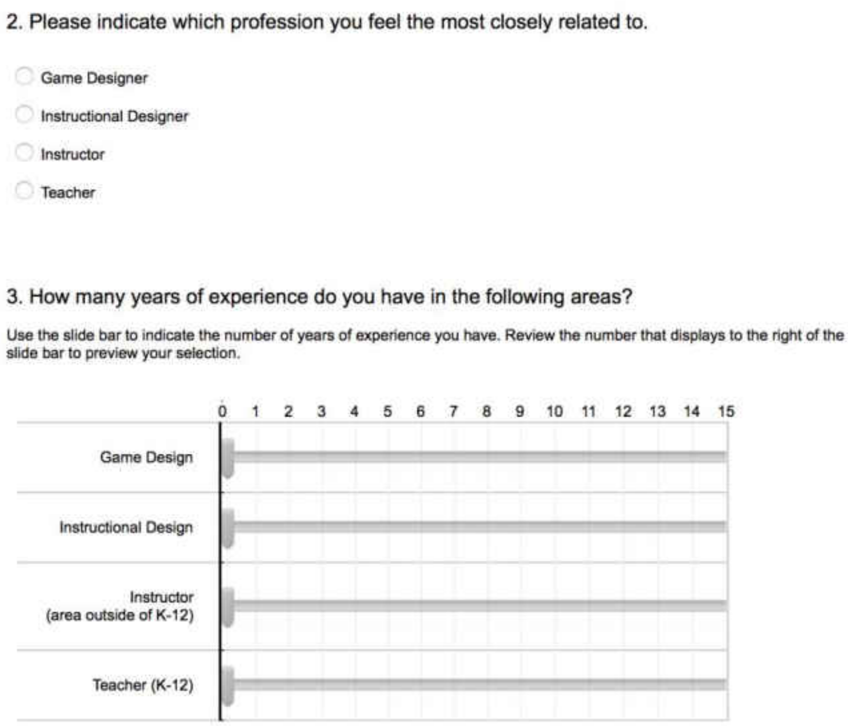
Figure 16: Survey demographic section (directions)



1. Please indicate which profession you feel the most closely related to.

- Game Designer
- Instructional Designer
- Instructor
- Teacher

Figure 17: Survey demographic questions (1)



2. Please indicate which profession you feel the most closely related to.

- Game Designer
- Instructional Designer
- Instructor
- Teacher

3. How many years of experience do you have in the following areas?

Use the slide bar to indicate the number of years of experience you have. Review the number that displays to the right of the slide bar to preview your selection.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Game Design																
Instructional Design																
Instructor (area outside of K-12)																
Teacher (K-12)																

Figure 18: Survey demographic questions (2-3_

4. Please indicate your gender.

- Male
- Female
- Other

5. Please indicate your age.

- [18 - 23]
- [24 - 29]
- [30 - 39]
- [40 - 49]
- [50 - 59]
- [60 - 69]
- [70 +]

Figure 19: Survey demographic questions (4-5)

APPENDIX E
AECT DESCRIPTION

AECT describes the association in the follow manner:

The **Association for Educational Communications and Technology (AECT)** is a professional association of thousands of educators and others whose activities are directed toward improving instruction through technology. AECT members may be found in colleges and universities; in the Armed Forces and industry; in museums, libraries, and hospitals; in the many places where educational change is underway. AECT members carry out a wide range of responsibilities in the study, planning, application, and production of communications media for instruction.

The Association has become a major organization for those actively involved in the designing of instruction and a systematic approach to learning. It provides an international forum for the exchange and dissemination of ideas for its members and for target audiences; it is the national and international spokesperson for the improvement of instruction; and, it is the most recognized association of information concerning a wide range of instructional and educational technology. Along with our members, we have 24 state and six international affiliates who are all passionate about finding better ways to help people learn. AECT is the oldest professional home for this field of interest and has continuously maintained a central position in the field, promoting high standards, both in scholarship and in practice. AECT has 9 divisions and a Graduate Student Assembly that represent the breadth and depth of the field. The association produces two bimonthly journals, *Educational Technology Research and Development* and *TechTrends.*

