University of Alberta

Incidental Learning and Virtual Worlds

by

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Dedication

This thesis is dedicated to my parents who always encouraged me to do the best I could and to always keep trying. Mom and Dad, thank you for everything you have done and all of your support through my many years of schooling. I also dedicate this thesis to my dear sisters who have been there for me in ways they may never realize. I love you all.

Abstract

This study sought to determine whether or not students could learn textual and pictorial information incidentally within virtual worlds and investigated whether or not other factors such as learning style or digital literacy predicted incidental learning. The study also investigated whether visual salience played a role in incidental learning. The study utilized a quasi-experimental design, and its participants were 155 undergraduate students from the University of Alberta enrolled in introductory educational psychology. The results indicated that in addition to incidental learning taking place in virtual worlds, learning style and digital literacy seemed to predict incidental learning in some instances. The results also suggested that visual salience played a role in incidental learning as the participants performed better on the information that was made visually salient. These findings have implications for schools that may want to use a virtual world to set up a classroom or a learning space for students.

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Virtual Worlds and Incidental Learning

The physical classroom is a complex environment that we as educators have become quite accustomed to over the years. However, many may not be as familiar with the possibilities, features, and benefits of virtual environments. This is a cause for concern in education because it seems that many schools are moving toward education within virtual world contexts. In fact, educators in multiple countries around the world are attempting to get their students more engaged, interactive, and collaborating in their learning environments through the use of virtual worlds (Eschenbrenner, 2008).

Virtual worlds offer a whole new context and environment for researchers to test and verify existing theories as well as develop new theories; virtual worlds are also a dynamic and interactive place for educators to teach. What was once thought to be a certainty in the physical world, may or may not translate well into the virtual world. The things we believe we know about education, cognitive processing, and student learning may or may not hold true in a virtual context. It is for these reasons that we need to conduct more research into virtual worlds. Virtual worlds also afford us many advantages as they are scalable and manipulable by the owners and users of the space New Media Consortium and EDUCASE Learning Initiative (2007). This facet not only allows researchers to manipulate and test an endless number of variables in any virtually replicated setting, but it also allows learners to manipulate, design, and control as much as they need to in whichever ‘world’ is put before them. The value of such flexibility and freedom to the field of research is almost immeasurable. For example, a virtual world can allow researchers to explore theories involving dangerous scenarios or re-enact situations that would be too costly to perform in the real world all the while having total control over the environment and at only a fraction of the cost. In education, it allows teachers and instructors to either replicate their physical classroom or create a novel space for their students to learn in and explore.

When considering student learning, there exists a number of theories as to how humans learn and process information. Among the many methods and forms of learning is a theory that considers how we learn things by chance or things that we happen to encounter. The following example introduces one of the existing theories of learning: If a teacher is instructing students on the technique of skating and through this experience, a few students happen to get an understanding of the properties of gravity and friction, there is both purposeful, direct learning taking place, and learning by chance. This ‘chance learning’ is referred to in the literature as incidental learning and will be described in more detail in the next section. The concept of incidental learning seems to have a short, yet varied history as it seemed to fall out of popularity and not much was published on the subject after the 1990s. It was studied in very limited and directed contexts that did not offer a large and diverse amount of value to the field of student learning. Of the research that exists, much of it is found within the fields of language acquisition and workplace learning. One possible reason that the topic may have fallen out of favor is that its full value to education was not understood at the time it was being studied the most. There also exists the possibility that the concept simply could not be studied as thoroughly as researchers would have liked in order to get a full understanding, which is an unfortunate situation for the field of education. The same is also true of another concept related to how students process information: salience. Salience is the quality of standing out or standing apart from the surrounding environment (Reynolds, 1992). For example, if there is a sheet of plain text and one word on the sheet is in bold font face, that single bolded word could be considered ‘salient.’ The topic of salience was investigated fairly heavily through the 1980s and 1990s but in very limited and directed contexts such as reading, neuroscience, and cognitive psychology (see Triesman & Gelade, 1980; Reynolds, 1992). After the 1990s the literature continued in those fields at what seemed to be a reduced rate. The concept of salience could add a lot of value to the field of education today because images, text, and other facets can easily be manipulated with the help of computers and software such as word processing programs. It is important to note that salience could refer to the semantic value of an object or a word, but it could also refer to the physical properties of the appearance of the object or word. In the latter case, and for the purpose of this research, the use of the word ‘salience’ refers to visual or perceptual salience. This was not necessarily the case in the 1990s when much of the work done by students was manual as opposed to being in digital form. Visual salience could now offer value to teachers and instructors if it does in fact effect how students learn and process information. For example, if an instructor decides to use multimedia or digitally created text within his or her lesson, the ease or difficulty with which students would process that information may encourage or discourage its use. When applied to virtual worlds, if the same digitally created information were to be imported into a virtual space, how would students process it? This is a question that research in the field of virtual worlds can help to answer.

The question of which ways students prefer to learn has been studied at length within the field of education (see Cassidy, 2004). One thing that this area of study lacks is consensus as to what role and significance these preferences for learning play in education and how to define them. This concept of learning preferences, better known as learning styles, encompasses the desire or efficiency that learners experience when they encounter information visually as opposed to verbally, or sequentially as opposed to having to go and collect the information from various areas and compile it themselves. Given inconsistencies within the literature (see Pashler, McDaniel, Rohrer, & Bjork, 2008), there exists a need to further explore the field and differentiate between the components that make up the concept. One possible reason that there is such confusion in the literature is that there is no consensus on the definition of learning preference or style. Another is that, as mentioned above, researchers have done all they can conceive of doing in the physical world with the tools they have and cannot go further at this point in time. This is where technologies such as virtual worlds may be of assistance.

While it seems that most students have unlimited access to technology, their level of knowledge or education as to the full use and potential of the technologies they use can be unclear. In the literature there exists a concept known as digital literacy. Digital literacy is widely studied in different areas by many researchers and like the concept of learning styles, it has many components and definitions (see Bawden, 2008; van Deursen & van Dijk, 2010). Simply owning a piece of technology does not equate to fully knowing how to use it or what it can do for the user. For example, it is very possible that a student could own a laptop, but only know how to use the internet and not the word processor or some other important component. In classrooms wanting to incorporate more technology and digital tools, it then raises the question of what level of digital literacy is needed for a student to succeed? How can all students be brought to the same level? How much technology or how many digital tools can a teacher reasonably incorporate into the curriculum? How many if any digital tools share the same foundation and will result in transferrable digital skills or knowledge to help them master new and evolving technologies? All of these questions can be answered with the help of further research into the field of digital literacy. With digital literacy becoming a foundational part of curriculum and educational design (see Alberta Education, 2013) further research into this area and all of the possibilities it can afford is quite timely.

The above mentioned areas of research and their possibilities are important to note because with the advance of technology in the past few decades and the availability of new technologies such as virtual worlds, allow such topics to be resurrected and studied once again. Virtual worlds allow researchers to manipulate variables that they might otherwise not be able to control in the real world due to physical, logical, or even financial constraints. We should revisit the concepts of incidental learning, visual salience, learning styles, and digital literacy within the context of a new and completely alterable environment to help improve and advance student learning. It is quite possible that there are some things that cannot be gleaned about student learning in the traditional physical context and virtual worlds can serve as a way to remove obstacles in the interest of furthering educational research. Currently there is not a lot of existing research that has investigated these concepts within a virtual context, making the research questions of this study very important. The main research question inquires as to whether or not incidental learning occur in virtual worlds. The sub research questions are:

a) Does making text visually salient make a difference in incidental learning within virtual worlds?
b) Does learning style as measured by Felder and Solomon's (1994) Index of Learning Styles predict incidental learning within virtual worlds? And lastly,
c) Does digital literacy, as measured by Hargittai's (2005) Measure of Web-Oriented Digital Literacy predict incidental learning within virtual worlds?

This study uses an informal and incidental theory of learning (Marsick & Watkins, 1990) to help identify whether or not environment plays a role in student learning. In the attempt to answer this question, a quasi-experimental design (Creswell, 2009) was used in which students were presented with two questionnaires to determine their learning style and digital ability, then attended the virtual world, and received an incidental learning post-test questionnaire. The data for the main research question and the first sub question were analyzed using a simple t-test to determine whether or not students were learning incidentally. The data for the remaining sub-questions was analyzed using a regression analysis to determine whether learning style or digital literacy was predicting the outcome of a student's incidental learning score. Within this design, the independent variables are defined as learning style, digital literacy, and visual salience, while the dependent variable is defined as incidental learning. I hypothesized that incidental learning would transfer within the virtual world, and that students who are more digitally literate and are more visual learners would subsequently have a better or higher incidental learning score.

The ultimate goal of this research is to begin looking into the field of learning within virtual worlds to examine the possibilities and potentials of incidental learning, learning styles, digital literacy, and visual salience. In addition, this study also seeks to identify conditions or characteristics that may help learners flourish within virtual environments. While a wealth of literature exists on virtual worlds and environments in education, and even more on learning styles (see Eschenbrenner, Nah, & Siau, 2008; Peterson, Rayner, and Armstrong 2009; Dunn, 1990; Pashler, McDaniel, Roher, & Bjork, 2009), there is almost no literature that examines *specific* forms of learning that may occur within virtual worlds. Consequently, a gap exists in the literature that questions whether incidental learning occurs within virtual worlds. Furthermore, questions about which other factors may affect or predict the amount of learning that takes place in virtual worlds is paramount if educators seek to advance learning to a 21st century level where students can leave the classroom and be fully functional in most or any given technological environment or tool. As a result, the research undertaken in this thesis attempts to investigate whether or not incidental learning occurs within virtual worlds. Finally, it is hoped that this research will help encourage educators and educational policymakers to consider the use of virtual worlds in engaging students with their own learning.

Literature Review[1]

Virtual Worlds

Virtual worlds are important to the field of education because they are increasing in popularity within the field of education (see Eschenbrenner, Nah, and Siau, 2008). These environments may continue to gain popularity in the near future, and as such it is important to understand and evaluate the strengths and opportunities that they may afford various educational contexts.

What is a virtual world? Of the definitions offered in the literature for the term ‘virtual world’ (e.g., New Media Consortium and EDUCASE Learning Initiative, 2007; Dickey, 2003; 2005; Junglas, Johnson, Steel, Abraham, Loughlin, 2007; Warburton, 2009), most seem to center around the three-dimensional (3D) aspect of these environments. New Media Consortium and EDUCASE Learning Initiative (2007) defines virtual worlds as “richly immersive and highly scalable 3D environments” (p. 18). Users explore virtual worlds using an avatar, which is a virtual representation of the user within the world. They then navigate their avatar in ways that they would move in real life, and in some cases, ways that are beyond human movement such as flying (New Media Consortium and EDUCASE Learning Initiative, 2007). Dickey (2003) refers to virtual worlds as “networked, desktop virtual reality in which users move and interact in simulated 3D spaces” (p. 105). The researcher also goes on to describe a virtual world as an interactive

[1] A version of this chapter has been published. Thomas, W., Boechler, P., deJong, E., Stroulia, E. & Delaney, M. (2012). Incidental Learning and Salience in Virtual Worlds. In T. Bastiaens & G. Marks (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2012* (pp. 1686-1690). Chesapeake, VA: AACE. Retrieved from www.editlib.org/

virtual reality with chat enabled ability, and suggests three main attributes that appear in most virtual worlds: 1) the appearance of a 3D space, 2) avatars or some sort of user representative, and 3) a form of communication for users, typically a chat environment (Dickey, 2005). Warburton (2009) suggests, “a virtual world provides an experience set within a technological environment that gives the user a strong sense of being there” (p. 415).

There are several brands of free virtual worlds including Second Life™ (SL), Active Worlds™, OnVerse™, as well as some that charge a membership fee such as There™. SL, is one of the most widely used virtual world software programs in education to date (Warburton, 2009). According to Baker, Wentz, & Woods (2009), over 100 post-secondary institutions worldwide own virtual space within SL. SL is a 3D Virtual world where users can create their own avatars, communicate with each other via voice and chat functions, and explore the world for free (Second Life, 2012). Some of the major components offered by SL include “technical infrastructure, immersion, and socialization” (Warburton, 2009, p. 418). These components can be a draw for teachers and instructors to introduce virtual worlds like SL into the classroom curriculum. In fact Baker et al. (2009) proposes that the opportunity for users to build and create content within the virtual world makes SL an attractive tool for education. In addition to the description of SL, Baker (2009) also gives a reminder about the comparison of SL to games, stating that although games can be played within the SL environment, SL itself is not a game. Instead it is a virtual space that offers countless possibilities for research and education (Ondrejka, 2008; Goral, 2008). Baker et al. (2009) suggests that SL can be thought of as a "space for social interaction" (p. 59) rather than a game. Having been introduced to the concept of a virtual world, the focus will now shift to identify some of the other concepts that may be confused with virtual worlds. Before going further, an important distinction should be made between virtual worlds and video games.

What is not a virtual world? According to Gee (2007) video games are considered to be "commercial games people play on computers and game platforms… [such as] action, adventure, shooter, strategy, sports, and role-playing games" (p. 7). In other words, games have goals, whereas virtual realities and virtual worlds do not. However, many video games can and do take place within a virtual world or environment, but are not a virtual world in and of themselves as they are two different concepts. New Media Consortium and EDUCASE Learning Initiative (2007) suggests that the difference between games and virtual worlds is that a game is limited to a fixed context and a set goal, whereas a virtual world can be set up for any situation and is far more flexible. The article suggests that virtual worlds can be created for almost any discipline because they are not as contextually based as games.

There also seems to be confusion about the difference between virtual reality and virtual worlds within the literature, with no solid consensus on this difference. Dickey (2003) suggests that virtual worlds differ from virtual reality mainly in terms of immersion, and proposes that virtual reality is far more immersive and typically involves all of the human senses for a deeper experience. According to Bryson's (2006), definition of a virtual reality, it is more similar to a virtual world than it is different. He considers a virtual reality to be "the use of computers and human-computer interfaces to create the effect of a three-dimensional world containing interactive objects with a strong sense of three-dimensional presence" (p. 62). According to this definition, a virtual world is similar to a virtual reality, but entirely different from a game as defined above. Now that virtual worlds have been introduced, it is important to consider their link to education and the academic realm.

Virtual worlds in education. Virtual worlds have been explored within an educational context to determine their value and usefulness. For example, as part of a qualitative analysis, Furguson (2011) looked at the connection between meaningful learning and creativity in students using virtual worlds. To explore this issue, a grounded-theory thematic analysis was applied to a 120-post forum discussion which took place over two-weeks with 19 participants including students and instructors. In order to execute the study, a program called Schenome Park was created and run within Teen Second Life™. This served as a virtual environment that allowed students to explore and create. A forum was also built for this world and the participant responses and comments were thematically analyzed. Furguson (2011) found that through their experience with Schenome Park, students were more creative by the national standards of creativity in the work they had completed. The creation of a learning space within a virtual world also opened the ability for students to participate nationally. This feature of worldwide sharing opens up the learning environment to many more learners so that all can benefit. The virtual world gave teachers and learners who had participated in the study an opportunity to move away from a formally constructed learning environment and consider their position in the educational context. Through this experience with a virtual world, learners also received an opportunity to work collaboratively with other students who were separated from them geographically. Furguson (2011) concluded that the community or culture that can be created within a virtual world like Teen Second Life™ allowed for meaningful learning to take place. Given the link of virtual worlds to education, the usefulness of virtual worlds should and will be evaluated next.

Benefits of virtual worlds to education. As part of an exploration of virtual worlds and their educational applications, Neeley, Bowers, and Ragas (2010) surveyed 227 post-secondary instructors on their experience within SL. One of the respondents indicated, "Second Life is not just a walled garden where only our students have access but a whole world to explore and interact with" (p. 99). This statement suggests that SL offers opportunities for instructors to promote interaction in the classroom and engage learners. Some common themes also emerged out of the instructor responses including: student responsibility and initiative encouraged by SL; authentic assessment; generative learning; authentic learning; and co-operative support. The ability for students to create objects or artifacts was one of the most commonly occurring themes in the responses when it came to generative learning strategies. In another investigation on virtual worlds in education, Baker et al. (2009) conducted a study in which students participated in a psychology class offered online and were subsequently surveyed for their feedback. Despite some of the technical difficulties encountered by participants, the survey feedback was fairly positive and users saw the benefit to interacting with their classmates and instructor, as well as the flexibility offered in the case that they could not attend a particular class for various reasons. Study results also led the authors to suggest that instructors may want to use SL or a virtual world to offer courses in order to increase student engagement. For example, a student who would not normally volunteer an answer or contribute to a discussion in person may be more willing to do so with the anonymity offered by an avatar within a virtual world.

In a review of virtual world usage in education, Eschenbrenner et al. (2008) examined 18 projects running in various post-secondary institutions around the world and have ascertained that educators are attempting to get their students more engaged, interactive, and collaborating in their learning environments. Teachers and instructors often try online collaborative technologies to achieve this, but online tools such as wikis and blogs are limited in their flexibility and usefulness. According to Eschenbrenner et al. (2008), a 3D virtual world offers the possibility of creating custom meeting and interaction space for users. It offers the opportunity to recreate an existing physical space in a virtual format, or to create a novel space in which users can simply interact, or create and test ideas. This presents opportunities for student engagement in activity and collaboration in an environment that is very similar to a face-to-face situation. In addition to the engagement aspect, the customizability of 3D virtual environments offers the opportunity for users to explore their creativity and new ideas. The review also suggested that virtual worlds help to promote student engagement simply by being a shared environment, which allows for a social aspect to their learning. After considering the usefulness of virtual worlds in education, it would be logical to subsequently consider the theoretical underpinnings and connections involved.

Theoretical connections and frameworks for virtual worlds. Jonassen and Howland, 2003 have suggested constructivism as a guiding theoretical framework for virtual worlds in education. Before taking this discussion in a constructivist direction, it is important to understand the premise of constructivist theory. To put it plainly, the constructivist theory of learning suggests that students should be an active part of learning and involved in the environment (Vygotsky & Cole, 1978). Jonassen and Howland (2003) looked at what learning is from a constructivist perspective. In constructivism, learners construct a personal model of the things they learn and encounter. “Whenever humans encounter something they do not know but need to understand, their natural inclination is to attempt to reconcile it with what they already know in order to determine what it means” (p. 4). They posit that the most immediate concern of schools should be to help students learn how to learn and adapt. Students need help learning how to build their own mental constructs of new ideas and concepts. In order for learning to be meaningful, activity should be coupled with constructiveness to help students make meaning of the concepts they encounter.

In a study on pedagogical affordances and constraints of virtual worlds, Dickey (2003) conducted an evaluative case study to examine how virtual worlds support constructivism and contribute to pedagogical affordances. Pedagogical affordances in this sense are simply the things that virtual worlds allow for with regard to various teaching styles and subjects. This lends itself to the constructivist school of thought in which a learner constructs their own knowledge via a unique experience, and to the constructionist school of thought wherein a learner also produces an artifact which acts as a representation of what have they learned (See Vygotsky & Cole, 1978; Brown et al., 1989; Papert, 1980). The study looked at university students enrolled in a 3D object-modeling course and how they modeled 3D objects within a virtual world called Active Worlds™ throughout the semester. From this study, it was found that virtual worlds could help promote constructivist learning for distance learners because they allow instructors and teachers to perform many of the same functions as they would in person. It was also found that the virtual world lived up to the standards of a constructivist learning environment, but experience may impact the use of the virtual world as the author notes that participants in this study were already familiar with the technology used. The results also suggested that the ability for users to choose a unique identity, avatar, and representation might further enrich the learning environment by allowing an air of anonymity, but still requiring users to be responsible for their actions in-world. In a review, wherein Dickey (2005) investigated the differences between two virtual world programs: Active Worlds ™ and Adobe Atmosphere ™, the affordances and constraints of the programs were compared in terms of both interface and design. From this comparison, it was suggested that the interactivity afforded by 3D virtual worlds lends itself to the realm of constructivist learning. This suggests that virtual environments offer the opportunity for unique user manipulation and exploration, which is a pillar of constructivist learning theory.

Virtual worlds appear to have much to offer the field of education. Regardless of which brand or version is used, their interactivity and manipulability seem to make them excellent options for classroom or educational use. Their connection to the constructivist theory of learning offers additional benefits to the development of students, and because they are not games in and of themselves (although commonly mistaken for games), this argument can help to strengthen the possibility that the use of virtual worlds will become more widespread. Having given some consideration to virtual worlds and their possible role in the field of education in general, the following section defines and discusses the role of a specific type of learning, incidental learning, in the context of virtual worlds.

Incidental Learning

Because humans are, by nature, learning beings, we are often able to learn in various and diverse ways. But the *type* of learning that takes place is something that must be discussed and understood as a part of this study. Incidental learning is important to virtual worlds because it seems that these worlds have excellent potential to be used as learning environments (see Furguson, 2011; Neeley et al., 2010), so it would be logical to consider what type of learning occurs within. In order to understand certain concepts, it may be necessary to cross over into other fields of research or combine the benefits of one field with those of another in order to optimize student learning experiences. Much of the literature that is available on incidental learning, however, centers on the topics of language acquisition and learning within organizations (see Marsick & Watkins, 1990; 2001; Marsick & Volpe, 1999; Reber, 1989; Stokes & Pankowski, 1988). While many viewpoints and opinions have been reviewed and considered, it seems that no consensus as to what defines incidental learning has been reached (Hulstijn, 2003; Gass, 1999). This section of the literature review seeks to define examine and synthesize the extant information available on incidental learning.

Defining incidental learning. In the literature, there is a limited amount of dialogue in regard to what incidental learning is and what it is not. While a variety of research has been conducted on incidental learning, a concrete and consistent definition of incidental learning has yet to be established. From the perspective of those unfamiliar with the term, there may also be some confusion regarding a number of terms with which incidental learning has been synonymized.

Incidental learning is a term that is difficult to isolate and define because it is both similar to, and a subset of, other terms in the learning literature. For example, Schugurensky (2000) considers incidental learning to be “learning experiences that occur when the learner did not have any previous intention of learning something out of that experience, but after the experience she or he becomes aware that some learning has taken place. Thus it is unintentional, but conscious” (p. 4). A practical application of this definition might be in the case of a student who signs a petition at school to stop the implementation of uniforms, and this action helps her become more active and aware of politics during an election, we might say that incidental learning has taken place. Incidental learning is a subcategory of, and can be considered a form of, informal learning. Marsick and Volpe (1999) define informal learning as the unstructured learning that takes place as people go about their daily lives; it typically occurs outside of formal institutions (informal learning will be explored in more detail later in this section). As a simple explanation, Gass (1999) defines incidental learning as a "byproduct of other cognitive exercises…" (p. 319). Additionally, in their research on learning in aging adults, Stokes and Pankowski (1988) also looked at incidental learning, and considered it as the "…acquisition of facts or information that occurs by chance while one is engaged in another activity" (p. 89). From the definitions above, it can be gathered that incidental learning is something that happens unintentionally while the learner is doing something else. This can have implications for education and student learning in classrooms because many times, while learners are receiving instruction for the day, they could be acquiring other information, or behaviours.

Because there is little written on incidental learning within the field of education, it is necessary to turn to other fields where the research is more recent and ongoing. Marsick and Watkins have conducted some of the most seminal work in the field of incidental learning within organizations and the workplace. In their view, incidental learning is "… never intentional and seldom explicit. It is serendipitous or coincidental with some other activity, and largely buried in the context of other tasks" (1990, p. 8). Consider the example of a student in a classroom. If a student attends a new class and observes that the instructor has a lack of control over other students, the new student may incidentally learn that the class is not important or worthwhile though he has not been explicitly told (Marsick & Watkins, 1990). As with most definitions, there are restrictions and delimiters. In their definition of incidental learning, Marsick and Watkins state:

> Incidental learning is always delimited by the nature of the task that spurred its creation… it is always tacit, whereas informal learning may be more or less tacit; and success in this kind of learning always depends on the ability of the person to frame the problem adequately. (p. 8)

A few circumstances in which incidental learning might take place from an organizational learning perspective include situations where an individual learns from their errors, makes an assumption, or forms a mental framework regarding others (Marsick & Watkins, 1990). More often than not, incidental learning occurs during everyday tasks, but not necessarily at a level of high effort or consciousness. Incidental learning is multifaceted because it includes different learning experiences such as learning from mistakes and learning by experimentation. Having defined the concept of incidental learning, an understanding of other learning contexts is also helpful in understanding the topic.

Informal learning. In a search of the literature regarding incidental learning, one construct that appeared frequently was that of *informal learning*. Informal learning is considered to be "a category that includes incidental learning…and [the] control of learning rests primarily in the hands of the learner" (Marsick & Watkins, 1990, p. 12). For example, if a student had a coach or a mentor, that would create a situation for informal learning to take place.

Schugurensky (2000) determined that informal learning occurs outside of a prescribed curriculum and there is no one directly teaching the program. This also infers that informal learning is stochastic; some students will learn, while others may not. Informal learning differs from typical formal learning where a ministry of education or another official body provides a set curriculum. However, Schugurensky (2000) also determined that learning outside a prescribed curriculum is not limited to non-formal educational institutions; informal learning occurs in both the non-formal and the formal setting. For example, informal learning may occur at a conference workshop (non-formal setting) as the keynote speaker discusses research on student motivation, and there could be informal learning occurring in a junior high school classroom as a veteran tells a war story while guest speaking (formal setting).

Informal learning can be appropriately considered as an 'umbrella term' that includes incidental learning. In an attempt to establish a hierarchy within the category of informal learning, similar to the encompassing category suggested by Marsick and Watkins above, Schugurensky (2000) suggests three types of informal learning: self-directed learning, incidental learning, and socialization (see Figure 1). A self-directed learner is considered to have direct intention to learn, as well as a certain level of consciousness. He states that self-directed learning is

> …both intentional and conscious. It is intentional because the individual has the purpose of learning something even before the learning process

> begins, and it is conscious in the sense that the individual is aware that she or he has learned something. (p. 3)

For example, if a student decided to learn all the defenses of a character in a videogame, he would be engaged in self-directed learning. Incidental learning is defined as unintentional learning experiences (same as above). Socialization is similar to incidental learning, but it focuses more on sociological and cultural aspects. It is also sometimes called tacit learning. Socialization is defined as "…the internalization of values, attitudes, behaviors, skills, etc. that occur during everyday life. Not only do we have no a priori intention of acquiring them, but we are not aware that we learned something" (p. 4). An example of this would be a person who learns the traditions, norms, or behaviors of a new culture by visiting a foreign country. This implies a lack of intention to learn on the part of the learner but still suggests a level of consciousness necessary for learning to occur. Given these suggested categories, it is clear that informal learning is a broader topic with sub-topics or varying forms.

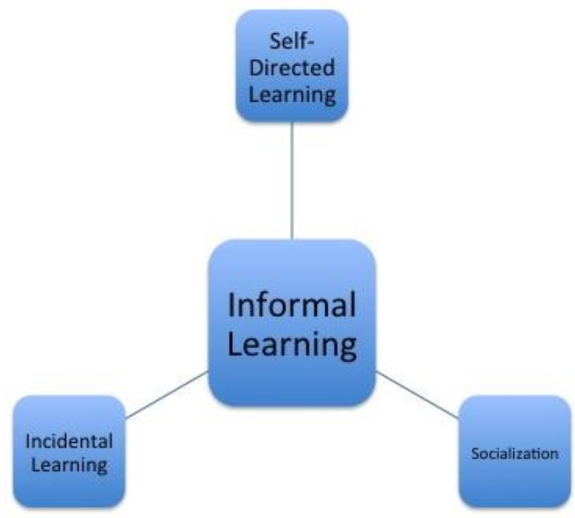

Figure 1. Categories of informal learning.

Incidental learning differs from informal learning because the information in incidental learning is coupled with the interaction at the time of communication, which is not the case with informal learning. Marsick and Watkins (1990) suggest a spectrum of consciousness and awareness for informal and incidental learning. It is proposed "the degree of conscious awareness plays an important role in the clarity of learning. This may be especially true for incidental learning because the person's attention is turned elsewhere" (p. 13). Some level of consciousness and attentiveness is required for both learning types, but incidental learning has a lower consciousness 'threshold' than does informal learning. This attention must be given to the information being communicated in order for learning to take place. This is important because before a person can learn anything, there must be a minimum level of consciousness. As consciousness increases, the type of learning that takes place can change. To further help shape the concept of incidental learning, Marsick and Watkins (1990) clarify that it is bound by the context of the task at hand. To clarify, when the learning coincides with a task, it is the task that determines factors such as allotted time and levels of success. Similarly, a socio-cultural aspect to incidental learning is also proposed, since incidental learning can take place in family, group, or cultural settings, at work or public places, or wherever there is social interaction (Marsick and Watkins, 2001).

Informal and incidental learning are similar in that both “take place wherever people have the need, motivation, and opportunity for learning” (Marsick & Watkins, 2001, p. 28). Also, both “generally take place without much external facilitation or structure (Marsick & Watkins, 2001, p. 30). In their 1990 work, Marsick and Watkins suggest informal and incidental learning differ

> …in that the messages that are being conveyed are often buried in the interaction. Attention is needed for people to learn both informally and incidentally, but a different kind of attention is needed in the latter. People must shift their attention to these byproduct messages and see them clearly before they can learn. (p. 14)

Incidental learning needs to be studied and is critical to education because it could have important implications for the way children learn and what they learn both inside and outside of the classroom. The setup of a learning space and surrounding environment could mean different things for different learners. Discovering what these ‘different things’ are, and informing teachers could make a substantial difference for the majority of learners.

Formal learning. Another term used in the literature that can be considered a context is formal learning. Marsick and Watkins (1990) propose that formal learning is a broad category and involves schools or other institutions, as well as a formal structure. Formal learning differs from incidental learning in that things formally learned are bound and often directed by a teacher or other authoritative source. Similarly, the teacher typically receives direction from a formal and official source (e.g., subject curriculum) before teaching the learner. This major distinction between formal and incidental learning presents itself in classroom contexts because in order to learn incidentally, no formal curriculum is required. Incidental learning can be unbound and unplanned, yet still take place. In a classroom, an educator may presume that his or her students are also implicitly learning certain things that are not explicitly remarked on, but that does not mean the educator did not plan for such learning. However, as stated by Schugurensky (2000) earlier, in order to qualify as incidental learning, there can be no prior intent to learn the subject matter on the part of the learner. In experimental settings, a researcher could mitigate this intent to learn by including distractor tasks and/or not informing the learner that the information encountered will be required of them later on (e.g., Baddeley, 1997). Formal learning, in this sense, is not the same as incidental learning because the teacher has directly advised the student (typically in an institutional setting) to learn or memorize the given material, and the student is aware that he/she will be tested on the given information or content.

Non-formal education. Another context connected to incidental learning is *non-formal education*. Coombs and Ahmed (1974) define non-formal education as “any organized, systematic, educational activity carried on outside the framework of the formal system to provide selected types of learning to particular subgroups in the population…" (p. 8). Schugurensky (2000) suggests that although non-formal education is organized and planned, it occurs without a traditional or formal system of schooling. There are teachers present, and a plan is followed; however, there is no grading attached to the learning. In order to help further differentiate, examples of non-formal education could be a first-aid training class, or a workshop at a conference. This term cannot be synonymous with incidental learning because it is more concerned with the *educational context* and setup as opposed to the actual learning. However, as an example, a student can still learn something incidentally in a first-aid training class; therefore, incidental learning can occur within non-formal educational contexts, but non-formal education is not incidental learning.

Unintentional learning. Unintentional learning is a construct that is very similar to the idea of incidental learning. In fact, incidental learning can be thought of as a form of unintentional learning because, as mentioned earlier it occurs unintentionally. In 2012, Schmidt and DeHouwer conducted a study examining unintentional learning. The study was conducted on 46 undergraduate students and sought to examine unintentional learning contingencies and how intentional learning influences performance on these contingencies. Half of the participants (control group) were told that there would be contingencies in the information presented to them (coloured words) while the other half were not. The study contained distractor words in red and words in green and participants were told that they were to respond to the font colour of the words. Those in the experiment group were told that some words would appear in a particular colour, more often and were instructed to learn the word most often presented in that particular colour (this created a goal for them). Afterwards the participants were questioned as to whether or not they realized the contingency and asked which colour each word had appeared in the most often. The study found that intentional learning can help to increase unintentional learning (more on intentional learning next). This conclusion was drawn because those who were informed of the contingencies beforehand performed better than those in the control group. Schmidt and DeHouwer use the term unintentional learning paradigm (the idea of unintentional learning) “to refer to a learning task that, in the absence of the instruction to learn contingencies, would result in unintentional learning” (p. 724). In the experiment, similar to an incidental task, those in the control group were not given prior knowledge about the contingencies before the experiment. Through this study the researchers showed that introducing a goal helps to improve learning, even if it is unintentional learning.

Intentional learning. The contrast to unintentional learning is that of intentional learning, which is on the other side of the spectrum. While it is not immediately confused with incidental learning, I include it here because of its relation to the context of unintentional learning. Intentional learning is a type of learning that applies itself very well to factual knowledge and has a set learning goal, which distinguishes it from incidental learning. Intentional learning typically occurs in formal (institutional) settings. It is similar to incidental learning in that it also requires some level of attention and noticing (Hulstijn, 2003) however, the two terms also differ on the grounds that they require differing degrees of effort on the part of the learner. Gass (1999) proposes a spectrum of effort on which incidental learning is on the minimal end, and intentional learning is closer to the maximum end (see Figure 2). While the literature does not provide any direction as to the idea of more or less ‘effort’, it seems to be determined by the complexity of the task and the amount of thought required to process the concept or task.

Figure 2. Spectrum of effort. Incidental learning falls at the lower end of the spectrum of effort.

Given the positioning of both incidental and intentional learning on this scale of effort (Gass, 1999), it seems that unintentional learning should be plaved close to, if not right beside incidental learning in Figure 2.

Incidental learning and consciousness. A spectrum of consciousness is proposed in regard to incidental learning. This spectrum demonstrates how much consciousness is required for learning to qualify as informal or incidental (see figure 3). Consciousness or level of awareness is an important part of learning, and as such, incidental learning begins near the middle of this spectrum (Marsick and Watkins, 1990; Watkins and Marsick, 1992).

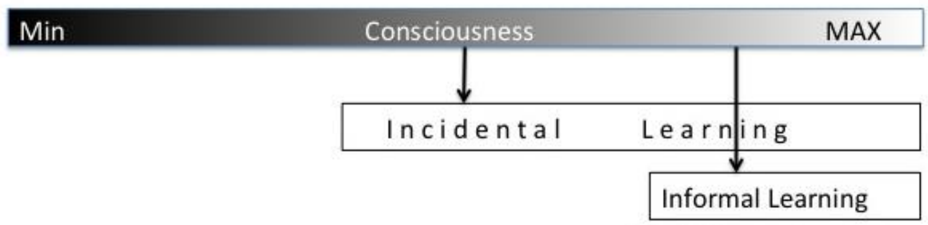

Figure 3. Spectrum of consciousness. Incidental learning lies in the middle of the spectrum of consciousness.

In incidental learning, consciousness is of more importance than in informal learning as attention plays a crucial role in learning and clarity. It has been suggested that informal and incidental learning share the commonality of occurring in day-to-day experiences without any formal or rigid structuring. Marsick and Watkins (2001) propose, “when people learn incidentally, their learning may be taken for granted, tacit, or unconscious. However, a passing insight can then be probed and intentionally explored” (p. 25). Terms such as tacit learning, formal learning, and non-formal learning, although related, cannot, and should not be considered synonymous with informal or incidental learning. Marsick and Watkins (1990) suggest that informal and incidental learning, while similar on some accounts, are quite different concepts:

> Incidental learning is defined as a byproduct of some other activity, such as task accomplishment, interpersonal interaction, sensing the organizational culture or trial-and-error experimentation. As such, incidental learning is never planned or intentional, whereas informal learning can be planned or intentional, as for example, in self-directed learning or help consciously sought from coaches or mentors. (p. 7)

Implicit learning. Another construct term associated with incidental learning that stems from the cognitive and behavioral psychology literature is called *implicit learning*. Though it is similar to incidental learning, it should not be confused with incidental learning. Seger (1994) defines implicit learning as the "non-episodic learning of complex information in an incidental manner, without awareness of what has been learned" (p. 163). In their research on implicit learning, Dienes and Berry (1997) stated the common element in implicit learning is that "the person typically learns about the structure of a fairly complex stimulus environment, without necessarily intending to do so, and in such a way that resulting knowledge is difficult to express" (p. 3). This essentially means that the learner cannot recall how or possibly even where they learned the information. This is quite similar to a description by Broadbent (1991). In a description of an experiment examining implicit learning, Broadbent (1991) says it is "one in which the person is able to choose the correct reaction while in a task, but is later unable to recall the key characteristics that controlled the behavior" (p. 128). An example of implicit learning could be seen in an individual learning to skate. This activity is done *implicitly*, but it is done in an *incidental* manner. This particular example would be *intentional* because the individual actually does want to know how to skate. If, however, through this learning experience, the individual learns some basic properties of friction, then the learning in regard to friction would be *unintentional* learning.

Seger (1994) suggests that implicit learning is related to attention and working memory. Seger also proposes some characteristics regarding implicit learning. It was determined that what is learned may be stored, but not necessarily immediately retrievable or dissociable from other information within the brain. While there is less of a consciousness as compared to the other types of learning, there is still an aspect of memory present in implicit learning. The information the learner acquires also has a level of complexity to it. Implicit learning "does not involve processes of conscious hypothesis testing but is an incidental consequence of the type and amount of cognitive processing performed on the stimuli" (p. 164). Similar to how Schugurensky (2000) and Marsick and Watkins (1990; 2001) look at incidental and informal learning, Seger (1994) too states that implicit learning is one of the many occurrences that does not require the learner to be fully cognizant.

According to Dienes and Berry (1997), there are also differing degrees of implicitness. They suggest that the implicitness of a fact or item is reliant on the idea that the knowledge or item is not easily accessible in some way or another. Much of the research in implicit learning involves the learning of made-up grammar or artificial language. In 1967, Reber presented the idea of an artificial or 'synthetic grammar' which is made up rules in a series of strings. In his experiment, strings of letters were presented to the participants repeatedly. Participants were not told that there was any order or consideration given to the strings and were asked to memorize the strings as part of a memory experiment. As the experiment progressed the participants became better at memorizing if there was a pattern to the string they were given, but those without any order to the strings didn't improve in their memorization. The participants in the first group learned the underlying structure and were able to use it to identify 'correct' and 'incorrect' strings in the second half of the experiment. It can be said that these participants implicitly learned a new 'grammar' and used what they learned to help them succeed in another task. There are similar instances of this in the learning of language and spelling. From this and other studies (see Dulany, Carlson, & Dewey, 1984; Mathews, Buss, Stanley, Blanchard-Fields, Cho, & Druhan, 1989; Millward, 1981; Morgan & Newport, 1981), it is evident that implicit learning focuses on the discerning and learning of underlying structures. These structures are learned through repetition and multiple interactions with any given stimulus or information that has not been explicitly presented to the learner. While this sounds a lot like incidental learning, one major distinction between the construct of implicit learning and incidental learning is that, as demonstrated above, incidental learning can occur after just a single interaction with presented material. Now that a more thorough description of the various learning types has been presented, it is time to turn to an examination of some of the existing studies involving incidental learning.

Additional studies on incidental learning. Other views of incidental learning include a language acquisition standpoint and a research study perspective. In the field of second-language acquisition, Hulstijn (2003) suggests that incidental learning is the idea of acquiring something like vocabulary through everyday activities. On the research side of incidental learning, Hulstijn says "incidental learning [involves] the 'picking up' of words and structures, simply by engaging in a variety of communicative activities… during which the learner's attention is focused on the meaning rather than on the form of language" (p. 355). This aligns with Marsick and Watkins' (1990) idea of incidental learning occurring while some other action or activity is taking place because while the learner is communicating as a daily necessity, learning is taking place. In theory, incidental learning includes abstract and factual (or declarative) knowledge, but in experimental setup and design, participants in studies of incidental learning are not informed as to whether or not they will be tested on the information they are presented with (see Baddeley, 1997; Doughty, 1991; Hulstijn, 1989; Robinson, 1996; 1997). As such, participants typically do not make any attempt to memorize this information. In one study, Hulstijn (2003) had separated participants into various groups. For this study:

> Participants in the incidental condition perform an orienting task on the stimulus materials, but they are given no instructions to learn and they are unexpectedly given a retention test afterwards. Participants in the intentional conditions are told in advance that they will later be tested. (p. 355)

In another study on word occurrence, task performance, and incidental acquisition of vocabulary conducted by Laufer and Rozovski-Roitblat (2011), subjects were tested unexpectedly and in a way that was, to their knowledge, unplanned. In a study by Plenderleith and Postman (1957) a recall test between intentional and incidental learning subjects was conducted. In the experiment, those in the incidental group were questioned as to whether or not they had tried to memorize the words or syllables presented, and the data of those who indicated that they had memorized was replaced. In this test, the incidental participants were not instructed to remember the words presented, which was one of the distinguishing factors between the two groups. In a 1988 study, Stokes and Pankowski set up their experiment so that the subject material was not common knowledge that could have been easily guessed on a recall test. In the study 79 aging adults viewed a television documentary in an informal setting. They were then given cued recall tests to evaluate how much they recalled and which aspects or ideas they recalled both immediately and after time had passed. The researchers concluded that the learning that occurred in this study was incidental because this is mostly the type of learning that takes place during television viewing (mid-consciousness and low effort). This is consistent with the fact and information acquisition definition Stokes and Pankowski (1988) provided earlier. The definition used over the course of this research study is incidental learning as unplanned learning that takes place while engaged in another task/activity.

The above-mentioned terms are only a few of many that exist in the literature and they have been described in this review in order to establish a basis for the definition of incidental learning. Informal and formal learning, non-formal education, unintentional and intentional, and implicit learning, while all somewhat related to incidental learning are most certainly not synonymous with the term. The term is still far from being well defined. In fact, at one point, Dienes and Berry (1997) refer to implicit learning occurring under “incidental learning conditions.” This suggests that incidental learning can also be thought of as a condition of learning. Although incidental learning is not the easiest concept to define, there are some steps we can take to help us understand it better. It is important to consider not only the concepts of context and construct, but also, the consciousness, and the effort that goes into a situation before incidental learning can be considered to have taken place. With the shift towards technology integration in today's classrooms, incidental learning may take on a larger role. Having discussed some of the extant learning types in the literature, it is important to also consider the way in which learners experience the learning process itself. Are there optimal ways to learn for particular learners? Do all learners learn the same? The following section explores the concept of learning styles in education.

Learning Styles

Learning styles are important to this research because it seems that different learners have varying learning preferences. Learning styles could potentially have an effect on how students learn in their classroom and ultimately how this transfers to online learning or virtual classroom learning. It must be understood because a particular type of learner may learn better or differently than another on one task, but not on another even though the information is given within the same environment. Before going further, it is important to get a good understanding of what constitutes a learning style.

What are learning styles? The term "learning style" is one that is very difficult to define. The problem arises not because there is a lack of definitions within the literature, but because there are multiple definitions in the literature, and to compound the issue, there does not appear to be any agreement on which definition is "correct." Pashler et al. (2008) refer to the idea of learning styles as

"…the concept that individuals differ in regard to what mode of instruction or study is most effective to them" (p. 105). Essentially, it refers to the idea that there are different ways of learning for different individuals. Dunn (1990) defines learning style as "the way each learner begins to concentrate, process, and retain new and difficult information" (p. 224). Hartley (1998) defines learning style as a characteristic approach to learning demonstrated by students. When attempting to learn new information, learners have the option to employ many learning styles, or simply utilize a single learning style. In another view, Sternberg, Grigorenko, and Zhang (2008) simply use the term "style" and define it as a difference in approach used by a learner to help them complete various tasks. They suggest that the term is cognitive because it looks at how an individual learns, understands, or interprets information, but the term is not to be confused with 'cognitive styles,' which will be discussed a little later on. In an overview of the theories, models, and measures of learning styles, Cassidy (2004) points out that while a particular 'style' may exist and have a structure, the structure itself relies on experiences and the present situation, and responds accordingly. In other words, the connection between ability and performance based on learning style depends on the task given.

There is such disagreement on a definition for the term "learning styles" that a group of leading researchers in the field ran a survey which asked other researchers how they would define learning style. Peterson, Rayner, and Armostrong (2009), recruited 94 researchers from around the world through conferences and mailing lists to complete the questionnaire. Of the 65 who responded, there were multiple definitions suggested, so the Delphi method was used to close in on a definition. After two rounds of voting the majority agreed upon the following definition of learning styles. “Learning styles are an individual’s preferred ways of responding (cognitively and behaviorally) to learning tasks which change depending on the environment or context. Therefore, a person’s learning style is malleable” (p. 12). The fact that multiple rounds of voting had to occur in order to reach a majority accepted definition demonstrates that there is still a lack of consensus of exactly how to define learning styles. For the purposes of this thesis, I have accepted and proceeded with the term as defined above by Peterson et al. (2009) because it is the most dynamic and in my view, the most appropriate for the research I am conducting.

Learning styles and theory. Within the concept of learning styles, there are different theories that exist. According to Pashler et al. (2008) the most popular is that of the matching or ‘meshing hypothesis.’ This idea suggests that there is an ideal teaching style that best fits a student with a particular learning style, and this idea has become prominent and influential across nearly all levels of schooling. The meshing hypothesis is in the same vein as the learning-styles hypothesis. The learning styles hypothesis is the idea that if learners are not taught in a way that fits their ideal learning style, then their learning will be inadequate, ineffective, or less efficient at best. Despite these ideas, Pashler et al. (2008) states that the learning styles hypothesis can in fact exist without the meshing hypothesis being correct.

What learning styles are not? Within the literature, there are multiple terms that are often mentioned alongside learning styles and in some cases used synonymously with learning styles. These terms include: cognitive styles, learning strategies, approaches to learning, cognitive structures, and thinking styles to name a few. For the purpose of conciseness, I will explore the most commonly found terms, which are cognitive styles and learning strategies.

Cognitive styles. Among the misused and misinterpreted terms, the most commonly mentioned and used interchangeably is 'cognitive styles.' In their review of literature and theorists in the field of styles research, Riding and Cheema (1991) indicate that there is no consensus as to the meaning of cognitive style and state that it seems to be dependent upon the author writing at the time. Hartley (1998) defines cognitive style as a characteristic approach used by students to handle various cognitive tasks. In another definition, Ausburn and Ausburn (1978) define cognitive style as a consistent way of learning employed by an individual, and state that it consists of psychological dimensions. They state that cognitive style suggests that there are differences in the way learners obtain, interact with, and process information and that these differences can be preferences set by the learner. In their research using the Delphi method, and surveying researchers in the field of cognitive and learning styles, Peterson et al (2009) could not settle on a single definition for cognitive style. After multiple voting rounds, there was still a split between two definitions. The authors chose to amalgamate the two most popular decisions to arrive at a definition that researchers could accept even though not all agreed. This definition states, "Cognitive styles are individual differences in processing that are integrally linked to a person's cognitive system. More specifically, they are a person's preferred way of processing (perceiving, organizing and analyzing) information using cognitive brain-based mechanisms and structures. They are partly fixed, relatively stable and possibly innate preferences" (p. 12). Now while these two definitions received the majority of votes, they were not the only ones submitted by the researchers surveyed. Recall that the study actually recalled two top definitions, suggesting that a consensus still does not exist.

Through their review of the literature, Riding and Cheema (1991) found that the term 'learning style' seemed to be used as a replacement for 'cognitive style' in some instances. They suggest that those who use the term 'learning style' do consider cognitive style, but are more focused on the educational facets and how they can be applied, while those who use the term 'cognitive style' have a more theoretical focus. Riding and Cheema (1991) also suggest that cognitive styles may actually be the basis of learning styles. To further differentiate between the learning style and cognitive style, they state that the number of dimensions or elements incorporated is also contrasting. A cognitive style tends to be more dichotomous, while learning styles tend to consider more varying elements that are not extremes. On a larger scale of measures, cognitive style and learning style fall between aptitude (natural ability) and personality (characteristic) measures, making them even harder to concisely define. The main idea behind cognitive styles seems to be that it is a more foundational and theoretical concept dealing with the brain and how it handles incoming information, making it more permanent and fixed than learning styles. Although this study is not concerned with cognitive styles, for the purpose of clarification, I consider the definition given by Peterson et al (2009) to be the correct definition of cognitive styles.