APPENDIX F
VARIABLES

EBI (five factors) (Schraw, Bendixen, & Dunkle, 2002)	**Five Levels of Teaching (five factors)** (Hokanson & Hooper, 2004)	**Game Attributes (19 attributes)** (Bedwell et. al, 2012)	**Game Categories** (Bedwell et. al, 2012)
SK = simple knowledge	1 Reception	Language (ATL_1), Communication (ATL_2)	ATL = action language
CK = certain knowledge	2 Application	Assessment (ASM_1), Progress (ASM_2)	ASM = assessment
IA = innate ability	3 Extension	Adaptation (CCH_1), Challenge (CCH_2), Conflict (CCH_3), Surprise (CCH_4)	CCH = conflict/challenge
OA = omniscient authority	4 Generation	Control (CTL_1), Interaction (Equipment) (CTL_2)	CTL = control
QL = quick learning	5 Challenge (*modified to personal challenge*)	Location (ENV_1)	ENV = environment
		Fantasy (GMF_1), Mystery (GMF_2)	GMF = game fiction
		Interaction (Interpersonal) (HUI_1), Interaction (Social) (HUI_2)	HUI = human interaction
		Pieces or Players (IMN_1), Representation (IMN_2), Sensory Stimuli (IMN_3), Safety (IMN_4)	IMN = immersion
		Rules/Goals (RUG_1)	RUG = rules/goals

APPENDIX G
EPISTEMOLOGICAL BELIEFS INVENTORY KEY

EPISTEMOLOGICAL BELIEFS INVENTORY KEY

5 Factors

SK = simple knowledge (1, 10, 11, 13, 18, 22, 24*, 30*)
CK = certain knowledge (2*, 6*, 14*, 19, 23, 25, 31*)
IA = innate ability (5, 8, 12, 15, 17, 26, 32)
OA = omniscient authority (4, 7, 20*, 27, 28)
QL = quick learning (3, 9, 16, 21, 29)
**Reverse coded to 5 = naïve beliefs: 2,6,14,20,24,30,31*

EPISTEMOLOGICAL BELIEFS INVENTORY QUESTIONS

Number. Questions. Factor

1. It bothers me when instructors don't tell students the answers to complicated problems SK
2. Truth means different things to different people CK
3. Students who learn things quickly are the most successful QL
4. People should always obey the law OA
5. Some people will never be smart no matter how hard they work IA
6. Absolute moral truth does not exist CK
7. Parents should teach their children all there is to know about life OA
8. Really smart students don't have to work as hard to do well in school IA
9. If a person tries too hard to understand a problem, they will most likely end up being confused QL
10. Too many theories just complicate things SK
11. The best ideas are often the most simple SK
12. People can't do too much about how smart they are IA
13. Instructors should focus on facts instead of theories SK
14. I like teachers who present several competing theories and let their students decide which is best CK
15. How well you do in school depends on how smart you are IA
16. If you don't learn something quickly, you won't ever learn it QL
17. Some people just have a knack for learning and others don't IA
18. Things are simpler than most professors would have you believe SK
19. If two people are arguing about something, at least one of them must be wrong CK
20. Children should be allowed to question their parents' authority OA
21. If you haven't understood a chapter the first time through, going back over it won't help QL
22. Science is easy to understand because it contains so many facts SK
23. The moral rules I live by apply to everyone CK
24. The more you know about a topic, the more there is to know SK
25. What is true today were true tomorrow CK
26. Smart people are born that way IA
27. When someone in authority tells me what to do, I usually do it OA
28. People who question authority are trouble makers OA
29. Working on a problem with no quick solution is a waste of time QL

30. You can study something for years and still not really understand it SK
31. Sometimes there are no right answers to life's big problems CK
32. Some people are born with special gifts and talents IA

APPENDIX H
IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Michelle Tristen Kepple**

Date: **April 28, 2015**

Dear Researcher:

On 04/28/2015, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review: Exempt Determination
Project Title: Designing Games for Learning: An Investigation of serious game attributes and beliefs about learning acquisition.
Investigator: Michelle Tristen Kepple
IRB Number: SBE-15-11249
Funding Agency:
Grant Title:
Research ID: NA

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 04/28/2015 02:41:19 PM EDT

IRB manager

APPENDIX I
IRB AMENDMENT

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Michelle Tristen Kepple**

Date: **April 30, 2015**

Dear Researcher:

On 04/30/2015, the IRB approved the following minor modification to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Compensation has been changed to a “thank you” gift in the form of a$5.00 electronic gift card. A revised consent document has been approved for use.
Project Title:	Designing Games for Learning: An Investigation of serious game attributes and beliefs about learning acquisition.
Investigator:	Michelle Tristen Kepple
IRB Number:	SBE-15-11249
Funding Agency:	
Grant Title:	
Research ID:	NA