Learning strategies. Another term that appeared in the literature that may be confused with learning styles was learning strategies. Learning strategies are defined by Hartley (1998) as the method used by learners during study. Multiple strategies exist and the student can select whichever helps them best complete their task. While this definition sounds very similar to that of learning styles, Hartley (1998) goes on to suggest that a learning style is more *implicit* than a learning strategy, which is more of a choice. The difference between learning style and learning strategy is that “different strategies can be selected by learners to deal with different tasks. Learning styles might be more automatic than learning strategies, which are optional” (p. 149). In other words, learners can choose whether or not to use a given learning *strategy* but they cannot do much in the way of selecting their learning *style*.

In addition to all of these terms and definitions, Pashler et al. (2008) refers to a concept called the ‘existence of study preferences,’ which suggests that as long as someone is asked about learning preferences, they will give a response. This implies that learning styles and the other styles mentioned may only really be a topic of discussion because learners have been given the opportunity to voice their personal preference. See Figure 4 for a depiction of where the three aforementioned terms fit on a spectrum.

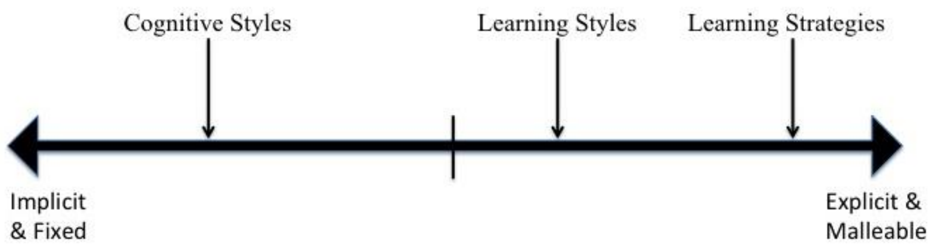

Figure 4. Spectrum of learning styles. Depiction of the spectrum on which learning styles and other terms fall. (Adapted from Ausburn & Ausburn, 1978; Riding & Cheema, 1991; Hartley, 1998; Peterson et al, 2009; Pashler et al, 2009)

History and background of learning styles. The concept of learning styles has a vast history that spans nearly 50 years and has been accepted both inside and outside the academic realm. As previously mentioned, there is not much consensus in the field of learning styles, but according to Coffield et al. (2004) three main areas exist: theoretical, pedagogical, and commercial. The area of theory is where the various learning styles are categorized and named and where instruments for measurement are created. The second area of pedagogy is research-based and investigates learning. It borrows from areas such as psychology, business, management, education, and educational policy. The commercial area of learning styles publishes and markets particular learning style inventories to businesses and educational institutions. Riding and Cheema (1991) present three main views to cognitive and learning styles: structure (content), process, and a combination of both structure and process. Within a structure view, stability becomes the focus and style becomes an established fact in an educational context. After categorizing style, the educational material is matched to compliment the learner's cognitive or learning style, which is similar to the matching or meshing hypothesis mentioned earlier by Pashler et al., (2009). With the process view, Riding and Cheema (1991) state that the focus is then how a cognitive or learning style develops and changes over time. There is then an attempt to further develop and build that process to overcome weaknesses in other areas. In the combined view, cognitive or learning style is seen as part structure and part process. It can be fairly stable, but always changing. In the combined view, style structure is constantly evolving and can be directly or indirectly influenced by events. Although not explicitly required for the purposes of this thesis, the research for this thesis was approached from a pedagogical and a combined standpoint.

Issues surrounding learning styles. As with many concepts and ideas within the field of education, the topic of learning styles has its share of issues not only because of its lack of consensus on the definition, but also because of the questions that arise from the instruments used to measure it. In a commentary on the use of learning styles in education, Roher and Pashler (2012) commented that despite the existing research on learning styles, there remains no basis or strong support for instruction tailored to student learning style. They also state that although many studies have been done, the results are always fairly weak from an empirical standpoint, in fact the results from many studies work against the field of learning styles rather than in its favor. At the end of their commentary, Roher and Pashler (2012) question the logistical demands of learning style tailored instruction for students because the learning style determination testing is so inefficient, and even go as far as to posit that there are likely many unpublished studies with equally unsupportive findings. Pashler et al. (2008) investigated the literature to find evidence of the usefulness of learning styles in pedagogy and agreed with Roher and Pashler (2012). They stated that there is currently no existing evidence for learning styles matching instructional strategies. In other words, there is a lack of support for the meshing or matching hypothesis. Coffield et al. (2004) had found that there is a lack of studies with hard empirical evidence that are fully robust, valid, and reliable. Pashler et al. (2008) recommend that in order to prove the need for separate learning style instruction, any studies proposing learning styles should result in a matching teaching method that works well for one student, but not equally well for a student of a different learning style. There should actually be an evident difference between the learning of the two students if learning styles do in fact exist. However, most studies that have been run have not used an adequate methodology to capture the appropriate validity of learning styles instruments and testing in the field of education, and of the studies that did manage to use an acceptable methodological approach, the results failed to support the idea of the existence of particular learning styles to match teaching strategies. Coffield et al (2004) believed that one of the complexities of the learning styles field is due to the fact that some models and instruments are designed for specific individual audiences. Because of this, researchers seem to be taking an existing model and modifying it to fit a new audience, resulting in multiple versions of any given model. This is confirmed by the identification of 71 existing models back in 2004. Of the models existing at the time, only 13 of them were unique and all of the other models were modifications or adaptations of one or more of the original 13 models Coffield et al. (2004). With all of these models, it is important to bear in mind that there are a few different approaches to learning style origins. While some theorists begin from the idea that learning styles are rooted in neural activity within various areas of the brain, other approaches suggest that learning style is rooted in personality traits, but there is no agreement on which is correct. When it comes to learning styles and pedagogy, often learning styles are misused and applied as labels to students, which can lead to students being streamed or treated differently, but many theorists encourage learning styles to be used as a collection of styles to be applied at different times. If used as a collection of styles, then any learner can work towards gaining various styles for various situations. Other theorists suggest that learning styles be used as an identifier of learner strengths and weaknesses so that they can understand where they may be having troubles academically and what may be causing these difficulties.

In their look into application of learning styles, Evans and Cools (2001) recommend that in order to make progress in the field of learning styles, researchers need to move away from focusing on matching learning styles to students and teachers because it is only a small portion of learning styles. Because it seems as though the matching or meshing hypothesis has directed researchers down a path resulting in a fairly myopic view of learning styles, they propose that more interdisciplinary collaborative research must be conducted in order to uncover more about the field of styles. The topic of how learning styles should be applied is another topic that gets into theoretical arguments going beyond the scope of this thesis, but it is mentioned here to give an idea of how vast and nebulous the field of learning styles has become over time.

Examples of learning style measures. With all of the learning styles models and instruments in existence, it is important to get a grasp of what exactly is available. In a review of theories, models, and measures in learning styles, Cassidy (2004) listed some of the existing learning styles and went on to describe, their authors and their instruments of measure later on in the review. This overview is summarized in Table 1.

Table 1.

Learning Style Models

Learning Style Concept	Author	Learning style Measure
Field-dependence/independence	Witkin (1962)	Embedded Figures Test (EFT)
Impulsivity-reflexivity	Kagan (1965)	Matching Familiar Figures Test (MMFT)
Leveller-sharpener	Holzman & Klein (1954)	Schematising Test
Holist-serialist	Pask (1972)	Problem-solving tasks
Verbalizer/visualizer	Pavio (1979)	Ability to generate information based on a spontaneous image
Style Delineator	Gregorc (1982)	The Style Delineator 40-item self-report
Assimilator-explorer	Kauffmann (1979)	32-item self-report instrument
Adaption-innovation	Kirton (1994)	32-item self report instrument
Intuition-analysis	Allinson & Hayes (1996)	38-item self-report questionnaire
ELM	Kolb (1984)	12-item self-report questionnaire
LSQ	Honey & Mumford (1992)	80-item self-report inventory
LSI	Vermunt (1994)	120-item instrument with 20 subscales
Surface-deep	Entwistle & Tait (1995)	RASI. A 44-item self-report inventory
SPQ	Biggs et al. (2001)	SPQ. A 20-item self-report questionnaire
ILP	Schmeck et al. (1991)	160-item self-report with 7 subscales

Conceptual level	Hunt, Butler, Noy, & Rosser (1978)	Paragraph Completion test
LSI	Dunn, Dunn, & Price (1989)	100-item self-report questionnaire
Styles of learning interaction model	Reichmann & Grasha (1974)	SLSS. A 90-item scale presented in 2 versions
Child rating form	Ramirez & Castenada (1974)	The Child Rating Form. A direct observation tool
ELSIE	Reinert (1976)	ELSIE. A 50 one-word item instrument
Cognitive Style Interest Inventory	Hill (1976)	Cognitive Style Interest Inventory. A 216-item self-report questionnaire
Learner types	Letteri (1980)	An instrument developed to represent multiple dimensions
Learning style profile	Keege & Monks (1986)	LSP. A 126-item assessment tool

Note. A non-exhaustive listing of learning styles to date. Adapted from Cassidy (2004).

From all of these learning styles I have chosen three of the more popular versions and models to describe further in order to present a clearer idea of the measurement of learning styles. The three learning style measures are the Dunn and Dunn Learning Styles Inventory, the Myers-Briggs Type Indicator (MBTI), and the Kolb Learning Style Inventory.

Dunn and Dunn Learning Styles Inventory. According to the review of Coffield et al. (2004) this inventory was authored by Dunn, Dunn and Price in 1989 and consists of a 100 item self-report questionnaire although there are shorter versions in existence. This model was developed over 35 years and is used heavily in elementary schools and teacher programs. It has a focus on the genetic and constitutionally based factors of learners in determining learning style. The questions stem from five components called ‘stimuli.’ These components are: environmental, emotional, sociological, psychological, and physiological. The model looks at learner preferences as opposed to strengths and weaknesses like other models do. The environmental component considers elements such as a learner’s preferred sounds and sound level, temperature, lighting, and room layout. The emotional component considers aspects such as a learner’s level of responsibility, persistence, motivation, and desire for structure. The sociological component assesses learner preference for things such as individual, partnered, or group learning. The physiological component considers the senses and perception, while the psychological component considers whether a learner is global or analytical, and whether they behave impulsively or reflectively. Given this description, Coffield et al. (2004) suggests that the Dunn and Dunn model seems to stress the biological and developmentally obtained characteristics of learners.

Myers-Briggs Type Indicator (MBTI). The MBTI is one of the tests that base learning style partially on stable personality type. The test focuses on five main personality type scales, which are: extraversion-introversion, sensing-intuition, thinking-feeling, and judging-perceiving, which result in 16 possible personality type combinations. In its standard form, the MBTI consists of 93 items on a forced-choice bipolar discontinuous scale, but there are other form versions for different purposes. After completing the questions on the indicator, one of 16 possible personality type combinations is returned. According to Coffield et al. (2004) most researchers accept the face validity of the MBTI to be reasonable, but questions still remain regarding the construct validity of the instrument. While many studies have been conducted on the MBTI and over 2000 articles have been written, concrete evidence to support the validity and pedagogical appropriateness of the instrument is lacking and most research results are inconclusive. Despite this inconclusiveness, the MBTI is still quite successful as a commercial testing instrument among business and within schools.

Kolb's Learning Style Inventory. Kolb's Learning Style Inventory (LSI) falls under the category of a flexibly stable learning preference assessment. It is based on the theory of experiential learning, which emphasizes learner-centered experience-oriented learning where meaning is made through direct experiences (Kolb, 1984). Coffield et al. (2004) note that the LSI has four learning styles: diverging, assimilating, converging, and accommodating. Kolb believed that "effective learners need four kinds of ability to learn: from concrete experiences (CE); from reflective observations (RO); from abstract conceptualizations (AC); and from active experimentations (AE)" (Pg. 61). The learning styles for this model consist of the following categories, which can be pictured on a set of intersecting axis:

Converging: abstract, active

Diverging: concrete, reflective

Assimilating: abstract, reflective

Accommodating: concrete, active

Kolb's LSI, like the other models is plagues with conflict between researchers. The validity and reliability of the LSI has been heavily criticized since its creation, and to add to the confusion, Coffield et al. (2004) point out that within the literature there seem to be as many supporting articles for the inventory as there are papers refuting its credibility.

As the above instruments demonstrate, it is near impossible to find one that is not contested and disputed within the literature, therefore researcher must decide on an instrument that best fulfills their intended purposes and conduct their research using that particular model.

Learning styles and virtual worlds. In an attempt to explain how a virtual world like second life can affect how users form their identity, their learning style compatibility, and the behaviour of trust, Junglas, Johnson, Steel, Abraham and Loughlin (2007) prepared a discussion on the matter. The discussion centers on the relationship between virtual worlds, learners, and their compatibility with the real world from a social psychology standpoint. The authors inquired as to whether or not learning styles traditionally exhibited by students translate into the virtual environment of a 3D virtual world such as Second Life (SL). As a method of determining existing learning styles, Junglas et al. (2007) suggested Felder and Silverman's (1988) Index of Learning Styles (ILS). Junglas et al. (2007) proposed that using virtual worlds in education could help to educate learners in the best and most comfortable environment possible that aligns with their particular learning styles and technological abilities. It is also suggested that the ability for users to explore with avatars within a 3D virtual world allows for more identity formation than in the real world, and that 3D virtual worlds work together with the learning styles of those in the millennial generation because there is multi-channel support via the multiple communication options available to users. Features like visual, textual, and auditory communication for users offered by virtual world programs like SL make these educational benefits possible. The authors also state that due to the prevalence of anonymity and the ease of changing avatars within virtual worlds, there may be more individuals in the stage of identity exploration, as well as more individuals who are non-committal than in the real world. Ultimately, Junglas et al. (2007) had called for the creation of a new learning style instrument that is relevant to millennial learners in order to better educate them within virtual environments.

Learning style measure in the current study. The decision was made to include learning styles as a measure in this study because, despite the flaws previously in regard to their definition and measurement, they are one of the only non-academic, non-IQ measures currently available. Learning style measures are also quite popular and accepted in various educational contexts (e.g., Kolb, 1984; Coffield et al., 2004). Because the purpose of this study is to provide more information into an under-explored area and encourage readers to reconsider how technology is used, this seems to be one of the most appropriate measures to consider and record for the intended audience.

While searching the literature, I came across an inventory of learning styles that, while almost just as contested as all the other existing inventories, contained the categories I wanted to assess, and had an acceptable level of validity and reliability for my study. The instrument I used is called the Index of Learning Styles and was created by Felder and Solomon (1994). The instrument consists of

8 categories along 4 spectrums. The spectrums consist of active-reflective, sensing-intuitive, visual-verbal, and sequential-global. The scales measure scores in terms of ‘balanced’ (a score of 1 to 3), ‘moderate’ (a score of 5-7), and ‘very strong’ (a score of 9-11) (see Appendix A for an example). The scores have different implications for the learners. If a learner is balanced, they will have an easier learning experience in an environment where that learning style is prioritized. If the learner has a very strong preference, the ILS suggests that they will experience more difficulty attempting to learn when that learning style is not prioritized in the surrounding teaching environment. Felder and Solomon (1993) state that everyone is in one of the two categories on each spectrum at any given time, which fits into the general definition of learning styles that suggests that a style is more flexible and adaptable as the situation or environment requires. Learners categorized as ‘active’ learn information most ideally when working with it. This could include teaching the information to others or having open discussions about it, resulting in the preference of working with others in pairs or groups. Learners categorized as ‘reflective’ learn information best by taking time on their own to think and process the information obtained. This may be important to virtual worlds because during the setup and design of a virtual space or environment, there may need to be designated active and reflective areas for learners. In these areas they could spend time working with information or reflecting alone on the information presented. Learners categorized as ‘sensing’ have a preference for learning factual information and set problem solving methods, while ‘intuitive’ learners like open-ended information that is non-

repetitive, with relationships that can be explored. This may be important to virtual worlds because when the decision of which topics or concepts to teach within a virtual world, it may be more beneficial to teach one within the virtual world, and one outside. At the same time, it is also possible that there is no difference, and that is something to be explored by this research. Learners categorized as ‘visual’ have a better memory for what they see, while ‘verbal’ learners have a better memory for words they see or hear. Authors suggest that ultimately a combination of visual and verbal information is best for all learners. This may be important to virtual worlds because the format of the information presented there would need to be considered as one format may be more efficient, but not necessarily as beneficial to the learners. Those categorized as sequential tend to use a linear and logical process of learning information whereas global learners tend to make leaps in their learning by obtaining bits of information and suddenly are able to put it together and see the bigger picture. This may be important for virtual worlds with regard to the process used to present information, and indirectly, the type of information presented. If factual information needs to occur in a linear fashion, a virtual world may or may not be the best environment for it to take place. It is the intent of this research to shed some light on the issue of not only incidental learning, but also learning styles within virtual worlds.

The concept of learning styles, as demonstrated above, is quite complex. With all of the various other terms surrounding it, it can be difficult to know which direction teaching practice should move in. Learning more about the connections between learning styles and learners will only serve to improve the quality of education provided to students. Upon giving consideration to learning styles as a measure for users of virtual worlds, it may also be beneficial to consider a second relevant measure that could help to predict student learning in virtual worlds. For this reason our focus will now turn to the topic of digital literacy.

Digital Literacy and Operational Internet Skills

Students' understanding of how the learning environment works can help to make them successful at learning. For this reason, it is important to consider a student's ability to use a particular technology if they are expected or encouraged to use it in the classroom or as a learning tool. At this point, it would be advantageous to shift the focus and examine the concept of Internet skills, which is embedded within digital skills, digital literacy, and ultimately information literacy.

Information literacy. The task of locating information on Internet skills is difficult due to the fact that it is nested within other types of literacies. The broadest and most overarching of these is the concept of information literacy. Information literacy is not the easiest term to define because it seems that different authors and researchers have their own ideas and approaches as to what it is and how it should be interpreted. In fact, the majority of the research and literature on the topic originates and is found in the field of library and information studies. Due to the fact that information literacy is not the focus of this study, only a brief introduction and explanation will be given. While investigating origins and concepts, Bawden (2008) states that the terms "information literacy" and "computer literacy" were created to accommodate information in computerized form (more on computer literacy later). Mossberger, Tolbert, and Stansbury (2003) define information literacy as "the ability to recognize when information can solve a problem or fill a need and to effectively employ information resources" (p. 38). This view of information literacy suggests that it does not necessarily involve technology right at the outset, but does leave the door open to technology as a means of obtaining said information. Steyaert (2002) defines information literacy as "the ability to translate this [technology literacy] into relevant information and implement it into one's life. It involves the ability and attitude to search for relevant information, translate it to one's own situation, and implement the necessary actions" (p. 204).

The concept of information literacy seems to have a root in taking information and using it to achieve a goal of some sort. But the concept of information literacy also has connections to other literacy terms. In Bawden's (2001) paper, information literacy is examined in relation to other types of literacy that exist in the literature, but specifically in relation to digital literacy. Eventually the term 'information literacy' expanded and began to include how individuals work with or handle information they encounter and in what form the information is presented. Mackey and Ho (2005) even go as far as to suggest a convergent model of information literacy that includes web-literacy and research literacy. Part of the reason that any concept of literacy is so difficult to pinpoint and clearly explain is best put by Karlson (2002):

> Literacy can never be understood as objective and ideologically neutral. Every use of writing is shaped in and by its social context, which means that even the most established and institutionalized conceptions of literacy can be traced back to social and cultural conventions and needs, as can any conception of prototypes. Each attempt to define literacy must both depart from and include the social institutions that surround and support it. (para. 14)

Essentially, there are almost as many terms, definitions, and concepts of literacy as there are fields to be researched. In relation to this study, having considered the umbrella term of information literacy it would be logical to focus in on a specific type of literacy, a subset of information literacy called: digital literacy.

Digital literacy. The term digital literacy has also been a difficult one to define clearly because, as with information literacy, there are multiple interpretations. The term digital literacy has not been around for very long. In fact, the term was officially introduced by Gilster (1997) in his book with the same title. The original explanation seemed to have the intent of presenting an understanding of literacy in a basic sense. In an attempt to define digital literacy, he mentions that it has more to do with the thought process and conceptualization than about mastering mere keystrokes (Gilster, 1997). He also mentions that it includes "…the ability to access networked computer resources and use them…" (p. 1). In the first chapter of his book he establishes a definition he believes to be realistic and general enough that a non-specialist audience can comprehend and make sense of the concept. Gilster (1997) calls digital literacy "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers” (p. 1). From these definitions it is apparent that the concept of digital literacy is not about any particular technology, but more about ideas and mindsets on any given technology, skill, or ability and information in any given form (Bawden, 2008). Beneficially, because the definition is somewhat broad, it is flexible enough that it can adapt to past and present situations, environments, and surroundings. Martin takes a similar broad approach as Gilster in his definition of digital literacy. He calls it:

> The awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse [sic], and synthesise [sic] digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process. (as cited in Bawden, 2008, p. 27)

In the examination of the origins and concepts of digital literacy, Bawden (2008) suggests that digital literacy can mean more than one thing, and that there is no single model that will work for everyone, or even a single person in every situation. He goes on to say that:

> Digital literacy touches on and includes many things that it does not claim to own. It encompasses the presentation of information, without subsuming creative writing and visualization. It encompasses the evaluation of information, without claiming systematic reviewing and meta-analysis as its own. It includes organization of information but lays

> no claim to the construction and operation of terminologies, taxonomies and thesauri. And so on. (p. 26)

From this reflection it becomes more obvious that the concept of digital literacies is quite vast and at times can prove to be nebulous. In tracing its history, Bawden (2008) mentions that the term ‘digital literacy’ fell out of favor in the late 1990s and into 2000 while the term ‘information literacy’ became more popular and widely used in higher education.

After looking at digital literacies, it became evident that there are other terms and concepts that may encroach upon the idea of digital literacy or borrow from it. For this reason, it would be best to examine some of these other terms in order to establish clarity as to their relation to digital literacy.

Terms related to digital literacy. The term digital literacy has been interpreted in various ways, but it always seems to tie back to some form of technology. Bawden (2001; 2008) states that some other terms (sometimes incorrectly used as synonyms) are: (1) information literacy (as discussed above), (1) computer literacy (used synonymously with: IT/information literacy, and technology/electronic/electronic information literacy), (2) e-literacy, (3) network literacy (used synonymously with: Internet literacy and hyper literacy), (4) informacy, (5) media literacy, (6) mediacy, (7) digital skills, and (8) web literacy. Some other terms mentioned in the literature include library literacy, ICT literacy, and information fluency. In 1980, the only terms that really caught on in the literature were library literacy and media literacy. By 1999 information, computer, network, and digital literacy had become popular with information and computer literacy being the most commonly occurring in the literature (Bawden, 2001). It would be worthwhile at this point to examine a few of these terms more closely.

Computer Literacy. The term computer literacy was popular back in the 1980s just before the term 'information literacy' came about in the 1990s. The term is still in use, but according to Bawden (2008) it refers more to one's ability to use a particular piece of software. Hunter (1983) referred to computer literacy as the understanding an individual needs to be able to function on a computer in his or her day-to-day tasks. It is also referred to as the knowledge, skill and attitudes necessary to effectively interact with computers (Husen & Postlethwaite, as cited in Bawden, 2001). Haigh (1983) suggests that computer literacy is the knowledge of computers that allows people to function efficiently enough to use them in their daily lives. Bawden (2008) posits that the concept of computer literacy could be an underpinning of digital literacy, but states that it is still unclear as to "whether [it] should be regarded as a part of digital literacy (perhaps in its formulation as "smart working" or "basic skills") or whether [it] should be assumed, before digital literacy is grafted on." (p. 29).

e-Literacy. The term 'e-literacy' is closely connected with the concept of digital literacy, but it is rarely ever used due to the simple fact that when it is pronounced, it sounds far too similar to 'illiteracy,' which is an opposing idea (Bawden, 2001; 2008).

Network Literacy. While some authors have upheld Gilster's (1997) general definition and idea of digital literacy, others have likened it to network literacy which has more to do with networked resources like the internet and their use in efficient and effective ways (Bawden, 2008). According to Bawden (2008), The term network literacy "focuses on digital information in networked form, and is synonymous with 'internet literacy'" (p. 23). In an article on network literacies for libraries, McClure (1994) referred to network literacy as "the ability to identify, access and use electronic information from the network" (p. 115).

Informacy. The idea of informacy arises from a combination of two concepts. It "implies traditional literacy, plus information literacy" (Bawden, 2008, p. 23). Ultimately, informacy can be considered another way of saying information literacy, which was discussed earlier.

Media Literacy or Mediacy. The term mediacy comes from a combination of the words 'media' and 'literacy' it "emphasizes an ability to deal with digital information in a variety of media" (Bawden, 2008, p. 23). Media literacy is "used to imply critical thinking in assessing information gained from the mass media: television, radio, newspapers, and magazines, and (increasingly) the Internet" (Bawden, 2001, p. 225). Media literacy is essentially the idea of being able to process and work with any form of media as an information source.

Digital Skills. The concept of digital skills, though only briefly mentioned by van Dijk (2005) is also related to the digital literacies "web" that currently exists. Digital skills are defined as "the collection of skills needed to operate computers and their networks to search and select information in them, and to use them for one's own purposes" (p. 73). This term, though it sounds very similar to digital literacy is slightly different in that it acknowledges both the hard and the soft skills needed to operate computers. This difference will become important later on when the focus shifts to examine van Dijk's (2005) categorization of skills.

Web Literacy. Web literacy is defined by Darrow (1999) as "the ability to access, search, utilize, communicate, and create information on the World Wide Web" (p. 35). For some, the idea of web literacy centers around one's ability to use the internet as a source of information and discern what is acceptable and what is not legitimate information. This is evident from Piper's (2000) statement that "while web literacy demands intelligent internet use, web literacy is not really quantitatively different than information literacy" (p. 49). In their look at challenges and opportunities of web literacy, Sorapure, Ingelsby, and Yatchisin (1998) suggest that "Web literacy, then, involves an ability to recognize and assess a wide range of rhetorical situations and an attentiveness to the information conveyed in a source's nontextual features" (p. 410). After an examination of web literacy and webpages, Karlsson (2002) implies that web literacy is made up of a series of different literacies and has a social practice component to it, making it more than just a single technology-related literacy. She suggests that the term is still quite ambiguous in the literature and may be more of a cognitive concept. In accordance with this idea, Mackey and Ho (2008) classify web literacy as something that "identifies the access and evaluation of web-based materials, as well as the production and distribution of web pages… it also includes the exploration of web-related issues through information science topics" (p. 545). In the testing of a convergent model of information literacy, Mackey and Ho (2005) conducted a study on students completing a course. 87 students were pre-tested via online survey at the beginning of the term. In their experiment, web literacy is defined in a much more technical sense as:

> a defined set of skills in web development knowledge (producing documents in HTML, XHTML, XML, and CSS), and web environment knowledge (web usability, web accessibility, information architecture, information ethics… Web literacy enables students to create meaningful content for the web and to effectively organize information in visual and textual media. (p. 548)

From this definition it becomes more evident that the focus of the definition for ‘web literacy’ in this particular study was more toward web development. The researcher wanted to know whether there was a relationship between information literacy, web literacy, and research literacy. Through this study, it was found that there is in fact a significant connection between information literacy and web literacy, which is composed of web development knowledge, web environment knowledge, and research skills. Having sorted through some of the various technology-related literacies, there is a need to consider some of the skills necessary for, and related to, these literacies. Next the focus will turn to the concept of Internet skills and its various categories.

Internet skills. Amongst all of the confusion of the previously mentioned terms, researchers from the Netherlands offer a more specific approach to the idea of digital literacy, namely in reference to internet skills, which is what this thesis research focused on. Van Deursen and van Dijk (2009; 2010) take issue with the current state and definitions of internet skills citing that many of the definitions for internet skills are misinformed because they do not have a theoretical underpinning, which results in multiple definitions that do not fully address the topic. They go on to suggest that most research into Internet skills do not consider anything more than ‘button knowledge’ yet the term ‘internet skills’ is still applied to it. A framework is proposed upon which Internet skills can be understood and its research can be guided. The research of van Deursen and van Dijk (2010) was spurred by the concept of the digital divide, which is the gap between those who have internet-enabled computers (or access to them) and those who do not (see DiMaggio, Hargittai, Celeste & Shafer, 2004; Neckerman, 2004; Hargittai, 2005).Van Deursen and van Dijk (2012) provide a listing and hierarchy of how Internet skills are related. These terms have been summarized from the literature in Figure 5. They suggest that there is no currently existing measure of Internet skill, so people often assume it is equated with Internet usage even though there is no clear relation between the two terms. A proposed cause for this lack of measurement is the inconsistency of the language and terminology used within the field as a whole. Van Deursen and van Dijk (2010) maintain that most terms are ill-defined and those that are defined are quite limited to a mere’ button knowledge’ while overlooking other important and critical skills. They go on to state that of the existing tests that attempt to measure internet skill, the questions asked do not specify a level of difficulty resulting in a measure of *internet* use as opposed to the sought after *internet skill(s)*. It is suggested that Internet skills are not a single concept or idea, but that they consist of a series of components which make up the term (van Deursen & van Dijk, 2009; 2010; 2012; van Dijk, 2005).

Categories of internet skills. There are categories of Internet skills, which are summarized in Table 2. The two main categories are the 'medium-related skills' and 'content related skills.' The first category, 'medium-related skills' (in this case, the medium is the internet) consists of 'operational skills,' which are basic Internet or computer use skills, and 'formal skills' which are skills related to Internet structure and tasks like searching. The second category of 'content related' skills consists of 'informational skills', which are actions users

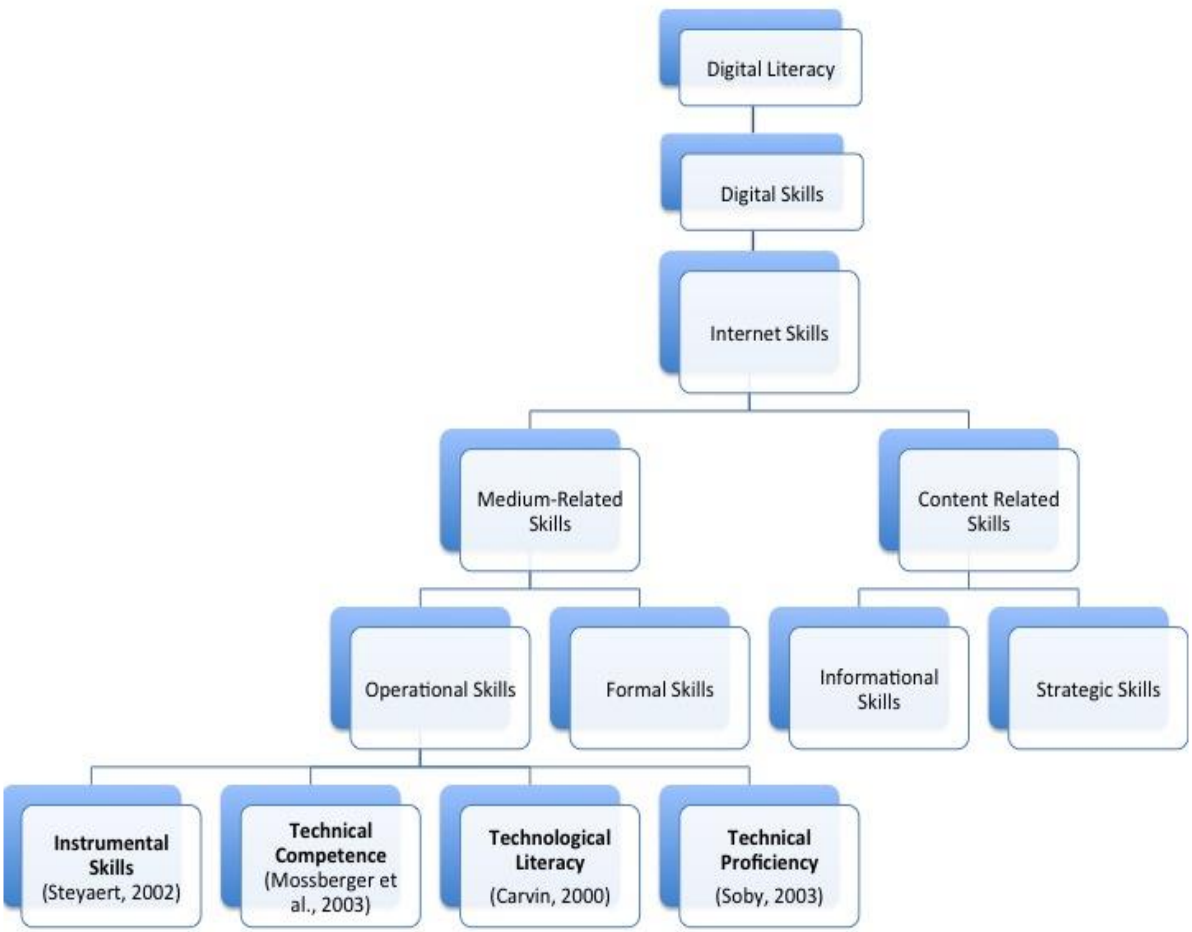

Figure 5. The concept of internet skills. Hierarchical summary of the internet skills concept

take to obtain the information they require, and 'strategic skills' which is the ability to use the internet to reach a desired goal. The authors then go further and suggest that there are additional subdivisions within these concepts (van Deursen & van Dijk, 2009; 2010; 2012; van Dijk, 2005). For the purposes of this research, I will focus in on the skill set I am interested in for this thesis, which are operational skills.

Table 2.

Internet Skill Indicators

Medium Related Internet Skills		
	Operational Internet Skills	Operational an Internet browser, meaning:
		• Opening web sites by entering the URL in the browser's location bar; • Navigating forward and backward between pages using the browser buttons; Saving files on the hard disk; • Opening various common file formats (e.g., PDFs); • Bookmarking web sites; • Changing the browser's preferences.
		Operating Internet-based search engines, meaning:
		• Entering keywords in the proper field; • Executing the search operation; • Opening search results in the search result lists.
		Operating Internet-based Form, meanings:
		• Using the different types of fields and buttons; • Submitting a form.
	Formal Internet Skills	Navigating on the Internet, meaning:
		• Using hyperlinks (e.g., menu links, textual links, image links) in different menu and website layouts.
		Maintaining a sense of location while navigating on the Internet, meaning:
		• Not becoming disoriented when navigating within a web site;

		• Not becoming disoriented when navigating between web sites; • Not becoming disoriented when opening and browsing through search results
Content-Relates Internet Skills		
	Information Internet Skills	Locating required information by doing the following:
		• Choosing a web site or a search system to seek information; • Defining search options or queries; • Selecting information (on web sites or in search results); • Evaluating information sources.
	Strategic Internet Skills	Taking advantage of the Internet by doing the following:
		• Developing an orientation toward a particular goal; • Taking the right action to reach this goal; • Making the right decision to reach this goal; • Gaining the benefits resulting from this goal.

Note. Conceptual definition and indicators for internet skills (van Deursen & van Dijk, 2010, p. 898)

Operational Skills. The term that best aligns with the purposes of this research seems to be that of operational internet skills because I am interested in finding out how a learner's ability to interact with the internet influences their ability to learn incidentally in virtual worlds. The definition of operational skills is based upon a collection of definitions from other authors within the digital literacies field (e.g., Carvin, 2000; Steyaert, 2003; Mossberger et al., 2003). The first definition borrowed by van Deursen and van Dijk (2009; 2010; 2012) was that of 'technical skills' originally contributed by Steyaert (2002). Instrumental skills are defined by Steyaert (2002) as "the ability to use technology to handle the basic functionality of the hardware or software involved" (p. 205). The next definition used to compose the concept of operational skills is that of ‘technical competence.’ Technical competence is defined by Mossberger et al. (2003) as “the skills needed to operate hardware, such as typing, using a mouse, and giving instructions to the computer to sort records in a certain way” (p. 38). Another definition used was ‘technological literacy. Technological literacy is defined by Carvin (2000) as “the ability to utilize common IT tools, including hardware, software, and Internet tools like search engines” (p. 42). Steyaert (2002) calls technological literacy “one’s ability to operate the technology…” (p. 204). Lastly the idea of ‘technical proficiency’ is included in the concept of operational skills. Technical proficiency is defined by Søby as “the basic component of digital literacy, including a foundational knowledge of hardware, software, applications, networks, and elements of digital technology” (as cited in van Deursen & van Dijk, 2010, p. 894). Although quite technical on their own, when taken together, these definitions are used to compose the concept of operational skills, which is ultimately defined as “the skills used to operate computer and network hardware and software” (van Dijk, 2005, p. 73). Van Duersen and van Dijk’s (2012) use this novel perspective on the topic of Internet skills to drive research in the field.

Research using van Deursen and van Dijk’s internet skills measure. Van Deursen and van Dijk (2009) conducted a study investigating the issues users face while using the Internet and incorporated the four sub-definitions on Internet skills in their study. 109 subjects were recruited by random dialing to towns and villages near the University of Twente in the Netherlands. Participants were given a questionnaire, and a series of assignments to complete while the screen actions were recorded and reviewed. Subcategorizing the definition of Internet skills into the four components allowed researchers to learn about, pinpoint, and classify issues related to topics like operation of the Internet. For example, from this study, it was found that 5% of the subjects had issues with the address bar; 37% had issues with saving files; and 90% were able to use bookmarks and favorites in their browsers (van Deursen & van Dijk, 2009). The study also found that age is mainly related to operational and formal problems, but does not seem to make a difference for informational and strategic skills. This is why it is important to divide the term ‘Internet skills’ into components, in order to minimize broad, sweeping generalizations and assumptions. For example, if one were to say that older individuals have poor Internet skills, by this model, it would not be entirely true. The study results suggest that tests of Internet skill should account for all four components of Internet skill, or specify which skill set it is they are examining. van Deursen and van Dijk (2009) go on to suggest that their taxonomy provides a more comprehensive view and understanding of the concept of internet skills.

In another study focusing on e-health, van Deursen and van Dijk (2011) tested 88 randomly selected participants from the Netherlands and again the four Internet skill components were taken into consideration. A questionnaire was given, followed by a set of health-related assignments, which the participants performed in a university office setting. From this study it was found that although the population sample was not large enough for generalization, individuals have adequate formal and operational skills, but are lacking in strategic and information skills. It was also found that operational, information, and strategic Internet skills had a vey weak correlation with Internet experience and time spent online. In other words, spending more time online or having used a computer longer than someone else does not necessarily improve one's operational, information, or strategic Internet skills. Van Deursen and van Dijk (2011) additionally found that when it comes to using the Internet for health-related information, the operational and formal skills of participants were insufficient. Through analysis, they determined that age was a factor in the formal and operational (or medium-related) skills, but this was not the case for the information and strategic (or content-related) skills. The results of these studies on Internet skills are important to the research at hand because it gives an indication of a given population (randomly sampled) digital literacy via operational Internet skills. If these skills do prove to be important to incidental learning in virtual worlds, then schools and other institutions considering entering the realm of education via virtual worlds will have to ensure that their participants are both prepared for and equipped with the appropriate level of internet skills. After reviewing some of the various Internet skills in the literature, it is important that an appropriate instrument is selected to measure these skills for the purpose of this study. Next, the instrument selected for data collection will be introduced.

Selected instrument. In the current study, The Survey of Web-Oriented Digital Literacies (Hargittai, 2005) was used as a predictor of incidental learning in students. The instrument was created to measure the actual web-use skill of individuals via survey questions in order to eliminate the need for bringing participants into a lab or testing facility in order to assess the skill. The goal of the author was to create a measure that would serve as a representation of an individual's observed web-use skills and answer questions about digital literacy that existing surveys fail to answer. Hargittai (2005) stated that much of the current literature on computer and internet skills focuses on perceived skills as opposed to actual ability This is an issue because internet use is about more than simply having internet access. A user's digital literacy can play a role in their use of the access they have available to them. The instrument seeks to examine the level of understanding of terms connected with digital literacy and to measure internet-related knowledge. It was used in this study because it was one of the most reliable and psychometrically sound instruments for measuring internet skill available at the time the study was executed. Hargittai (2005) added to the validity of the Survey of Web-Oriented Digital Literacies by having participants complete an additional set of survey questions to test for guessing and false responses. Hargittai (2005) utilized the instrument in a study that examined 100 randomly selected web user's online skills using observation, surveys, and interviews. The survey method was chosen because it allowed for a large data collection from a large sample size. Results demonstrated that the knowledge reported in the survey was a fairly accurate representation of the participant's actual knowledge of their internet-related understanding. The study demonstrated that students who understood the computer and internet-related terms were better at finding information online and took less time to do so. It was also found that individuals who self-assess their understanding and comprehension of web-related terms on a

5-point Likert scale did a better job predicting their internet navigation abilities as opposed to simply asking individuals to self report on whether the think they can use the internet.

Although the instrument includes ‘web-oriented digital literacies’ it fits very well with van Deursen and van Dijk’s (2009, 2012) idea of operational Internet skills. It fits because ultimately, it is examining web-use skills which, when examined more closely, appears almost identical to the concept of operational Internet skills under the category of medium-related Internet skills. For these reasons Hargittai’s (2005) Survey of Web-Oriented Digital Literacy was used to account for participant’s Internet use skills as a predictor of incidental learning.

After considering virtual worlds, incidental learning, learning styles, and digital literacy in the way of operational internet skills, it would be sensible to consider additional factors that may influence these variables. For this reason, the next section will examine the concept of salience in relation to student learning.

Visual Salience

The concept of visual salience plays an important role in this research because it is a factor that may affect how learners process information encountered within a virtual world. It differs from learning style and digital literacy in that it is either a true or false condition. It is not necessarily something internal or inherent that learners “carry” with them, but it is an external feature or characteristic. In order to gain clairity, the concept will be explored further before moving forward.

A reading perspective. An important variable to consider in this study is that of salience. The concept of salience appears in two main areas throughout the literature, but is not very well defined. The first area that concerns itself with the notion of salience is that of reading and language acquisition. Reynolds (1992), a prominent researcher in the field, accepts the Webster's Dictionary definition of salience, which is "the property of standing out" (p. 349). This definition suggests that the manipulation of text can lead to various elements of the text standing out. The field of reading and language acquisition goes on to look at ideas such as the selective attention strategy (SAS) and how it factors into salience and learning. The SAS suggests that readers rank information they read in order of importance and then process information in order of its importance. SAS is summarized into three points by Anderson (1982). The summary states:

> 1. Text elements are initially processed to some minimal degree and graded for importance. 2. Extra attention is devoted to elements in proportion to their importance. 3. Because of the extra attention, or a process supported by the extra attention, important text elements are learned better than other elements (as cited in Reynolds, Shepard, Lapan, Kreek, & Goetz, 1990, p. 749).

This suggests that importance in attention leads to learning in students. Therefore, text that the reader determines to be most important is better attended to and subsequently better learned. Reynolds (1992) defined learning as "the outcome of free recall, structured recall, and recognition tests" (p. 345). Reynolds, Wade, Trathen, and Lapan (1989) believe that within the reading research literature, the term 'importance' should be replaced with the term 'salience' because it is more accurate. The term 'salience' is more accurate because having something stand out does not necessarily mean that it is more valuable or important. This slightly modifies the formulaic idea originally presented by the SAS summary that importance plus attention leads to learning and suggests that salience plus attention is what leads to learning. Reynolds et al. (1989) posit that the term salience actually includes importance as well as interest, but that cannot be done using the term 'important' alone which seems superior to interest. This also supports Reynolds and Shirey's (1988) statement that information presented as being important is "better learned than unimportant information" (p. 354, as cited in Reynolds, 1992). The 'attention' aspect of the SAS considers two main components: duration and intensity. According to Reynolds et al. (1989) the duration and intensity of attention is encompassed within the term 'attention' used within the SAS model. The finer details of the SAS are beyond the scope of this review of the literature. Garner, Gillingham, and White (1989) attempt to take the concept of salience further by linking it to the idea of 'seductive details.' Seductive details are defined as "propositions presenting irrelevant details – interesting, but unimportant information" (p. 43). Because these details can attract the reader's attention, Garner et al. (1989) suggest that they play a role in salience among readers.

A psychological and neuroscientific perspective. In the second area that concerns itself with visual salience, cognitive psychology, and neuroscience, there exists a slightly different perspective on salience. Itti (2007) looks at the concept of visual salience, and defines it as "…the distinct subjective perceptual quality which makes some items in the world stand out from their neighbours and immediately grab our attention." In this view, "the core of visual salience is a bottom-up stimulus-driven signal that announces 'this location is sufficiently different from its surroundings to be worthy of your attention'" (para. 4). Goldstein (2008) refers to stimulus salience as areas that are "…conspicuous, and therefore attract attention based on their stimulus properties" (p. 120). From this review of the salience literature it is evident that although the definitions are not exactly the same across the disciplines, they are similar in their main idea that salience is a quality possessed when an item, object, text, or scene is overt, or stands out in comparison to other things in its surroundings. In the Feature Integration Theory of Attention, Triesman and Gelade (1980) propose that our attention is immediately drawn to salient items, and that these items stand out. The theory goes on to state that "attention must be directed serially to each stimulus in a display whenever conjunctions of more than one separable feature are needed to characterize or distinguish the possible objects presented" (p. 97). In the above definition, separable features could be colour, size, shape, etc. A more technical approach to saliency involves the use of computational models in the form of a 'saliency map.' Konuskan (2008) defines a saliency map as:

> a two-dimensional topographically arranged map that represents the visual saliency or conspicuity of a particular scene, image, photo or stream of images as in a video or a movie. It combines different visual features (e.g., different colors, orientations, etc.) in many dimensions into one

> normalized map with a particular location corresponding to the most salient object in the image." (p. 17)

Research on salience in the reading literature. In a study investigating reading strategies, Hidi and Baird (1988) investigated the effect of 'interestingness' (how interesting a text is) or text-based interest on the recall of information. The study looked at creating text-based interest in expository texts among elementary students. In order to carry out the study, a text was replicated three times with a different interest-evoking strategy employed each time. Students were randomly assigned to groups, given a version of the text, and subsequently asked to recall the information presented. This particular study used three strategies to create salience. The first was adding attributes that contribute to sentence interest, the second was the insertion strategy of adding elaborative information regarding the main ideas in the text, and the third was manipulating the text so that the reader felt the need to resolve the incompleteness of the novel information presented. The study did not find an overall significant difference in recall, but did find a difference in recall of information that was concrete, specific, or contained personally involving information. It was also found that interesting information is more likely to be recalled, but typically it is the salient information that is specifically recalled. This means that the information before or after the salient portion is not covered under the strategies. Lastly, it was mentioned that although the salient information was recalled fairly well by students, the salience (elaboration strategy in this case) "…may increase the recall of some important sentences, these improvements are likely to be related to concrete, personal activities and unfortunately do not seem to carry over to more general, more abstract, and more scientific information" (p. 479). With regard to the SAS, Reynolds et al. (1990) examined the differences in the use of SAS among strong and weak readers and found that regardless of the success level of the reader, students "focused both the duration and intensity of their attention and on those text segments that contained information relevant to their inserted questions…'' (p. 754). Among the two groups of readers the SAS was utilized as a reading strategy, demonstrating that the majority of readers use the SAS to help them learn information they read (Reynolds et al., 1990).

In a study on interest and recall, Wade, Schraw, Buxton, and Hayes (1993) investigated "seductive details" as a way to increase salience within text. Wade et al. (1993) presented 43 post-secondary students with a biography that had some interesting but unimportant details added to it. These were termed 'seductive details.' The information went into some detail on the personal life of the main character. These details were considered to be salient in the study. In the end, it was found that participants dedicated more attention to the seductive details and learned them better than originally expected at the outset. A participant in the study said that the seductive details "jumped out of the page at me" (p. 105) while reading, which contributes to the definition of salient information and text elements standing apart from the rest.

Research on salience in the visual attention literature. The visual attention literature from the field of cognitive psychology and neuroscience also involves the exploration of salience as it relates to attention. From this field of research, the idea of visual search seemed pertinent to this review. The idea suggests that a target can be defined by its individual characteristics or through a combination of characteristics called a “conjunction” (Triesman & Gelade, 1980). In a seminal study regarding attention, Treisman and Gelade (1980) sought to answer the question of why some things are better attended to and focused on than others through the Feature-Integration Theory of Attention. This theory posits that features such as colour, orientation, size, and spatial frequency are processed differently when encountered visually. For their research, Treisman and Galade (1980) performed a series of experiments to test predictions about visual search (among other things) and which tasks unveil the limits of attention. In these studies, an example of a salient object would be one that is facing a different direction or is different colours from the surrounding objects, making it stand out. Comparing an element such as colour to other elements, one of the studies considered feature discrimination where different features of a commonly appearing object in a set are manipulated and the participants are instructed to search for the object or item that stands out or is salient. In this set of studies, more than one feature was manipulated at a time and the amount of time required to locate the salient or prominent object was taken into consideration. In the end, study results showed that visual search for targets defined by a single feature (e.g., colour or orientation difference) happens in parallel across a visual display and leads to salience or standing out.