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 04/30/2015 10:56:29 AM EDT

IRB manager

Page 1 of 1

APPENDIX J
EBI TOTAL VARIANCE EXPLAINED

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.924	15.386	15.386	4.924	15.386	15.386
2	3.030	9.470	24.857	3.030	9.470	24.857
3	2.670	8.344	33.201	2.670	8.344	33.201
4	2.296	7.175	40.376	2.296	7.175	40.376
5	1.573	4.915	45.291	1.573	4.915	45.291
6	1.531	4.784	50.075			
7	1.243	3.885	53.959			
8	1.160	3.625	57.584			
9	1.120	3.500	61.084			
10	1.017	3.177	64.262			
11	.893	2.790	67.051			
12	.874	2.732	69.784			
13	.846	2.644	72.427			
14	.760	2.374	74.801			
15	.719	2.247	77.048			
16	.690	2.155	79.203			
17	.669	2.091	81.294			
18	.652	2.036	83.330			
19	.597	1.866	85.196			
20	.556	1.738	86.934			
21	.530	1.655	88.589			
22	.472	1.476	90.065			
23	.428	1.337	91.402			
24	.406	1.267	92.669			
25	.405	1.266	93.935			
26	.354	1.106	95.041			
27	.317	.991	96.032			
28	.298	.932	96.964			
29	.282	.880	97.844			
30	.263	.821	98.665			
31	.221	.689	99.354			
32	.207	.646	100.000			

APPENDIX K
SGA ATTRIBURES PERCENT OF SELECTION

Table 5: SGAs weighted percentage of selection

Serious Game Attributes	Total Sample	Game Designers	Instructional Designers	Instructors	K-12 Teachers
Sample Size (*n*)	*142*	*21*	*55*	*35*	*31*
Language/ Communication	70.70%	58.10%	68.00%	79.43%	74.19%
Rules/Goals	70.14%	66.67%	67.27%	80.00%	66.45%
Progress	69.15%	63.81%	69.09%	74.86%	66.45%
Pieces or Players	68.59%	67.62%	69.45%	76.00%	59.35%
Interaction (Interpersonal)	65.63%	63.81%	61.09%	76.57%	62.58%
Representation	64.93%	65.71%	60.73%	74.86%	60.65%
Interaction (Equipment)	64.65%	58.10%	61.45%	78.29%	59.35%
Location	64.65%	59.05%	62.55%	77.14%	58.06%
Interaction (Social)	63.24%	59.05%	58.91%	74.29%	61.29%
Safety	62.82%	60.00%	58.91%	73.14%	60.00%
Surprise	61.41%	57.14%	57.45%	73.71%	57.42%
Assessment	61.13%	57.14%	60.36%	66.29%	59.35%
Mystery	60.70%	57.14%	59.27%	67.43%	58.06%
Control	57.61%	49.52%	56.73%	66.29%	54.84%
Conflict	56.76%	53.33%	53.09%	63.43%	58.06%
Challenge	54.34%	56.19%	53.09%	62.29%	55.48%
Adaptation	54.23%	56.19%	49.45%	62.86%	51.61%
Fantasy	50.42%	38.10%	48.73%	60.00%	50.97%

[1]Percentages are the total weighted frequency counts for all levels of SGA.

APPENDIX L
EBI COMPONENT MATRIX (UNROTATED)

Table 6: EBI Component Matrix[a]

	Component				
	1	2	3	4	5
EBI_29_QL	.626				
EBI_13_SK	.594			-.344	
EBI_22_SK	.546		-.337		-.416
EBI_16_QL	.539			.391	
EBI_28_OA	.515				-.410
EBI_19_CK	.502	.317			
EBI_26_IA	.499	-.461			
EBI_10_SK	.482			-.386	
EBI_21_QL	.467		-.434		
EBI_3_QL	.448	-.304			
EBI_15_IA	.441	-.363			
EBI_1_SK	.420				
EBI_7_OA	.402		.348		
EBI_9_QL	.324			-.321	
EBI_5_IA		-.719			
EBI_30RC_SK		.517			-.309
EBI_12_IA	.450	-.492			
EBI_32_IA		-.467	.419		
EBI_31RC_CK		.455		.387	
EBI_17_IA	.440	-.451			.305
EBI_20RC_OA		.402	.322		
EBI_23_CK	.471	.301	.521		
EBI_6RC_CK		.388	.480		
EBI_24RC_SK			-.476		
EBI_25_CK	.365		.444	.421	
EBI_27_OA			.407		
EBI_11_SK				-.456	.366
EBI_4_OA	.364			-.384	
EBI_18_SK				-.376	
EBI_14RC_CK			-.327	.331	
EBI_2RC_CK			.308	.427	.483
EBI_8_IA	.313	-.351			-.352

Extraction Method: Principal Component Analysis.
a. 5 components extracted.