In their study of computational models and visual attention, Itti and Koch (2001) examined multiple computational models of visual attention and saliency maps. In the end it was suggested that salience does not depend on the task in which it occurs, and that if an object is salient enough, it will stand out from the scene around it. Koch and Ullman (1985) attempted to answer the question of how human neural networks shift visual attention and perform other phenomena. This was done in consideration of the “winner-take-all” mechanism (WTA). The WTA theory acts as a hierarchy and suggests that whatever a viewer focuses the most attention on is at the top of this hierarchy and takes priority, meaning that the WTA chooses the most overt location in a scene and that is what is salient to the viewer. This process of determining salience happens on different levels so items are ranked in terms of their salience. The Koch and Ullman (1985) study suggests that if the first thing viewers search for is eliminated, then they will move their attention and focus down the hierarchical list on to the next most prominent area. Although much of the rest of the work in the field of visual attention is beyond the scope of this thesis, from these studies it seems evident that items or objects are better attended if they stand out or are salient.

Although some of the concepts presented here such as language acquisition, reading strategies, salience maps, computational models and neuropsychological measurements also go beyond the scope of this literature review and this thesis, there is a main thread that runs across the disciplines. The idea of salience is that there is something noticeably different or overt among a presented set of items whether they be words or images. For this reason, and for the purpose of this thesis I will be using a combination of the Merriam Webster definition of salience supported by Reynolds (1992) and the definition of Itti

(2007). The Merriam Webster definition has been updated to cite that something is salient if it is “standing out conspicuously: prominent; especially: of noticeable significance” (Salience, 2012). The definition from Itti (2007) states that visual salience is “…the distinct subjective perceptual quality which makes some items in the world stand out from their neighbours and immediately grab our attention.” It is mind the slight nuance with the term salience. Salience could refer to the semantic value of an object or a word, but it could also refer to the physical properties of the appearance of the object or word. This study uses the latter, referring to it as “visual salience” and all future references to ‘salience’ are to be considered as such.

Methods

This study seeks to answer a series of questions stated in chapter one about incidental learning and virtual worlds. This study sought to answer the following questions:

1. Does incidental learning occur in virtual environments?
2. Does visual salience play a role in incidental learning in virtual environments?
3. Does learning style predict incidental learning within virtual environments?
4. Does web literacy predict incidental learning within virtual environments?

Two separate instruments were used in the process of this study. The methodology utilized to answer the above-mentioned research questions is presented in this chapter. The chapter consists of four sections: (a) participants, (b) pretest measures, and (c) procedures,

Participants

The sample consisted of 155 undergraduate students enrolled in the Education program at the University of Alberta. The original participant sample was 163, but due to incomplete questionnaires, data from 8 of the students had to be discarded. The participants were represented through a convenience sample recruited by the Faculty of Education's research participant pool, which draws its participants from two Educational Psychology courses for pre-service elementary and secondary education teachers. Participants were either registered in the Educational Psychology for Teaching course, the Technology Tools for Teaching and Learning course, or both. Credit was awarded for attending the study and the sample was not restricted to any specific gender, age, or race.

Pretest Measures

Index of learning styles. The Index of Learning Styles or ILS (Felder & Solomon, 1994), used as a pre-testing instrument during the study, was employed to gauge student's learning styles and preferences. It consisted of 44 forced choice questions forming four dimensions or subscales: Active/Referencing, Sensing/Intuitive, Visual/Verbal, and Sequential/Global. Each dimension had 11 corresponding questions within the inventory (Felder & Spurlin, 2005). The choices offered were either "a" or "b" for each of the questions with "a" representing one end of a particular spectrum, and "b" representing the other end (see Appendix A).

Internal consistency reliability of the ILS was estimated by Cronbach's alpha (Cronbach, 1951) for four samples. The active/reflective, sensing/intuitive, visual/verbal, and sequential global scores were found to be 0.595 (n= 540), 0.697 (n= 539), 0.633 (n= 544), and 0.530 (n= 532) respectively. The sample population values differ because incomplete cases were discarded prior to analysis (Zywno, 2003). While Nunnally (1978) advises that a reliability value of 0.80 will suffice for the instruments used in a study for basic research reliability standards (not predictor tests or hypothesized measures); Tuckman (1999) suggests that an alpha value of 0.50 or above for attitude tests is acceptable. Based on this level of acceptance, these alpha values fit well within Tuckman's (1999) accepted alpha value $\alpha=0.5$ for attitude tests. A Pearson correlation was used for test-retest reliability analysis for each of the four dimensions and a time lapse of 8 months was used between testing. For the Active/Reflective, Sensing/Intuitive, Visual/Verbal, and Sequential/Global scores, a Pearson's correlation (n= 124) of 0.683, 0.678, 0.511, and 0.507 were found respectively (Zywno, 2003). This demonstrates a moderate to strong correlation between the scores of the first and second administration of the ILS. The inter-item correlation for internal consistency reliability calculations within each dimension also showed a very little if any correlation between the items with results ranging from 0.09 to 0.17 suggesting that the ILS assesses different qualities between the dimensions as it claims (Zywno, 2003). Calculations for construct validity suggest that there is "...no significant differences between the means of the scales in the consecutive years, supporting the construct validity of the ILS" (Zywno, para. 24, 2003). ANOVA statistics also suggest a convergent validity for the ILS scores as the difference in scores across the two-year period and different student cohorts was very small. The students tested “at different times and in different places [and] share[d] many characteristics hypothesized by the model” (Zywno, para. 25, 2003). This also suggests a discriminant validity of the ILS as there were “significant differences for populations with different characteristics” (Zywno, para. 26, 2003). All three sets of statistical analyses results demonstrate the validity and reliability of the ILS.

Survey measures of web-oriented literacies. The survey measures of Web Oriented Literacies (Hargittai, 2005), which was also used as a pre-testing instrument during the study, was used as a web literacy measure determining the extent to which students were familiar with internet use. It consisted of 27 Likert-type items. Responses are scored from 5 (full) to 1 (none); the higher the average overall score, the more web-literacy or understanding the student is said to have (see Appendix B).

Prior studies by Hargittai and Hsieh (2012) using the Web-Oriented Literacies measure determined an internal consistency reliability well above the standard minimum consistency coefficient of 0.80 (Cronbach, 1951). The web-use skill measures that comprise the web-oriented literacies survey has maintained a Cronbach’s alpha value of above .90 in each of Hargittai’s (2012) studies using first-year university students. Across the three surveys listed, the first resulted in an alpha value of 0.9409 (n=1,004), 0.9413 (n=1,041), and 0.9530 (n=483). These values are sufficient to support internal consistency reliability of the instrument.

Procedures

This study employed a quantitative methodology of data collection and analysis. The first step in the quantitative data collection process included accessing 163 students through the Educational Psychology research participant pool at the University of Alberta. In exchange for course credit, students signed up for one or more of the multiple available studies being offered during the semester. Each session took approximately 1 hour to complete.

Students completed the study in a computer lab with anywhere between 4 and 20 students per session. Each participant signed a consent form and the researcher gave the instructions. Participants were instructed to begin by completing the ILS and the Web-Oriented Literacies survey with only one answer/selection per question. Participants were then tasked with walking their avatar around the virtual space using the arrow keys on the keyboard, to follow the directional arrows on the sidewalk. Participants were also instructed to answer the questions on the coloured boards along the pathway (the virtual campus contained two different types of boards). One set of boards was designed to look like blank-canvas billboards containing factual information about the University of Alberta (see Appendix F), and the others were small solid coloured boards with specific questions on them for the participant to answer by either clicking their mouse, or typing in a response (see Appendix G). Participants were only directed to complete the questions on the coloured boards, and the billboards were not mentioned or acknowledged (recall from the literature review that in experimental setup and design, participants of incidental learning studies are not advised of the fact that they will be questioned about the information presented to them during the experiment (See Baddeley, 1997; Hulstijn, 1989).

After receiving the instructions, participants were given two questionnaires to complete prior to beginning the experiment. Upon completing both questionnaires, they were then instructed to notify the researcher, so that the two questionnaires could be collected and, a username and password was given to the participant to enable them to log in to the OpenSim Viewer for Second Life and access the virtual University of Alberta campus. Upon logging in, participants were briefly reminded of how to navigate within the virtual space and reminded to walk and follow the sidewalk and the directional arrows, then notify the researcher when finished (their avatar had returned to start). The specific direction of walking was stressed because the avatars within the virtual space have the ability to both run and fly. Using any function other than walking increased the chance that a participant may pass by an important aspect or feature of the virtual space too quickly without realizing they have done so.

Due to system and space constraints, it was only possible to have a maximum of 6 students logged in at any given time. The virtual space was created in its entirety and then duplicated 5 times to create a total of 6 separate virtual spaces. There was only one participant per virtual space at any given time to avoid the distraction of seeing other avatars completing the same path in the virtual world. For this reason, once all participants had completed the questionnaires and after the first 6 participants had logged into the system, all subsequent participants were asked to wait outside the room in order to avoid other students watching the task being performed before they had a chance to log in with their own avatar. As the first six participants completed the virtual task, the additional participants were called back into the room one by one as a virtual space became available.

Upon completion of the path in the virtual space, participants notified the researcher and were then logged out of the virtual space and the program was shut down. Participants were then given two post-tests created by the researcher to test their incidental learning. The first post-test was a 20-item forced-choice image recognition test, which asked participants to identify images they recognized from the virtual campus. The items contained pictures taken from the bulletin boards lining the pathway in the virtual campus, and the choices "YES" or "NO" (see Appendix J). The second post-test consisted of one 10-item sentence completion questionnaire where participants had to fill in the blank to complete the sentence with information that was presented on the bulletin boards lining the pathway of the virtual campus (see Appendix K). Students were allowed to complete the post-tests in any order they preferred.

Results[2]

This study intended to investigate the relationship between incidental learning and virtual worlds. It also intended to investigate whether other factors such as text, visual salience of text, and images played a role in this relationship. The purpose of this study was achieved by examining the correlations between the

[2] A version of this chapter has been published. Thomas, W., Boechler, P., deJong, E., Stroulia, E. & Delaney, M. (2012). Incidental Learning and Salience in Virtual Worlds. In T. Bastiaens & G. Marks (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2012* (pp. 1686-1690). Chesapeake, VA: AACE. Retrieved from www.editlib.org/

learning styles, digital literacy, and incidental learning. It also examined the significance values of incidental learning in virtual worlds. This chapter presents the results of the statistical analysis for the four research questions. The assumptions and descriptive statistics were first reported followed by the t-test and paired-sample t-test for incidental learning. Next a series of regressions was presented to analyze the relationship between the various learning styles, digital literacy, and incidental learning. Lastly some additional regression and multiple regression analyses were presented combining various predictor variables in order to thoroughly answer the question of whether or not incidental learning truly occurs within virtual worlds.

All participants for the study were drawn from the Faculty of Education undergraduate research participation pool at the University of Alberta. A total of 163 participants signed up to participate in the study. Of those who signed up for a particular testing time, only 155 returned completed pre-measures and post-tests, and the data of the remaining 8 participants was subsequently discarded.

In the analysis of the Index of Learning Styles (ILS), the scores were initially difficult to analyze. Due to the fact that the scale for the ILS is in a dichotomous format (‘a’ or ‘b’), it presented challenges in preparing the data for statistical analysis. Totalling all “a” responses and all “b” responses, then subtracting the larger value from the smaller and attaching the letter of the larger value as a suffix is what totalled the ILS scores from the questionnaire. Therefore, in order to analyze the learning styles data, the totals were treated as continuous data. Previous researchers have taken a similar approach using different values (see van Zwannenberg, Wilkinson, & Anderson, 2000; Zwyno, 2009). The researchers re-categorized scores from their original concatenated values (e.g., 5a, 7b, 9a, 11b, etc) in order to remove the suffix letters brought about by the primary scoring process. This resulted in a continuous scale of data ranging from -11 to 11 (counting in odd numbers). For the purposes of this study and in the interest of making the data simpler to analyze, the scores were converted into a range of 0 to 11 by giving the re-categorized -11 to 11 range a new representation. The range became 0 to 11 by assigning -11 a placeholder of 0 and -9 a placeholder of 1, and -7 a placeholder of 2, and so on up to 11 (See figure 6).

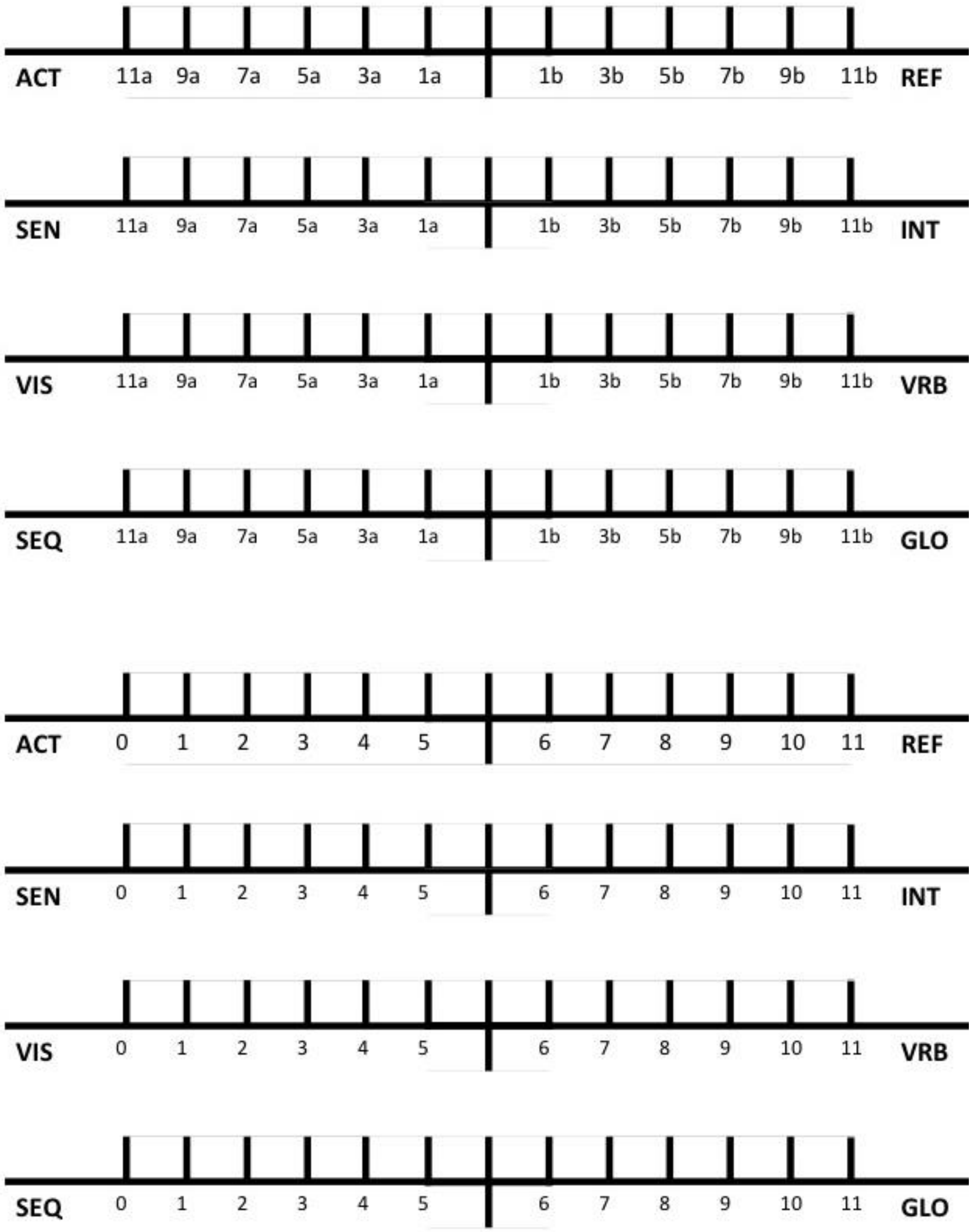

Figure 6. Index of Learning Styles scoring conversion. Score value conversion in order to obtain continuous format. Above: Original ILS scoring. Below: After converting score values.

Assumptions

The analysis required a series of regressions and t-tests. For correlations and simple regressions, the assumption of linearity was verified using a scatterplot and a linear relationship (although sometimes weak) was observed. In the scatter plots, the dots were scattered well throughout the coordinate plane, but still followed a line, which suggests a linear relationship, meeting the assumption according to Field (2009). The assumption of homoscedasticity was verified using predicted vs. residual plots. Equal distribution of data points was observed, which confirmed the assumption according to Field (2009). The assumption of independence was assumed to be met due to the fact that there were no evident flaws (i.e., random assignment, proper sampling, and no information leaking between the groups) in the experimental design. Because each set of data was collected from a different participant this suggests that it is independent. According to Field (2009) this helps to fulfil the assumption of independence. The assumption of normality was considered met because it is robust to violation in regression analysis. According to Field (2009) having a sample size larger than 30 tends to result in a normal distribution.

For the t-test the assumption of continuous dependent variable was met because each score had an equal chance of taking on any value within the instruments used. According to Field (2009) this assumption is met because each participant had the same opportunity to achieve any score on the allotted spectrum of the instruments used in the study, and there were no restrictions placed on values.

Field (2009) states that Levene's test can be used to verify the homogeneity of variance in groups of data. For the ANOVA test, the assumption of homogeneity of variance was verified by Levene's test to examine equal variances. The test results were not significant, which indicates that the variances were in fact similar and the assumption was met.

Main Analysis

The descriptive statistics for both the independent and the dependent variables are listed in Tables 3 and 4.

Table 3

Descriptive Statistics for Learning Style Dimensions and Digital Literacy

Learning Style Dimension	*n*	*M* (*SD*)	*95% CI*
Active-Reflective	155	5.32 (2.29)	[4.95, 5.68]
Sensing – Intuitive	155	4.74 (2.58)	[4.33, 5.15]
Visual – Verbal	155	3.68 (2.61)	[3.27, 4.10]
Sequential - Global	155	4.92 (2.02)	[4.60, 5.24]
Digital Literacy Score	155	2.99(0.68)	[2.89, 3.10]

Note. CI = Confidence Interval

Table 4

Descriptive Statistics for Incidental Learning of Text

Incidental Learning	*n*	*M* (*SD*)	*95% CI*
Salient Text Score	155	2.44 (1.45)	[2.21, 2.67]
Non-Salient Text Score	155	2.05 (1.43)	[1.82, 2.28]
Total Text Score	155	4.49 (2.66)	[4.07, 4.91]
Image Score [a]	155	12.46 (3.04)	[1.98, 2.95]

Note. CI = Confidence Interval; [a]Test Value set to 10

Research Question 1: Does incidental learning occur in virtual worlds? In order to answer this question, two separate analyses were performed and the results are listed in Table 5. Two analyses were used because in this particular study, incidental learning was measured by both text and images. In order to help clarify, the question can be rephrased into two parts. First, does incidental learning of text occur in virtual worlds? And second, does incidental learning of images occur in virtual worlds? To answer the first question, a one-sample t-test was performed to determine whether there was a difference between the total text score mean and mean of zero. There was a significant difference from a mean of zero found. The value of zero is used because according to Field (2009) "under the null hypothesis we assume that the experimental manipulation has no effect on the participants; therefore we expect the sample means to be very similar" (p. 325). In other words, the observed mean of the differences is compared with a hypothesized value of zero. These results suggest that students do learn textual information incidentally in virtual worlds. To answer the second part of this research question, another t-test was applied. For this particular analysis, the test value for the expected difference was adjusted from 0 to 10 to account for the possibility of participant guessing. Because the basic probability for true/false multiple choice questions, the probability of getting 1 question right by random guessing is 0.5, and the expected score for a student who random guesses every question out of 20 questions is 10 (20*0.5). In other words, on the off chance that a student guessed the answer to each question, he or she could have scored a 10/20, so the test-value of the analysis was adjusted to account for a possible score of 50% due to chance. Because the test value is based on an 'expected value' as per Field (2009), this test value was adjusted to the expectation of a participant guessing. The t-test found a significant difference from a mean of 10. The resulting effect size for the total text score was 0.86 (large effect) and for the image score was 0.63 (medium effect). The large and medium designations were determined according to Cohen's (1988) effect sizes. These results suggest that students do learn pictorial (image) information incidentally in virtual worlds.

Table 5

One-Sample t Test for Incidental Learning

Incidental Learning Type	*N*	*t*	*df*	*Sig.*	*Mean Diff*	*95% CI*
Total Text Score	155	21.03	154	0.00[*]	4.49	[4.07, 4.91]
Image Score [a]	155	10.11	154	0.00[*]	2.46	[1.98, 2.95]

Note. [*]P-value is significant at the 0.05 level (2-tailed); [a]Test value set to 10

Research Question 2: Does making text visually salient make a difference in incidental learning within virtual worlds? In order to answer this question, a paired-samples t-test was conducted to compare the salient text scores to the non-salient text scores and according to Field (2009) the paired-samples or dependent T-test can be used for these purposes. Table 6 shows that there was a significant difference in the scores for salient text, and non-salient text conditions. These results suggest that visual salience really does have an effect on the incidental learning of text. Specifically, these results suggest that when salient and non-salient text is presented to a learner, they incidentally learn the salient text better than the non-salient text. The data also shows a strong and significant correlation between the salient and the non-salient text scores (r=0.71), which is to be expected, as they are subsets of the same incidental learning text variable. This correlation also suggests that if a student performs well on the salient portion of the incidental learning test, they also performed well on the non-salient portion of the incidental learning test. The test also resulted in an effect size of 0.50 (medium effect).

Table 6

Paired-Sample t Test for Textual Incidental Learning

	Salient		Non-Salient						
	M	*SD*	*M*	*SD*	*n*	*95% CI*	*r*	*t*	*df*
Textual Incidental Learning	2.44	1.45	2.05	1.42	155	[0.22, 0.57]	0.71	4.47*	154

Note. *P-value is significant at the 0.05 level (2-tailed)

Research Question 3: Does learning style as measured by Felder and Solomon's (1994) Index of Learning Styles predict incidental learning within virtual worlds? This question was answered for each of the four learning styles and for each of the forms of incidental learning. To answer this question, it was broken down into 4 sub-questions:

1. Does learning style predict incidental learning of text within virtual worlds?
2. Does learning style predict incidental learning of visually salient text within virtual worlds?
3. Does learning style predict incidental learning of non-salient text within virtual worlds?
4. Does learning style predict incidental learning of images within virtual worlds?

In order to analyze these questions, a series of simple regressions were performed (see Table 7). Table 8 shows that the SEQGLO variable was correlated with the incidental learning of salient text (n=155, r=0.17, p-value=0.04), and text overall (n=155, r=0.17, p-value=0.04). Although the correlations are weak, they are positive, linear, and statistically significant. A small effect size of 0.02 was found for both the salient and overall text. This suggests that the more global a learner was, the better they tended to score on the incidental learning test for text overall, but more so for salient text. From the analysis of the data, there did not appear to be any learning style that correlated significantly with the incidental learning of non-salient text. Each of the four learning style dimensions resulted in statistically non-significant and weak correlations between learning style and incidental learning of non-salient text.

Table 7

Correlation Matrix of Learning Styles and Incidental Learning

Measure	ACT/ REF	SNS/ INT	VIS/ VRB	SEQ/ GLO	Image Score	Total Text Score	Salient Text Score	Non-Salient Text Score
ACTREF	1.00	0.09	0.27^{**}	0.025	0.03	0.05	0.08	0.02
Sig. (2-tailed)		0.28	0.00	0.758	0.72	0.50	0.34	0.78
SNSINT		1.00	0.03	0.473^{**}	0.18^{*}	0.09	0.10	0.07
Sig. (2-tailed)			0.69	0.000	0.028	0.27	0.22	0.36
VISVRB			1.00	-0.114	-0.06	0.09	0.10	0.07
Sig. (2-tailed)				0.158	0.47	0.26	0.21	0.41
SEQGLO				1.00	0.13	0.17^{*}	0.17^{*}	0.14
Sig. (2-tailed)					0.11	0.04	0.04	0.09
Image Score					1.00	0.53^{**}	0.49^{**}	0.49^{**}
Sig. (2-tailed)						0.00	0.00	0.00
Total Text Score						1.00	0.93^{**}	0.92^{**}
Sig. (2-tailed)							0.00	0.00
Salient Text Score							1.00	0.71^{**}
Sig. (2-tailed)								0.00
Non-Salient Text Score								1.00

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The answer to the last of the four questions was also found through a simple regression and the results are displayed in Table 9. From the regression analysis of the data, it appeared that one particular learning style predicted the incidental learning of images within virtual worlds. A significant correlation was found for the Sensing/Intuitive (SNSINT) learning style dimensions and the image (pictorial) incidental learning score and a small effect size of 0.03 resulted. Although the correlation was somewhat weak, it suggested a positive linear relationship between learning style and pictorial incidental learning, implying that as a learner moved from sensing to intuitive along the SNSINT spectrum, their incidental learning score increased. In other words, the more intuitive a learner was, the higher his or her incidental learning of images was. Those who performed better on the incidental learning measure tended to be intuitive learners.

Table 8

Simple Regression for the Sequential/Global Learning Styles as Predictors of the Incidental Learning of Text and Images in Virtual Worlds

Predictive Measures	*B*	*SE B*	*β*	*t*	*r*	*Adjusted R^2*	*Sig*
Incidental Learning (total)	0.22	0.11	0.17	2.07	0.17	0.02	0.04*
Incidental Learning (salient)	0.12	0.06	0.17	2.09	0.17	0.02	0.04*

Note: *Correlation is significant at the 0.05 level (2-tailed); N=155

Table 9

Simple Regression for the Sensing/Intuitive Learning Styles as Predictors of the Incidental Learning of Images in Virtual Worlds

Predictive Measures	*B*	*SE B*	*β*	*t*	*r*	*Adjusted* R^2	*Sig*
Incidental Learning (image)	0.21	0.09	0.18	2.24	0.18	0.03	0.03*

Note: *Correlation is significant at the 0.05 level (2-tailed); N=155

Research Question 4: Does digital literacy as measured by Hargittai's (2005) Measure of Web-Oriented Digital Literacy inventory predict incidental learning within virtual worlds? To answer this question, it was broken down into a series of sub-questions:

1. Does digital literacy predict incidental learning of text within virtual worlds?
2. Does digital literacy predict incidental learning of visually salient text within virtual worlds?
3. Does digital literacy predict incidental learning of visually non-salient text within virtual worlds?
4. Does digital literacy predict incidental learning of images (pictorial) within virtual worlds?

In the analysis of this question a simple regression was performed and the results are displayed in Table 10. The results indicate that digital literacy did predict incidental learning of overall text within virtual worlds (small effect size 0.04). The simple regression resulted in a weak, but statistically significant linear correlation. This correlation suggests that the higher a learner's digital literacy score, the better they performed or the higher their overall score on the incidental learning test for text. The same trend occurred for the incidental learning of salient text (small effect size 0.04). In that regression, a weak but statistically significant positive linear correlation was found. This result suggests that the higher a learner's digital literacy score, the better they performed on the visually salient component of the incidental learning test for text. A similar trend was found for digital literacy as a predictor of the incidental learning of non-salient text (small effect size 0.03). This correlation was weaker than the previous two, but still statistically significant. This correlation suggests that the higher a learner's digital literacy score, the higher their score on the incidental learning test for non-salient text. With regard to the fourth question of digital literacy predicting the incidental learning of images, the results are similar to the first two text results. A weak, but statistically significant positive linear relationship was found (small effect size 0.07). This result suggests that the higher a learner's digital literacy score, the better they performed on the incidental learning test for images.

Table 10

Simple Regression for Digital Literacy as a Predictor of the Incidental Learning of Text and Images in Virtual Worlds

Conditions	*B*	*SE B*	*β*	*t*	*r*	*Adjusted R^2*	*Sig*
Incidental Learning (total)	0.85	0.31	0.22	2.74	0.22	0.04	0.01**
Incidental Learning (salient)	0.45	0.17	0.21	2.67	0.21	0.04	0.01**

Incidental Learning (non-salient)	0.40	0.17	0.19	2.37	0.19	0.03	0.02*
Incidental Learning (image)	1.26	0.35	0.28	3.62	0.28	0.07	0.00**

Note: *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); N=155

Table 11

Complete Correlation Matrix for All Variables

Measure	ACT/ REF	SNS/ INT	VIS/ VRB	SEQ/ GLO	Digital Lit	Image Score	Total Text Score	Salient Text Score	Non-Salient Text Score
ACTREF	1.00	0.09	0.27**	0.025	0.05	0.03	0.05	0.08	0.02
Sig. (2-tailed)		0.28	0.00	0.758	0.56	0.72	0.50	0.34	0.78
SNSINT		1.00	0.03	0.473**	0.30**	0.18*	0.09	0.10	0.07
Sig. (2-tailed)			0.69	0.000	0.00	0.028	0.27	0.22	0.36
VISVRB			1.00	-0.114	-0.06	-0.06	0.09	0.10	0.07
Sig. (2-tailed)				0.158	0.45	0.47	0.26	0.21	0.41
SEQGLO				1.00	0.28**	0.13	0.17*	0.17*	0.14
Sig. (2-tailed)					0.00	0.11	0.04	0.04	0.09
Digital Lit					1.00	0.28**	0.22**	0.21**	0.19*
Sig. (2-tailed)						0.00	0.01	0.01	0.02
Image Score						1.00	0.53**	0.49**	0.49**
Sig. (2-tailed)							0.00	0.00	0.00
Total Text Score							1.00	0.93**	0.92**
Sig. (2-tailed)								0.00	0.00
Salient Text Score								1.00	0.71**
Sig. (2-tailed)									0.00
Non-Salient Text Score									1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 11 represents the Pearson correlation and the significance for each variable. The analysis has revealed that there are two cases of correlation between two sets of independent variables. The first is between the Visual/Verbal (VISVRB) and the Active/Referencing (ACTREF) learning style dimensions. This correlation appears to be statistically significant, but has a weak positive linear correlation. The second case is the Sequential/Global (SEQGLO) and the Sensing/Intuitive (SNSINT) learning style dimensions. The analysis resulted in a moderate and statistically significant positive linear correlation. This result was expected as the authors Felder and Spurlin (2005), in the validation literature for the ILS indicate an overlap between the sequential/global dimensions and the sensing/intuitive dimensions. This overlap in dimensions has also been pointed out by other researchers (see van Zwanenberg et al., 2000; Zywno, 2003). Felder and Spurlin (2005) suggest that while this poses a psychometric issue (colineraity or multicolinearity), it does not interfere with the original purpose of the ILS, which is to inform instructors as to how they can improve their lessons and teaching styles for students. One suggested way of identifying multicolinearity is to look at the correlation matrix (see Table 11) and identify any highly correlated (above 0.80) variables (Field, 2009). A second, and more statistically sound method according to Field (2009), is to examine both the Variance Inflation Factor (VIF) and the tolerance value, which help to identify strong linear relationships between predictors. Menard states that tolerance values below 0.1 are cause for concern of colinearity, and Myers suggests that a VIF value larger than 10 indicates a problem with colinearity (as cited in Field, 2009). For the current study, the Tolerance and VIF values are shown in Table 12. Upon inspecting these values, it is evident that although the two predictors are correlated, there is no serious statistical issue with colinearity. This aligns with the findings of Zwyno (2003) who found that this correlation was not a cause for concern.

Table 12

Colinearity Statistics for Learning Style Dimensions

Predictor	Tolerance	Variance Inflation Factor (VIF)
ACTREF	0.92	1.09
SNSINT	0.77	1.31
VISVRB	0.91	1.10
SEQGLO	0.76	1.32

This psychometric discovery encouraged some further analysis on the data involving these overlapping learning style dimensions. In order to investigate this, a multiple regression for the salient, non-salient, total, and image scores for incidental learning was run, effectively ‘collapsing’ the categories (see Table 13). This also raised the question as to whether collapsing the two dimensions would help to better predict the digital literacy score of a learner, so the same multiple regression analysis was run with digital literacy as a dependent variable.

Table 13

Multiple Regression for Sequential/Global and Sensing Intuitive/Learning Styles as Predictors of Incidental Learning of Text and Images, and Digital Literacy Scores

	Predictive Measures	*B*	*SE B*	*β*	*t*	*r*	*Adjusted* R^2	*Sig*
Incidental Learning (total)	SNSINT	0.02	0.09	0.02	0.23	0.17	0.02	0.82
	SEQGLO	0.20	0.12	0.16	1.71			0.09
Incidental Learning (salient)	SNSINT	0.02	0.05	0.03	0.30	0.17	0.02	0.77
	SEQGLO	0.11	0.07	0.15	1.70			0.09
Incidental Learning (non-salient)	SNSINT	0.01	0.05	0.01	0.12	0.14	0.01	0.90
	SEQGLO	0.09	0.06	0.13	1.46			0.15
Incidental Learning (images)	SNSINT	0.18	0.11	0.15	1.66	0.19	0.02	0.10
	SEQGLO	0.09	0.14	0.06	0.65			0.52
Digital Literacy	SNSINT	0.06	0.02	0.33	2.52	0.34	0.10	0.01*
	SEQGLO	0.06	0.03	0.18	2.03			0.04*

Note: *Correlation is significant at the 0.05 level (2-tailed)

The result of collapsing the two dimensions into one was not statistically significant. There was very little change to the statistical output between the multiple regression using all of the learning styles combined, and separating the overlapping categories. There were also no statistically significant results that came out of the analysis for incidental learning. When considering digital literacy, the output in Table 13 demonstrates that there is a significant and positive linear correlation between digital literacy scores and the collapsed SNSINT and SEQGLO dimensions. This means that the more Sensing/Intuitive a learner was, or the more Sequential/Global a learner was, the higher that learner's digital literacy score was.

After considering the initial outcome of the regressions with the various learning style dimensions, the question regarding strength of learning style preference became relevant. The data was then considered from the perspective of those who possessed a moderate or strong learning style. In order to further investigate the effect of learning styles, the data of the participants who scored a “balanced” value in the ILS were removed, and the analysis was re-run using only the data of those participants who scored a “moderate” or “strong” on the various dimensions (see Figure 7). This is in line with Felder and Spurlin’s (2005) suggestion that it may be good to specifically consider participants with strong or moderate preferences.

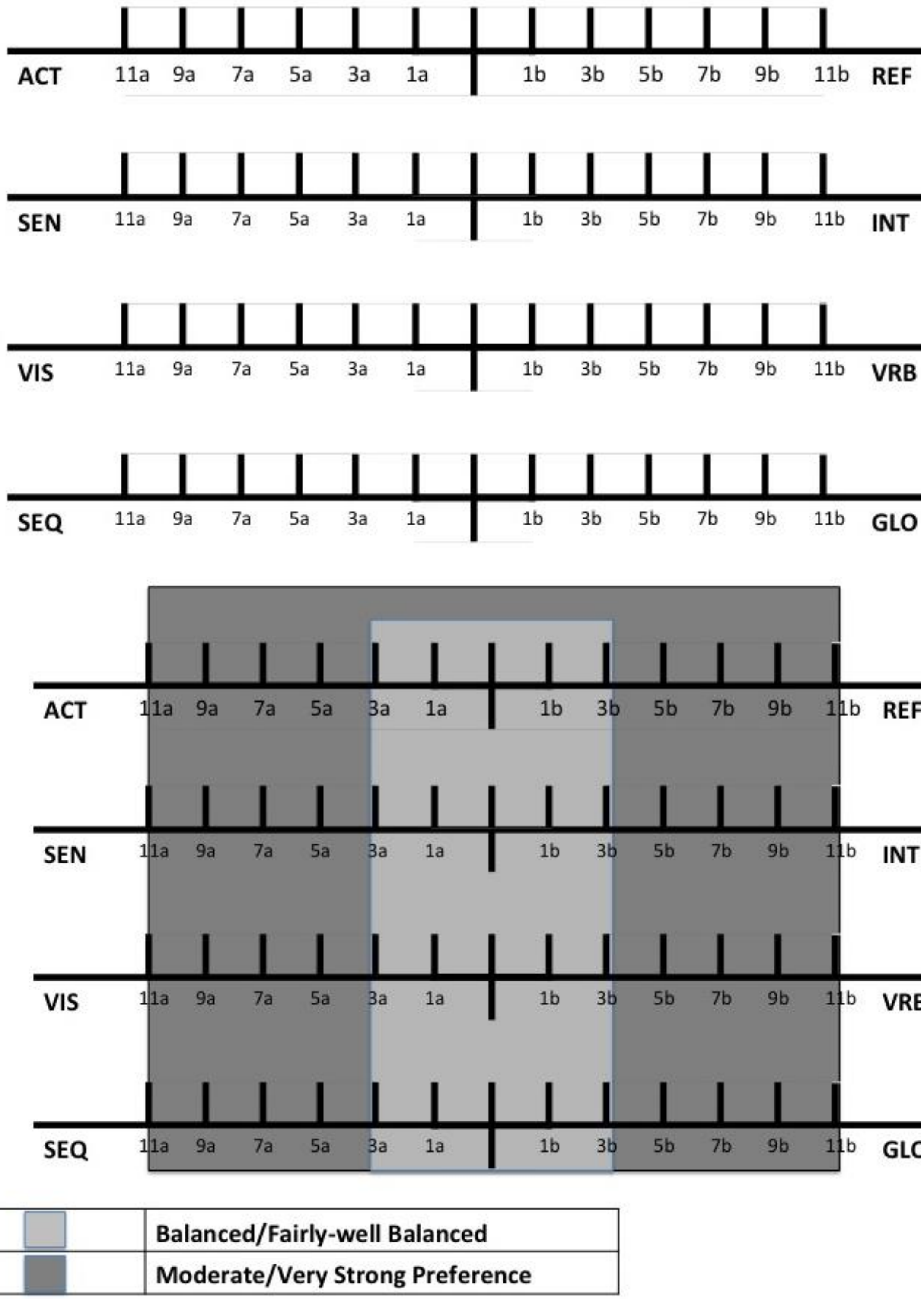

Figure 7. Combination regions of scoring data. Above: Original scoring scale. Below: New scoring scale accounting for moderate/strong scores.

Prior to running this analysis, the data was recoded to represent the 'moderate' and 'strong' ends of the eight categories on the four dimensions of learning styles, and a series of independent sample t-Tests were run. To verify the assumption of normality after having dropped the 'balanced' cases from the data set, a Levene's Test for Equality of Variances was run as recommended by Field (2009). No significance was found for the assumption of equal variances for any of the recoded variables, therefore each of the variances can be considered equal.

Table 14

Independent Samples t-Test for Recoded 'Strong' and 'Moderate' Combined Learning Styles for the Active and Referencing Categories of the ACTREF Dimension

Incidental Learning Type	*Learning Style Category*	*N*	*Mean (SD)*	*t*	*df*	*Sig.*	*Mean Diff*	*95% CI*
Incidental Learning (total)	Active	35	4.14 (2.63)	-0.95	58	0.35	-0.66	[-2.04, 0.73]
	Referencing	25	4.80 (2.66)					
Incidental Learning (salient)	Active	35	2.17 (1.42)	-1.15	58	0.25	-0.43	[-1.17, 0.32]
	Referencing	25	2.60 (1.41)					
Incidental Learning (non-salient)	Active	35	1.97 (1.50)	-0.60	58	0.55	-0.23	[-0.99, 0.53]
	Referencing	25	2.20 (1.38)					
Incidental Learning (image)	Active	35	12.20 (2.87)	-1.043	58	0.30	-0.84	[-2.45, 0.77]
	Referencing	25	13.04 (3.35)					

The t-test results in Table 14 show that there was no significant difference between the means when the dimensions were separated into their strong and moderate components. This means that regardless of whether or not a student was strong/moderate on the active side or strong/moderate on the referencing side of the ACTREF dimension, there was not a significant difference in their incidental learning score.

Table 15

Independent Samples t-Test for Recoded 'Strong' and 'Moderate' Combined Learning Styles for the Sensing and Intuitive Categories of the SNSINT Dimension

Incidental Learning Type	*Learning Style Category*	*N*	*Mean (SD)*	*t*	*df*	*Sig.*	*Mean Diff*	*95% CI*
Incidental Learning (total)	Sensing	55	4.36 (2.50)	-1.65	75	0.10	-1.05	[-2.31, 0.22]
	Intuitive	22	5.41 (2.58)					
Incidental Learning (salient)	Sensing	55	2.44 (1.37)	-1.76	75	0.08	-0.61	[-1.30, 0.08]
	Intuitive	22	3.05 (1.36)					
Incidental Learning (non-salient)	Sensing	55	1.93 (1.33)	-1.26	75	0.21	-0.44	[-1.12, 0.25]
	Intuitive	22	2.36 (1.47)					
Incidental Learning (image)	Sensing	55	12.20 (3.08)	-1.97	75	0.05	-1.57	[-3.16, 0.02]
	Intuitive	22	13.77 (3.37)					

The t-test results in Table 15 show that there were no significant differences between the means when the dimensions were separated into their strong and moderate components, although the incidental learning of images was near the point of significance. This means that regardless of whether or not a student was strong/moderate on the sensing side or strong/moderate on the intuitive side of the SNSINT dimension, there was not a significant difference in their incidental learning score.

Table 16

Independent Samples t-Test for Recoded 'Strong' and 'Moderate' Combined Learning Styles for the Visual and Verbal Categories of the VISVRB Dimension

Incidental Learning Type	*Learning Style Category*	*N*	*Mean (SD)*	*t*	*df*	*Sig.*	*Mean Diff*	*95% CI*
Incidental Learning (total)	Visual	81	4.30 (2.79)	-0.31	96	0.76	-0.23	[-1.71, 1.25]
	Verbal	17	4.53 (2.81)					
Incidental Learning (salient)	Visual	81	2.30 (1.50)	-0.28	96	0.78	-0.12	[-0.93, 0.70]
	Verbal	17	2.41 (1.66)					
Incidental Learning (non-salient)	Visual	81	2.00 (1.47)	-0.30	96	0.76	-0.12	[-0.89, 0.65]
	Verbal	17	2.12 (1.32)					
Incidental Learning (image)	Visual	81	12.60 (3.17)	0.09	96	0.93	0.08	[-1.57, 1.72]
	Verbal	17	12.53 (2.70)					

The t-test results in Table 16 show that there were no significant differences between the means when the dimensions were separated into their strong and moderate components. This means that regardless of whether or not a student was strong/moderate on the visual side or strong/moderate on the verbal side of the VISVRB dimension, there was not a significant difference in their incidental learning score.

Table 17

Independent Samples t-Test for Recoded 'Strong' and 'Moderate' Combined Learning Styles for the Sequential and Global Categories of the SEQGLO Dimension

Incidental Learning Type	*Learning Style Category*	*N*	*Mean (SD)*	*t*	*df*	*Sig.*	*Mean Diff*	*95% CI*
Incidental Learning (total)	Sequential	40	4.35 (2.50)	-1.70	57	0.10	-1.23	[-2.68, 0.22]
	Global	19	5.58 (2.81)					
Incidental Learning (salient)	Sequential	40	2.40 (1.39)	-1.67	57	0.10	-0.65	[-1.44, 0.13]
	Global	19	3.05 (1.43)					
Incidental Learning (non-salient)	Sequential	40	1.95 (1.38)	-1.45	57	0.15	-0.58	[-1.37, 0.22]
	Global	19	2.53 (1.54)					
Incidental Learning (image)	Sequential	40	11.75 (3.16)	-1.35	57	0.18	-1.20	[-2.97, 0.58]
	Global	19	12.95 (3.24)					

The t-test results in Table 17 show that there were no significant differences between the means when the dimensions were separated into their strong and moderate components. This means that regardless of whether or not a student was strong/moderate on the sequential side or strong/moderate on the global side of the SEQGLO dimension, there was not a significant difference in their incidental learning score.

Discussion

The purpose of this study was to investigate whether or not incidental learning takes place within virtual worlds and determine if learning style or digital literacy served as predictors of incidental learning. It also looked at whether visual salience played a role in incidental learning. This is important because it seems that more schools are incorporating virtual worlds into their learning environments (Eschenbrenner et al., 2008). By having the participants walk through the virtual world I was able to measure their incidental learning at the end of their tour.

Each of the research questions revealed important findings worth highlighting. First, there is preliminary evidence that students learn incidentally in virtual worlds, and second, visual salience does help students better learn incidentally within these virtual worlds. Third, it appears that certain learning styles do predict incidental learning within virtual worlds, and fourth it also appears that digital literacy is a predictor of incidental learning within virtual worlds. Lastly, it seemed that strength of the learning style preference did not play a very significant role in incidental learning.

Research Question 1

Does incidental learning occur in virtual worlds? The findings suggest that students do learn textual and pictorial information incidentally in virtual worlds. When given a test of incidentally learned textual information, participants were able to recall a statistically significant amount of the information presented to them during the study. This is evident based on the fact that students were able to answer some of the questions presented to them even though they were not told where to find the answers or how to acquire them. The average score of participants was 45% on the sentence completion test. While this may seem to be a low percentage and the amount learned or retained by participants was not substantial when considered from an academic grading perspective the fact that participants were not instructed to learn or remember anything suggests that they were still able to learn something incidentally. Within the virtual world, the billboards had the answers to the sentence completion task, but in order to give the answer on the final test, students would have had to have read the answer and given it some thought before proceeding on to the next task. This aligns with Marsick and Watkins (1990), and Schugurensky's (2000) definition of incidental learning as something that occurs unintentionally while the learner is doing or engaged in some other task. While the learners were completing the distractor tasks, they were also collecting and learning other information along the way.

This finding has implications for education because when learners are engaged in a particular task within a virtual world or environment (e.g., a virtual classroom) they could be incidentally learning unintended information from their surroundings. This could also have implications for information presented via video, images, and sound. If incidental learning is occurring it is important to consider the implication that has on cognitive processing. Mayer (2005) and Sweller (2005) have theories about cognitive load, which is the stress or strain on a learner's thought processing while learning. They suggest that the more a learner is processing with the use of their senses, the more demand is placed on the cognitive processes. Mayer's (2005) Cognitive Theory of Multimedia Learning (CTML) suggests that there are various ways to reduce the strain on the cognitive processes (see Mayer, 2005). These findings in combination with the CTML raise the question of whether or not incidental learning is a contributing factor to this level of 'stress' that is the cognitive load. The question of what types of information is best learned would be an important question for future research to investigate. If it turns out that conceptual information is better learned than factual information, this is something that educators need to know. This investigation especially critical for those who are wanting to incorporate virtual worlds into their teaching of curriculum.

Research Question 2

Does visual salience play a role in incidental learning in virtual environments? The results also indicate that visual salience does have an effect on incidental learning within virtual worlds in that learners performed significantly better on the learning of salient text than on non-salient text. This is evident because the answers which corresponded to the information presented in a visually salient format (bold text), were recalled more frequently by students than those that were not presented in a visually salient manner (non-bold text). The data also showed a strong relationship between the salient and non-salient text scores, which is to be expected as they are a part of the same variable. This correlational relationship suggests that if a student performs well on the salient portion of the incidental learning test, they also performed well (although not *as* well) on the non-salient portion of the incidental learning test. This finding aligns with the claims of Reynolds (1992) that salience helps learners focus attention and therefore better remember and learn information. The finding that visually salient text did make a difference in incidental learning also supports the suggestion of Anderson (1992) that importance in attention leads to learning in students. Therefore, text that the reader determines to be most important (or salient) is better attended to and subsequently better learned. This also supports the findings of Hidi and Baird (1988) who found that there was a difference in recall of information that was concrete or specific among other things. The information presented in the current study was about the University of Alberta's history, and was purely factual and concrete. The findings agree with Hidi and Baird (1988) because they suggest that it is salient information that is specifically recalled even though interesting information is more likely to be recalled. While the majority of the existing literature regarding salience seems to be limited to the field of language acquisition, these findings offer a step in a different direction for future research into salience in education.

These findings have implications for the field of education because teachers and instructors may not be considering what is made visually salient in their virtual worlds or environments, and by extension, what is made visually salient in their digitally presented information. Since these results have shown that visual salience does have an effect on incidental learning within virtual worlds, the answer to this question (the findings) may have implications for education. Itti and Koch (2001) stated that salience doesn't depend on the task which occurs, but if an object is salient enough, it will stand out from the scene around it. Future research in the area of visual salience and virtual worlds and student learning will need to examine what exactly constitutes visual salience and ask if there is a better type of visual salience or optimal degree of visual salience. The question of what types of visually salient information are best recalled should also be investigated in future research. If students are recalling conceptual or unimportant salient information better than factual information, this is something that educators would need to know in order to best teach the learners in their classrooms. Given this question, we also must ask about what happens to learning over time. Does the incidentally learned visually salient information stay in tact over the period of a day or a week? What is the case over a month or a year? The same could be asked in order to determine whether or not the incidentally learned visually salient information decays over time, and how long that may take. This has important implications for different levels of education because if a student needs to learn something that they will need to recall for a final exam at the end of the term, it may or may not be the best decision to teach it in a virtual world via the incidental approach, but at the same time the opposite could very well be true. Only future research can shed light on these issues.