APPENDIX M
EBI COMPONENT MATRIX (ROTATED)

Table 7: EBI Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
EBI_23_CK	.780				
EBI_6RC_CK	.704				
EBI_25_CK	.668				
EBI_20RC_OA	.493				
EBI_2RC_CK	.489				-.434
EBI_27_OA	.443				
EBI_13_SK		.655			
EBI_10_SK		.642			
EBI_18_SK		.573			
EBI_11_SK		.568			
EBI_9_QL		.474			
EBI_4_OA	.392	.444			
EBI_7_OA	.342	.398			
EBI_1_SK		.370			
EBI_16_QL			.664		
EBI_21_QL		.323	.605		
EBI_29_QL			.590		
EBI_14RC_CK			.576		
EBI_31RC_CK	.351		.475		
EBI_19_CK		.353	.468		
EBI_24RC_SK			.406		
EBI_5_IA				.683	
EBI_17_IA				.676	
EBI_12_IA				.632	
EBI_32_IA			-.369	.583	
EBI_26_IA				.581	.398
EBI_30RC_SK				-.550	
EBI_22_SK			.386		.629
EBI_28_OA	.420				.547
EBI_15_IA					.541
EBI_8_IA					.518
EBI_3_QL					.448

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

APPENDIX N
EBI COMPONENT TRANSFORMATION MATRIX

Table 8: EBI Component Transformation Matrix

Component	1	2	3	4	5
1	.413	.527	.478	.315	.473
2	.477	.197	.147	-.807	-.246
3	.730	-.153	-.581	.314	-.088
4	.265	-.757	.589	.093	-.045
5	.002	.295	.256	.376	-.840

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX O
EBI COMPONENT SCORE COEFFCIENT MATRIX

Table 9: EBI Component Score Coefficient Matrix

	Component				
	1	2	3	4	5
EBI_1_SK	.016	.109	-.015	.015	.050
EBI_2RC_CK	.176	-.040	.144	.126	-.279
EBI_3_QL	-.034	.057	-.048	.058	.168
EBI_4_OA	.109	.136	-.140	-.070	.098
EBI_5_IA	-.052	-.108	.030	.221	.068
EBI_6RC_CK	.243	-.061	.008	-.017	-.038
EBI_7_OA	.095	.132	-.097	.076	-.011
EBI_8_IA	.006	-.091	-.040	.044	.242
EBI_9_QL	-.034	.165	-.003	-.035	.012
EBI_10_SK	-.015	.226	.009	-.001	-.040
EBI_11_SK	-.061	.245	-.018	.067	-.166
EBI_12_IA	-.009	.010	.057	.212	-.009
EBI_13_SK	-.014	.222	.027	.042	-.036
EBI_14RC_CK	-.024	-.022	.217	.037	-.075
EBI_15_IA	-.046	-.045	.025	.046	.224
EBI_16_QL	.015	-.049	.220	.016	.039
EBI_17_IA	.016	.074	.020	.243	-.090
EBI_18_SK	-.071	.227	.038	-.007	-.110
EBI_19_CK	.022	.084	.135	-.077	.017
EBI_20RC_OA	.156	.063	-.080	-.084	.041
EBI_21_QL	-.068	.097	.211	.052	-.096
EBI_22_SK	-.037	-.016	.074	-.109	.283
EBI_23_CK	.256	-.040	.005	.018	.006
EBI_24RC_SK	-.101	.000	.126	-.068	.112
EBI_25_CK	.227	-.094	.073	.073	-.059
EBI_26_IA	.052	-.080	.024	.166	.123
EBI_27_OA	.140	.089	-.151	-.058	.064
EBI_28_OA	.119	-.028	-.065	-.060	.254
EBI_29_QL	.024	.048	.179	-.010	.020
EBI_30RC_SK	.041	-.026	.063	-.225	.143
EBI_31RC_CK	.114	-.039	.185	-.058	-.120
EBI_32_IA	.022	.080	-.148	.206	-.033

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

APPENDIX P
INSTRUCTIONAL MODELS RESPONSES

Participants were asked: “What models or frameworks do you use to design serious games?”

Models	**Game Designers**	**Instructional Designers**	**Higher Education Instructors**	**K-12 Teachers**
ADDIE	◆	◆	◆	◆
ARCS		◆		
Bartle's Test	◆			
CCAF matrix		◆		
Component Display Theory		◆		
Cognitive Load Theory		◆		
Crawl, Run, Walk			◆	
CyGaME Metaphrics		◆		
Dick & Carey			◆	
Fullerton's Game Design Suggestions			◆	
Gagne's 9 Events		◆		
Gee's 4C/ID		◆		
Kemp	◆			
Malone's Curiosity, Fantasy, & Challenge		◆		
Mayer's Multimedia	◆	◆		
MDA	◆			
MUD	◆			
PBL	◆	◆		
Pyramid of Learning			◆	
Rapid Prototyping		◆		
Schank's Goal based Scenarios		◆		
Split Attention Affect		◆		
UBD	◆			
Van Merrienboer Complex Steps			◆	
Waterfall	◆			

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