Research Question 3

Does learning style as measured by Felder and Solomon's (1994) Index of Learning Styles predict incidental learning within virtual worlds?

This question will be answered via 4 sub questions relating to learning styles, incidental learning, and virtual worlds.

1. Does learning style predict incidental learning of text within virtual worlds? The results indicate the sequential/global (SEQGLO) dimension as a significant predictor of text within virtual worlds. Although the correlation was weak, it still suggested that the more global a learner was, the better they tended to score on the incidental learning test for text overall. However, the data does not indicate a notable relationship between the acting/referencing (ACTREF), sensing/intuitive (SNSINT), or visual/verbal (VISVRB) dimensions.

2. Does learning style predict incidental learning of visually salient text within virtual worlds? The only learning style that predicted the incidental learning of visually salient text in this study was the SEQGLO dimension. Again, although the correlation was weak, it still indicated that the more global a learner was, the better they tended to score on the test for incidental learning of visually salient text. Learners scored better on test of visually salient text than they did on the test for text overall, although not by much.

3. Does learning style predict incidental learning of visually non-salient text within virtual worlds? After analyzing the data, it was apparent that there were no learning styles that specifically predicted the incidental learning of visually non-salient text.

4. Does learning style predict incidental learning of images within virtual worlds? The data indicates a weak, but statistically significant positive linear correlation between learning style and the incidental learning of images. This positive linear relationship indicates that as a learner moves from the sensing end to the intuitive end of the SNSINT dimension, their incidental learning score for images increased. In other words, the more intuitive a learner was, the higher their incidental learning of images was. Those who performed better on the image incidental learning measure tended to be intuitive learners. This finding aligns with Felder and Solomon's (1994) description of intuitive learners. They suggest that intuitive learners may be more comfortable with new concepts and like discovering possibilities. They also work faster than those who are 'sensing'. Many of these conditions presented themselves within the virtual world. First, the information presented (both picture and text) was random factual information that few students would know unless they had previously researched it so it was new to them. Also, the entire task was completed in under an hour, so as they moved through the virtual world answering the distractor questions, they would have been moving at a faster pace than they normally would during a class. Unfortunately, the current literature does not seem to have any studies that have investigated the role of an intuitive learning style in image processing.

The findings for sub question 1 and 2 imply that the more global a learner is, the more they learned incidentally is consistent with the research of Felder and Solomon (1994). In their research they state that global learners tend to learn information taken in without any particular or logical order to it, and it simply makes sense to them. They also go on to say that these learners can quickly figure things out; they often have trouble explaining how they reached their answers or conclusions. Some of the other findings for the sub-questions above were unexpected, as it had been thought that the visual and verbal learners would have performed better in an environment involving text. This was expected because in their research, Felder and Solomon (1994) suggested that verbal learners learn more from written and spoken words. Because the text within the virtual world was all written, it follows that being a verbal learner should have predicted the incidental learning of text (regardless of visual salience). One possible reason as to why the learning style dimension of VISVRB was not good a predictor of incidental learning of text is that the combination of text and images contributed to an overload in cognitive processing as suggested by the CTML (Mayer, 2005). It is possible that attempting to process the pictures at the same time as the text in such a short time period hindered the incidental learning of the information. It is also possible that the dimension of VISVRB as designed by Felder and Solomon (1994) does not differentiate enough between the two components or is not well defined enough to act as an appropriate predictor for this particular research question. It is also possible that some participants were not strong readers, so while the text was visual, it was not well comprehended or processed by the participant. A possible solution to this potential issue and a suggestion for future research is to try adding or substituting an audio component where the text is either read aloud, or replaces the written words and re-running the experiment. These findings have important implications for education and for future research. One implication for education is that if the information learned incidentally within a virtual world needs to be explained later on in detail, these students may have difficulty learning. In the classroom, this could translate into more time spent repeating information or time spent doing remedial work to help those who do not function well within the virtual world setting. The concept of retention should also be considered as an implication. Now that there is some support for incidental learning in virtual worlds, how long can this information be retained? This is of great importance in the classroom depending on the forms of assessment used and the concepts being presented. The question of whether information is going to be immediately tested or tested a few months after it is presented will dictate whether or not the information or concept should be initially taught in a virtual world. For future research it would be of interest to collect data from a second incidental learning test after a period of time has passed and compare the results.

Research Question 4

Does digital literacy as measured by Hargittai's (2005) measure of web-oriented digital literacy predict incidental learning within virtual worlds? This question will be answered via 4 sub questions relating to digital literacy, incidental learning, and virtual worlds.

1. Does digital literacy predict incidental learning of text within virtual worlds? The findings resulting from research question 4 part 1 indicate a weak but positive and significant relationship between digital literacy and incidental learning of text demonstrating that digital literacy does predict incidental learning. This relationship suggests that the higher a learner's digital literacy score was, the better they performed (or the higher their overall score) on the incidental learning of text.

2. Does digital literacy predict incidental learning of visually salient text within virtual worlds? As in part 1 of research question 4, the findings for part 2 revealed a weak, but significantly positive relationship between digital literacy and the incidental learning of visually salient text. This result suggests that the better a learner's digital literacy score was, the higher they tended to score on the visually salient component of the incidental learning test.

3. Does digital literacy predict incidental learning of visually non-salient text within virtual worlds? Here the correlation was weaker than question 4 part 1 and part 2 which were both weak but positive and significant. This relationship suggests that the more digitally literate a learner was, the higher they tended to score on the incidental test for visually non-salient text.

4. Does digital literacy predict incidental learning of images (pictorial) within virtual worlds? The finding resulting from research question 4 part 4 is similar to the weak but positively significant findings in the previous three parts. Although the positive linear relationship was fairly weak, it was the strongest of all of the correlations in the set of regressions for question 4. This result suggests that the higher a learner's digital literacy score, the better they performed on the incidental learning test for images.

The findings from sub questions 1 to 4 align sensibly because it seems logical that if a learner is more comfortable with the technology they are using and the environment they are in, they would be more likely to perform well on the tests for incidental learning. If a learner is very familiar with how to use a game controller because she has played video games all through her childhood and then is subsequently asked to complete a task using that game controller, she is more likely to be successful at this task than not. This has important implications for the field of education. With the current rate that technology is developing and becoming available to consumers, schools are likely to want these technologies as well. In order to keep students up to date with the technologies they will encounter in the work world it would be best that they be introduced to these in schools. Taking this into consideration, assuming that many schools already have basic technology such as the internet, if a teacher wants to create and use a virtual world classroom as a learning environment for students, digital literacy should be a consideration. If a student is not digitally literate or scores very low in digital literacy, he or she may struggle to learn within this environment. On the other side of this issue, if the student has a high digital literacy, he or she may end up incidentally learning many things within the environment, which could be beneficial or detrimental. There may also be implications for where education boards and ministries should invest additional funding. If increased digital literacy helps students perform better in incidental learning, it may also help them learn better in other ways as well. These findings could also have implications for parents. When a parent is deciding which technologies to have in the home, they may choose one over another if it means that the technology they choose will give their child an advantage when he is ready to attend school. For example, if a parent knows that a local school uses virtual environments in the curriculum, he or she may be more inclined to purchase a product like The Sims™ or another virtual program or simulation. Although this research does not suggest it, a parent may feel that purchasing these types of programs could possibly help develop their child’s digital literacy skills.

A good topic for future studies would be to investigate the effects of incidental learning within virtual worlds alongside other types of learning in the same environment simultaneously. There could very well be information overload, which distracts the student, or it may not make a difference at all. Only further research can attempt to answer this.

From personal experience, it seems that many students are bringing multiple and various technologies into the classroom. Given the fact that they have them, it does not indicate anything about whether or not they know how to use them correctly. This ties into the concept of literacy at a technology or digital level. It seems there is a need for a valid, reliable, classroom-friendly instrument to be developed that can assist teachers and instructors in determining where their students' digital literacy skills lie. Tapping into these technologies that students already seem to have, and allowing them to utilize them to help construct knowledge and understanding could help to incorporate a constructivist approach into student learning (see Vygotsky & Cole, 1978; Papert, 1980).

Additional Investigation

In order to more fully explore the data on learning styles, an additional analysis targeted how participants who ranked as 'strong' or 'moderate' as opposed to 'balanced' on the dimension scales performed. The analysis sought to begin answering the question of whether or not the strength of learning style preference was relevant. This additional question was asked because Felder and Spurlin (2005) suggested it as an area for future researchers to consider. After looking at the combined data of those in the strong and moderate category for each dimension, it turned out that strength of learning style preference did not make a significant difference. In the ACTREF dimension the results showed that regardless of whether or not a student was strong/moderate on the active side or strong/moderate on the referencing side of the ACTREF dimension, there was not a significant difference in their incidental learning score. In the SNSINT dimension, the results showed that regardless of whether or not a student was strong/moderate on the sensing side or strong/moderate on the intuitive side of the SNSINT dimension, there was not a significant difference in their incidental learning score. When it came to the VISVRB dimension, the results demonstrated that regardless of whether or not a student was strong/moderate on the visual side or strong/moderate on the verbal side of the VISVRB dimension, there was not a significant difference in their incidental learning score. And lastly, with regard to the SEQGLO dimension, the results indicated that regardless of whether or not a student was strong/moderate on the sequential side or strong/moderate on the global side of the SEQGLO dimension, there was not a significant difference in their incidental learning score.

One possible reason that the results did not detect a significant difference with any of these learning style dimensions is that, upon combining the categories, the data of all of the balanced participants had to be discarded. This in turn significantly dropped the number of participant data left to work with and it is possible that the number of remaining data was simply too small to detect a difference. A remedy to this problem for future research would of course be to obtain a much larger sample size so that discarded data does not have such a dramatic impact. Another possibility is that the test used simply was not rigorous enough for the question being asked. It is very possible that the methods Felder and Solomon (1994) used to differentiate learners works well for the purposes of instructors modifying their lessons, but not for the purpose of predicting incidental learning. This is important to note because it also raises the question of whether or not other types of learning can be, or are best measured with this instrument. Lastly, it is also possible that learning styles is not the best variable to use as a predictor of incidental learning in students. Perhaps variables such as gender or age may better serve this purpose and this is where future research can help further the field.

The implications that this has for education lie in the fact that it did not seem to matter what learning style was preferred. In the classroom that could indicate that teachers and instructors need not consider what a learner's preference is before embarking upon the process of incorporating virtual worlds into their teaching. This is an interesting implication because there is much debate in the literature as to whether or not learning styles are a valid concept in education (e.g., Roher & Pashler, 2012). If the literature is suggesting that learning styles are invalid, and the research seems to be presenting inconclusive results, then perhaps it is time to take a more in-depth look at what the concept of learning style really means.

Limitations

There are a few limitations to note about this study. First, due to time constraints, the number of questions presented to the participants was limited, so future research should consider including more questions on assessments such as sentence completion tests. It is possible that by adding additional questions, researchers can collect more in-depth information to better assess the variables of the study. Time constraints were also a limitation in this study because I was not able to pre-test or post-test participants as thoroughly as I could have if I had two hours to complete the study. The issue with adding time is that there is a possibility of participant fatigue. It should also be noted that this study only tested factual knowledge and not conceptual or other types of knowledge. Because there are so many different types of information, this may have limited the study. Using only factual information about the University of Alberta campus simply may not have been interesting enough to participants. Perhaps more abstract or personally interesting information would serve students better in virtual worlds, but this is something to be investigated by future research. In addition to the factual nature of the information presented, there was also no way to know that the students had not been exposed to the information presented in the virtual world previously. One solution would have been to pre-test the students on their knowledge of the topic presented, but in addition to taking up additional time, it would have unnecessarily increased the risk of priming the student's knowledge, thereby biasing the results. The fact that a convenience sample as opposed to a randomized sample was used for this study is also a limitation to this study. This type of sample limits the generalizability of the results to this particular sample. Another potential limitation is a potential confounding variable. One possible confounding variable to this study could be the fact that some students may have guessed the answer to the questions during the sentence completion task. This would normally be an issue in most studies, but because the information presented to the students was not commonly known knowledge, the chance of a student correctly guessing the answer without having encountered it within the virtual world with his or her avatar was unlikely. Another limitation was the instrument used for measuring learning styles. As mentioned in the results chapter, the two learning style predictors SEQGLO and SNSINT were slightly correlated. While the statistics behind this issue were not a significant cause for concern, it would be best to repeat the study using an instrument that does not have any correlated predictors so as to get a more accurate measure of student learning styles. One last limit to this study was the fact that it did not test participants for their reading ability. If there happened to be participants who were poor readers or could not read, this would have affected their ability to perform within the virtual world and on the post-tests for incidental learning. Given all of these limitations, it is still important to note that they do not provide enough weight to justify disregarding the importance and relevance of the current findings presented here.

Conclusion

This study sought to provide some insight into the field of incidental learning and virtual worlds. Using Felder and Solomon's (1994) Index of Learning Styles and Hargittai's (2005) Survey of Web-Oriented Digital Literacies measures, the study was able to discern that incidental learning does occur in virtual worlds, and that particular digital literacies and particular learning style preferences served as predictors of incidental learning in virtual worlds. Learners performed better when information was made visually salient. This research demonstrates the importance for educators to understand students, their learning preferences, and digital abilities, especially when it comes to virtual environment settings. The research completed in this study addresses the lack of literature on incidental learning as it relates to virtual worlds. It also addresses the lack of literature in the field of salience as it relates to education and virtual worlds as they connect to digital literacy. In addition to addressing this lack, it attempts to offer some light to these fields of research by combining these concepts and examining their relationship to one another from an educational perspective. These findings have implications for schools that may want to use a virtual world to set up a classroom or a learning space for students. Teachers and instructors must make the information they are presenting visually salient so that the learners will pay attention to it and be able to recall it when needed. These results demonstrate that it is not enough to simply present all information in a virtual world in the same manner. Further research needs to be conducted to determine how best to display target information within virtual environments to optimize learning. This could also have implications for information presented through other mediums such as video, images, and sound. Because many virtual worlds allow for various types of media input, future research should investigate these other media in order to determine the impact that salience has as learners interact with it. Future research should also investigate the effect of visual salience on different types of information, such as conceptual in comparison to factual. It is hoped that the results of this research will assist educators in their planning as we move toward more technology-rich learning environments. This research is very timely and important given that there are multiple virtual world projects running globally and that more educators are seeking ways to get students engaged (Eschenbrenner et al., 2008). Education and technology, if combined in the appropriate manner, can compliment each other and serve as a benefit to learners in classrooms around the world.

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Appendix A

Index of Learning Styles

DIRECTIONS

INDEX OF LEARNING STYLES

Enter your answers to every question on the ILS scoring sheet. Please choose only one answer for each question. If both “a” and “b” seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
   a) try it out.
   b) think it through.

2. I would rather be considered
   a) realistic.
   b) innovative.

3. When I think about what I did yesterday, I am most likely to get
   a) a picture.
   b) words.

4. I tend to
   a) understand details of a subject but may be fuzzy about its overall structure.
   b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
   a) talk about it.
   b) think about it.

6. If I were a teacher, I would rather teach a course
   a) that deals with facts and real life situations.
   b) that deals with ideas and theories.

7. I prefer to get new information in
   a) pictures, diagrams, graphs, or maps.
   b) written directions or verbal information.

8. Once I understand
   a) all the parts, I understand the whole thing.
   b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
   a) jump in and contribute ideas.
   b) sit back and listen.

10. I find it easier
a) to learn facts.
b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
a) look over the pictures and charts carefully.
b) focus on the written text.

12. When I solve math problems
a) I usually work my way to the solutions one step at a time.
b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
a) I have usually gotten to know many of the students.
b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
a) something that teaches me new facts or tells me how to do something.
b) something that gives me new ideas to think about.

15. I like teachers
a) who put a lot of diagrams on the board.
b) who spend a lot of time explaining.

16. When I'm analyzing a story or a novel
a) I think of the incidents and try to put them together to figure out the themes.
b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
a) start working on the solution immediately.
b) try to fully understand the problem first.

18. I prefer the idea of
a) certainty.
b) theory.

19. I remember best
a) what I see.
b) what I hear.

20. It is more important to me that an instructor
a) lay out the material in clear sequential steps.
b) give me an overall picture and relate the material to other subjects.

21. I prefer to study
a) in a study group.
b) alone.

22. I am more likely to be considered
a) careful about the details of my work.
b) creative about how to do my work.

23. When I get directions to a new place, I prefer
a) a map.
b) written instructions.

24. I learn
a) at a fairly regular pace. If I study hard, I'll "get it."
b) in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
a) try things out.
b) think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to
a) clearly say what they mean.
b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
a) the picture.
b) what the instructor said about it.

28. When considering a body of information, I am more likely to
a) focus on details and miss the big picture.
b) try to understand the big picture before getting into the details.

29. I more easily remember
a) something I have done.
b) something I have thought a lot about.

30. When I have to perform a task, I prefer to
a) master one way of doing it.
b) come up with new ways of doing it.

31. When someone is showing me data, I prefer
a) charts or graphs.
b) text summarizing the results.

32. When writing a paper, I am more likely to
a) work on (think about or write) the beginning of the paper and progress forward.
b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
a) have "group brainstorming" where everyone contributes ideas.
b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone
a) sensible.
b) imaginative.

35. When I meet people at a party, I am more likely to remember
a) what they looked like.
b) what they said about themselves.

36. When I am learning a new subject, I prefer to
a) stay focused on that subject, learning as much about it as I can.
b) try to make connections between that subject and related subjects.

37. I am more likely to be considered
a) outgoing.
b) reserved.

38. I prefer courses that emphasize
a) concrete material (facts, data).
b) abstract material (concepts, theories).

39. For entertainment, I would rather
a) watch television.
b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
a) somewhat helpful to me.
b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
a) appeals to me.
b) does not appeal to me.

42. When I am doing long calculations,
a) I tend to repeat all my steps and check my work carefully.
b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
a) easily and fairly accurately.
b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
a) think of the steps in the solution process.
b) think of possible consequences or applications of the solution in a wide range of areas.

Appendix B

Survey Measured of Web-Oriented Digital Literacies

How familiar are you with the following computer and Internet-related items? Please choose a number between 1 and 5 where 1 represents "no understanding" and 5 represents "full understanding" of the item.

	Understanding Scale				
	None	**Little**	**Some**	**Good**	**Full**
JPEG	1	2	3	4	5
Frames	1	2	3	4	5
Preference settings	1	2	3	4	5
Newsgroups	1	2	3	4	5
PDF	1	2	3	4	5
Refresh/Reload	1	2	3	4	5
Advanced search	1	2	3	4	5
Weblog	1	2	3	4	5
Bookmark	1	2	3	4	5
Bookmarklet	1	2	3	4	5
Spyware	1	2	3	4	5
Bcc (on email)	1	2	3	4	5
Blog	1	2	3	4	5

How familiar are you with the following computer and Internet-related items? Please choose a number between 1 and 5 where 1 represents "no understanding" and 5 represents "full understanding" of the item.

	Understanding Scale				
	None	**Little**	**Some**	**Good**	**Full**
Tagging	1	2	3	4	5
Tabbed browsing	1	2	3	4	5
RSS	1	2	3	4	5
Wiki	1	2	3	4	5
Malware	1	2	3	4	5
Social Bookmarking	1	2	3	4	5
Podcasting	1	2	3	4	5
Phishing	1	2	3	4	5
Web feeds	1	2	3	4	5
Firewall	1	2	3	4	5
Cache	1	2	3	4	5
Widget	1	2	3	4	5
Favorites	1	2	3	4	5
Torrent	1	2	3	4	5

Appendix C

Ethics Approval

Notification of Approval

Date:	January 10, 2012
Study ID:	Pro00027788
Principal Investigator:	Wayne Thomas
Study Supervisor:	Patricia Boechler
Study Title:	Incidental Learning and Virtual Environments
Approval Expiry Date:	January 8, 2013

Approved Consent Form:	Approval Date	Approved Document
	1/10/2012	Revised Consent Letter
	1/10/2012	Debreif FINAL.docx

Thank you for submitting the above study to the Research Ethics Board 3 . Your application has been reviewed and approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Dr. Wendy Wismer

Associate Chair, Research Ethics Board 3

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix D

Participant Consent Form

UNIVERSITY OF ALBERTA
Department of Educational Psychology
Faculty of Education
6-102 Education North
Edmonton, Alberta, Canada T6G 2G5
www.ualberta.ca
Tel: 780.492.5245
Fax: 780.492.1318

Participant Consent Form

Title of Study: Virtual Worlds Study

Research Investigators:
Wayne Thomas (Graduate Student)
Technology and Learning Sciences Lab
(5-106 Education North)
11279 - 88 Ave
Edmonton, AB
T6G 2G5
E-mail: wthomas@ualberta.ca
Phone (780) 492-9716

Dr. Patricia Boechler (Supervising Professor)
Office: 5-147 Education North
11279 - 88 Ave
Edmonton, AB
T6G 2G5
E-mail: patricia.boechler@ualberta.ca
Phone (780) 492-7273

You are being asked to participate in a study that will require you to operate an avatar around a virtual world. You are a part of this study because you signed up for research participation credits in either a EDPY, EDIT, or PSYCO course. The results of this study will be used in support of my final thesis project.

This study consists of four main parts and will take just under 2 hours to complete. In the first part of the study, you will be asked to fill out a learning styles survey and a digital literacy survey. These are pencil and paper tests that will indicate your preferred learning style as well as your comfort level with technology. Next you will have the opportunity to control an avatar and navigate it around the virtual world while completing a few tasks. Next you will be given another short pencil and paper test asking you to fill in the blanks and a multiple choice test. Lastly, you will use your avatar again and follow the instructions given by the research assistant.

You will not benefit in any particular way from being in this study. We hope that the information we get from doing this study will better help us understand how individuals function within virtual worlds. There is no monetary compensation for participating, but you will receive **2 credits** for your Research Participation.

There are no known risks to participating in this study. Participation in this study is completely voluntary and you have the option to discontinue participation at any time or refuse to answer any questions that may make you feel uncomfortable. There will not be any penalty for withdrawing from the study; you will still be rewarded research credit for your participation. You will also be given a signed copy of this consent form.

All information gathered in this study will be kept confidential and anonymous and is used for research purposes only. Analyses of the data will be conducted on group responses and not individual responses. Once the study is completed, the data will be kept securely stored. Dr. Patricia Boechler of the University of Alberta will keep all collected data from this study in a locked facility. Identifying information will be removed as soon as the data is coordinated and

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entered. Once all data is assembled, your name will be replaced with alpha-numerical codes and your name will be removed from the database. After the allotted retention period (5 years), data from this experiment will be destroyed via shredding and the electronically stored data will be deleted. Any research assistants involved with this project will comply with the University of Alberta Standards for the Protection of Human Research Participants http://www.ualberta.ca/~unisecr/policy/sec66.html.

If you have questions about this research, and/or if you want to obtain copies of the results of this research upon its completion, please contact myself, Wayne Thomas (email: wthomas@ualberta.ca) or Dr. Patricia Boechler (email: patricia.boechler@ualberta.ca, office: 5-147 Education North). A Research Ethics Board at the University of Alberta has reviewed the plan for this study for its adherence to ethical guidelines. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615. This office has no direct involvement with this project.

I have read the Letter of Information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

______________________	______________________	__________
Participant's Name (Please Print)	Participant's Signature	Date
______________________	______________________	__________
Researcher's Name (Please Print)	Researcher's Signature	Date

(Please keep a copy for your own personal records)

Consent Version Date: 09.01.2012

Appendix E

Written and Verbal Participant Preamble

The following instructions were written on the whiteboard when participants entered the room:
“Please use the arrow keys to move your avatar. Only use the WALK function. DO NOT run or fly!!”

The following instructions were given to participants verbally before beginning the experiment:

“Do not turn over the sheets next to your computer. NO NOT turn on your monitor. You WILL need a Pen/Pencil. Please select only ONE response on each question of the questionnaires.”

“Welcome everyone, My name is _______________________________. I am a grad student with the Faculty of Education. Today I am asking you to participate in a study we are conducting about virtual worlds. There are two consent forms beside your computer. Please read this and if you agree to participate today, sign and date both forms. When you are finished with the forms, leave one next to your computer, and take the other with you for your own records. I will give you a few minutes to do this.”

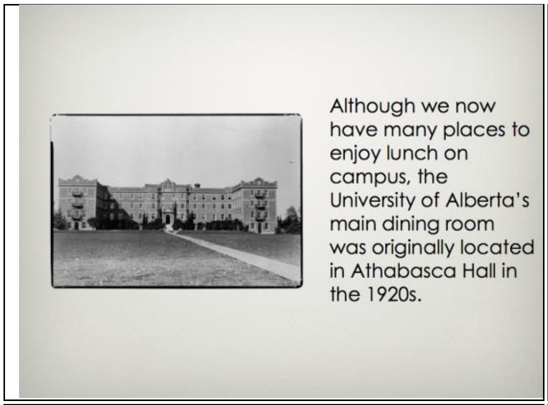
“Today we are going to begin with a few paper and pencil tasks. Please flip over the sheets at your desk and complete the questionnaire. When you finish both, please raise your hand and wait. I will come over and collect your questionnaire. I will ask some of you to step outside of the room for a few minutes, but this is because we can’t have too many people in-world at once, so I’ll have you logging in in groups. Please write your name on every sheet. I will then give you a log in name and password and you can log into Second Life, which is already open on the desktop (just turn on your screen). Use your avatar to walk around the virtual world and complete the tasks on the coloured signs. To move the avatar, you will only need the arrow keys/ You **MUST WALK YOUR AVATAR.** Follow the arrows on the ground and **PLEASE STAY ON THE SIDEWALK FOR THIS TASK**. Along the way, there will be some questions on coloured boards. Please answer the questions. They will tell you how to answer (e.g., click or select, or type in chat window). For questions that ask you to type, open the chat window. The chat option is located at the bottom of the screen. Simply type your answer in the box and press ‘enter,’ then continue on. Follow the path until you reach the end when you finish, please raise your hand and I will bring you the last questionnaire. Please select only one answer per question. [Log them out when you verify they’ve reached the end]. Please answer all questions to the best of your ability. When you complete this questionnaire please gather tour sheets together with your login sheet (strip of paper) and raise your hand. Please wait for further instruction.”

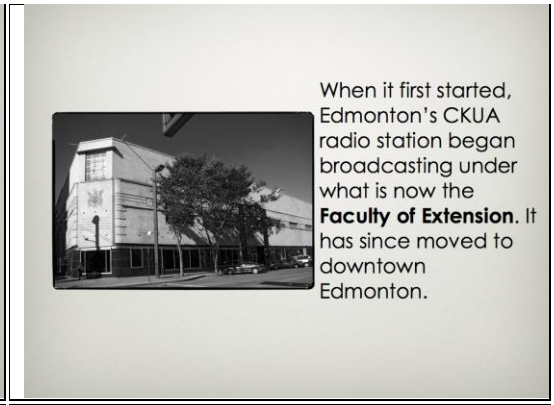
“If at any point you are confused about how to proceed, please raise your hand and we’ll be happy to answer any questions. We would much rather you asked a question than proceed without really understanding what you are supposed to do. Are there any questions so far?”

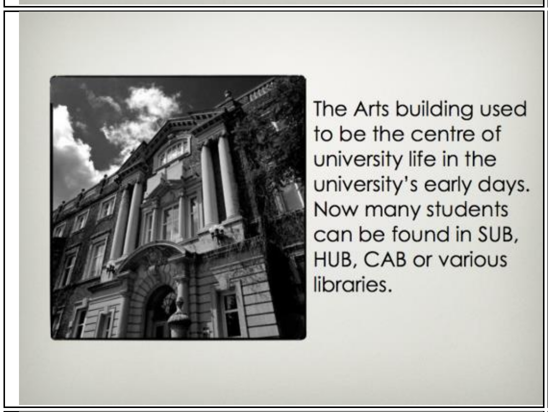
“Before you begin, I want to thank you for agreeing to be in this study. Without your willingness to participate, we couldn’t address our research questions.
You may begin.”

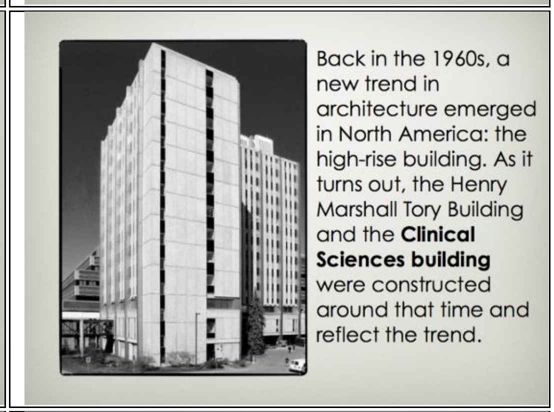
Appendix F

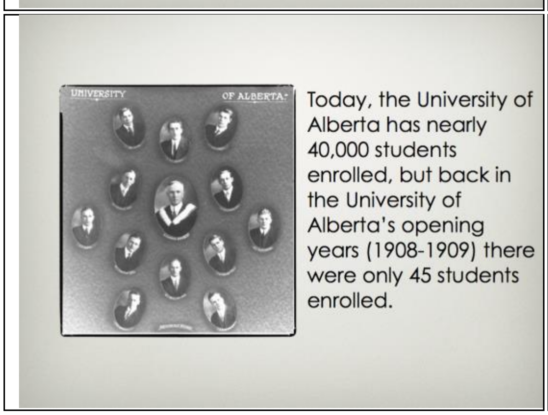
Billboard Slides

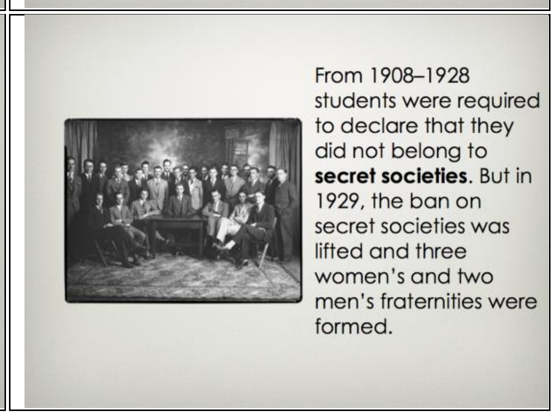


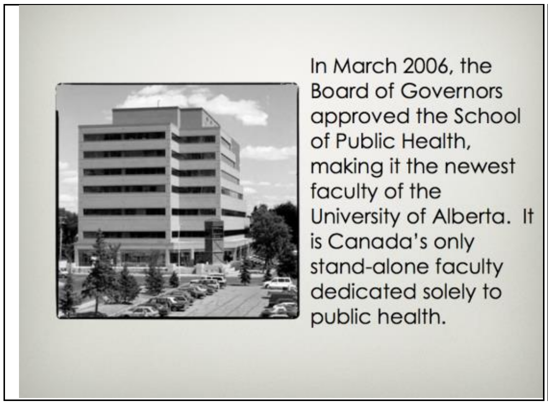


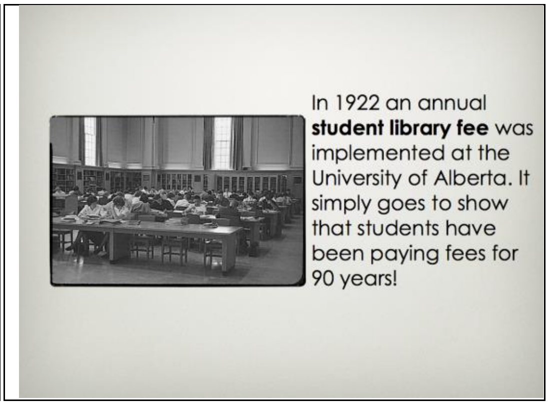


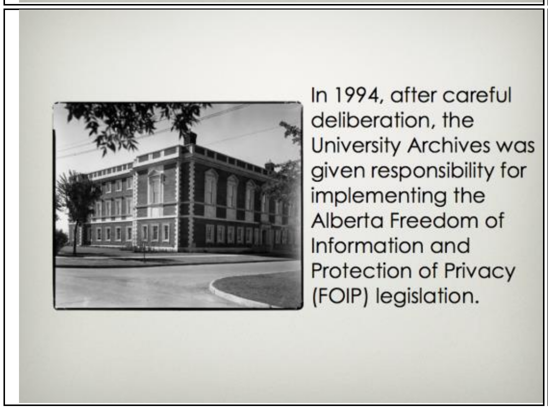


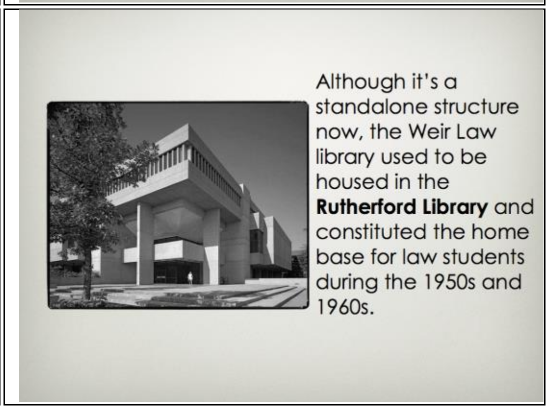





In March 2006, the Board of Governors approved the School of Public Health, making it the newest faculty of the University of Alberta. It is Canada's only stand-alone faculty dedicated solely to public health.


In 1922 an annual **student library fee** was implemented at the University of Alberta. It simply goes to show that students have been paying fees for 90 years!


In 1994, after careful deliberation, the University Archives was given responsibility for implementing the Alberta Freedom of Information and Protection of Privacy (FOIP) legislation.


Although it's a standalone structure now, the Weir Law library used to be housed in the **Rutherford Library** and constituted the home base for law students during the 1950s and 1960s.

Appendix G

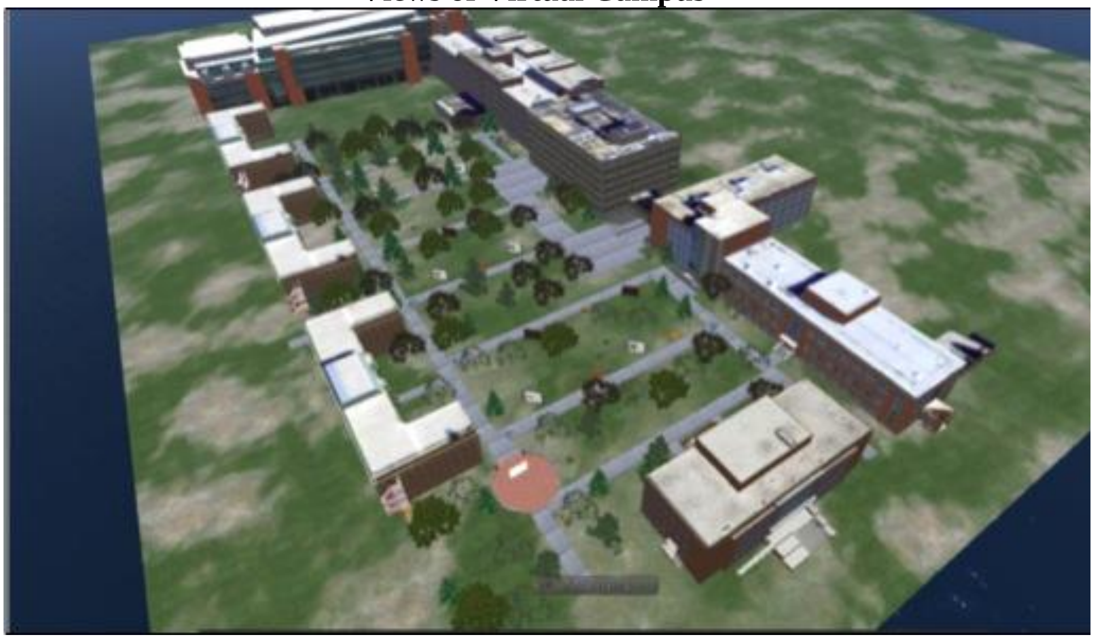
Distractor Billboard Slides

2 x 2=___ (Please type your answer in the ‘chat’ box)	What is the first month of the calendar year? (Please Select One) a) April b) June c) January d) September
Please click on the green sphere.	The capital city of Canada is? (Please Select One) a) Toronto b) Ottawa c) Calgary d) Vancouver
12 ÷ 4=___ (Please type your answer in the ‘chat’ box)	Please click on the yellow cylinder.

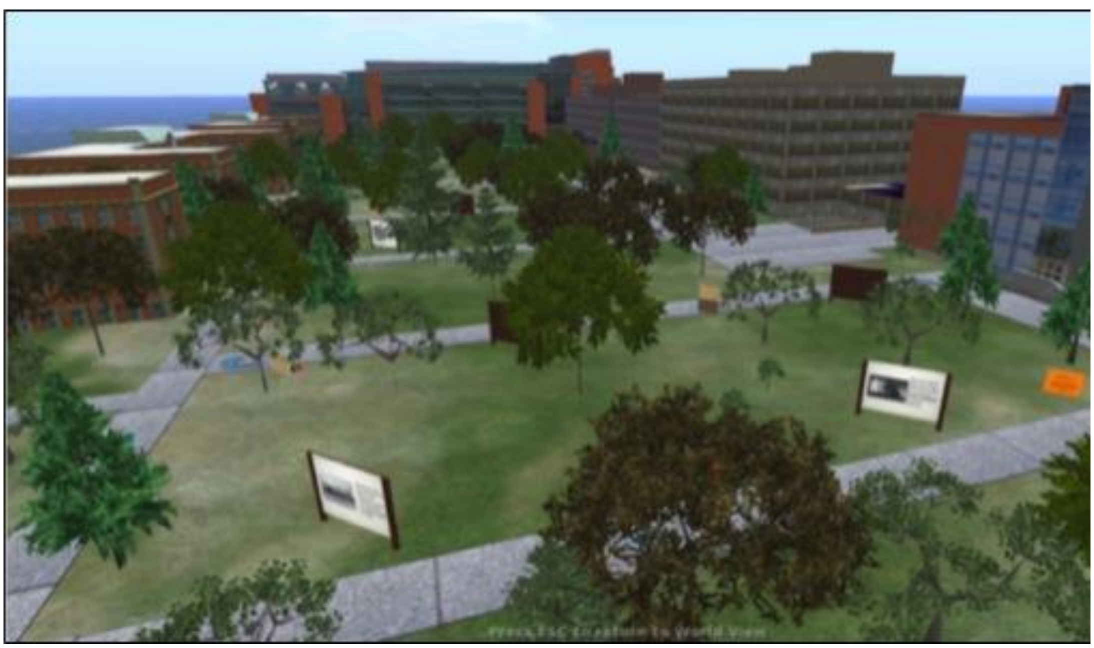
Please click on the red pyramid.	How many hours are in one day? (Please Select One) a) 12 b) 24 c) 36 d) 48
Please click on the brown cube.	7+6+5+4=___ (Please type your answer in the 'chat' box)

Appendix H

Views of Virtual Campus



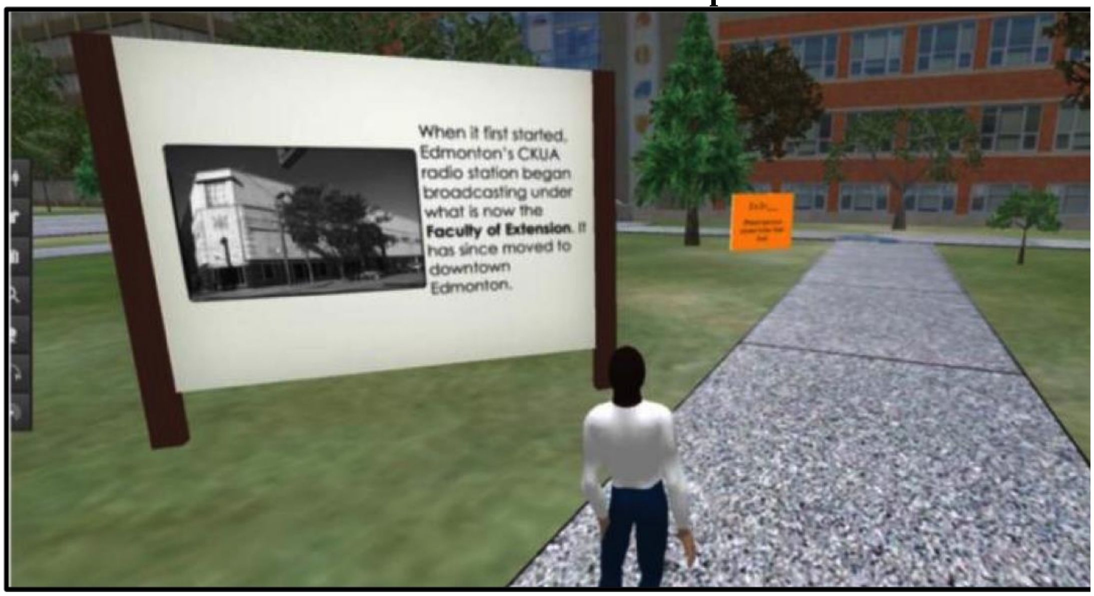
Aerial of the virtual world



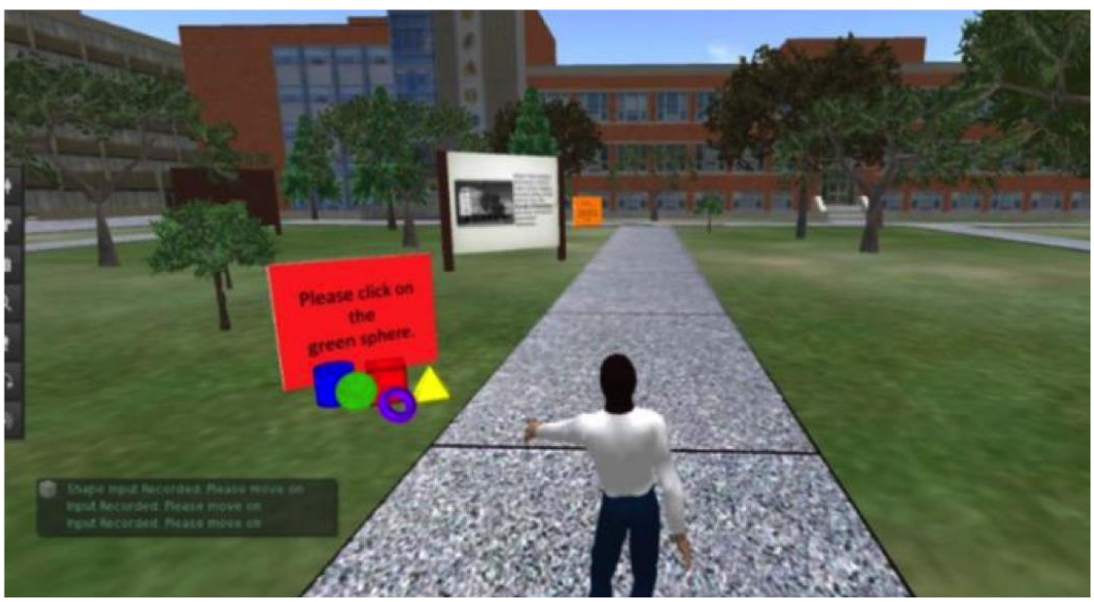
Path view of virtual world

Appendix I

Avatar Views of Virtual Campus



Avatar viewing billboard



Avatar answering distractor question

Appendix J

Image Recognition Test

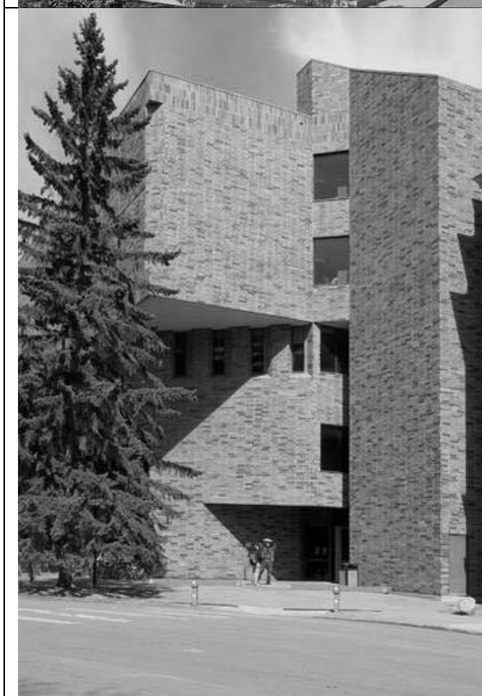
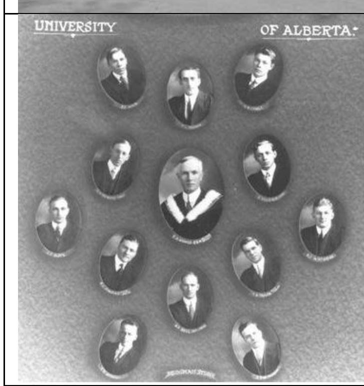
LOGIN NAME+ Number: ____________

Please identify the images you recognize from the virtual world by circling **Yes** or **No**.

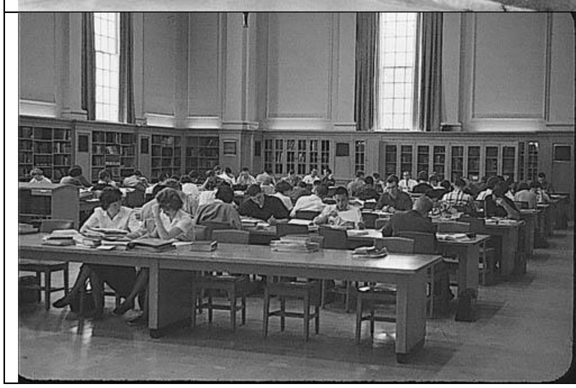
	YES	NO
	YES	NO
	YES	NO

	YES	NO
	YES	NO
	YES	NO
	YES	NO

	YES	NO
	YES	NO
	YES	NO
	YES	NO

	YES	NO
	YES	NO
	YES	NO

	YES	NO
	YES	NO
	YES	NO

	YES	NO
	YES	NO
	YES	NO

Appendix K

Sentence Completion Test

Sentence Completion Items

1. The University's main dining room was originally located in________________________

2. CKUA radio began its broadcasting under the faculty of __________________________

3. The ______________________building used to be the centre of University Life

4. The Henry Marshall Tory Building and the _____________________________ Building were built to reflect a trend of high rise buildings back in the 1960s

5. In the University of Alberta's first year of operation, only ___________________students were enrolled

6. Before 1929, students had to declare that they did not belong to __________________________

7. The _______________________________________ is the most recently added faculty at the University of Alberta

8. An annual ____________________________________ was implemented at the University of Alberta in 1922

9. The University Archives was tasked with the responsibility of implementing provincial____________________________ legislation

10. The Law Library was originally housed in _______________________________________

Appendix L

Study Debrief Form

Study Debrief

Title of Research: Virtual Worlds Study

Research Investigators:

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This study examined learning within a virtual world context, and had four parts. You were first asked to assess your abilities in a number of different areas by completing two paper-and-pencil tests learning style and digital literacy. You were then asked to perform some tasks in the virtual world measuring your ability to function within it. At the end of these tasks, you were asked to complete a word completion and an image completion task. Lastly you were asked to follow some instructions given by a research assistant.

This study was also designed to look at a few things. The first is to examine whether or not incidental learning occurs in virtual worlds. Incidental learning occurs when people learn information they were not purposefully attending to. We wanted to know if you remembered any of the information you saw in the virtual world even though we did not instruct you to pay attention to it or to remember it. The last set of pencil and paper tests completed were to test what you picked up or learned while inside the virtual world (your incidental learning). The second is to look at how students with different learning styles and literacy levels perform within the environment. The initial pencil and paper tests that were completed were to help us determine your learning style and comfort with technology. We wanted to know if students that were strong visual learners found this environment easier to learn from than students with other learning styles. Lastly we wanted to test the usability of the virtual world for a future project and see how much activity the world could handle at a given time.

If you have questions about this research, and/or if you want to obtain copies of the results of this research upon its completion, please contact Wayne Thomas (email: wthomas@ualberta.ca) or Dr. Patricia Boechler (email: patricia.boechler@ualberta.ca, office: 5-147 Education North). A Research Ethics Board at the University of Alberta has reviewed the plan for this study for its adherence to ethical guidelines. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615.