Exploring the Dimensions of Self-Efficacy in Virtual World Learning: Environment, Task, and Content

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Abstract

This study explores the dimensionality of college students' self-efficacy related to their academic activities in the open-ended virtual world of Second Life (SL). To do this, relevant dimensions of self-efficacy were theoretically derived, and items to measure these dimensions were developed and then assessed using a survey methodology. Using data from 486 students enrolled in an introductory accounting course supplemented by the use of SL, the results of this study confirm the distinction of three dimensions of self-efficacy: Virtual World-Environment Self-Efficacy (VWE-SE), Learning Domain Self-Efficacy (LD-SE), and Virtual World-Learning Domain Self-Efficacy (VWLD-SE). Additionally, this study found that both VWE-SE and VWLD-SE were correlated with course learning. Implications for research and course design are discussed.

Keywords: virtual world, three-dimensional multi-user virtual environment (3D MUVE), Second Life, self-efficacy, financial accounting education

Introduction

Technologies that place the user at the center of the learning experience are rapidly being incorporated in educational settings (Johnson, Adams, & Cummins, 2012). One such innovation is the virtual world. Most virtual worlds resemble three-dimensional (3D) Earth to varying degrees, with depictions of land, sky, and water. Users are represented by avatars, simulated bodies though which the virtual world is sensually perceived. Avatars dynamically interact with objects and other users in the world. Communication is both asynchronous and synchronous, mediated by text, voice, and body language.

There are a variety of virtual worlds available, each offering distinct features depending on the audience and overall objectives. Some virtual worlds are designed with a specific educational audience in mind. For instance, the private virtual world of River City is intended for adolescent students, with objects and activities designed to improve their practice of scientific inquiry (Ketelhut, Nelson, Clarke, & Dede, 2010). Other virtual worlds are available to the public and are more open ended, allowing users to create and shape the space. For instance, in Second Life (SL), the user is represented by his or her avatar and can shape the virtual environment in any manner that is useful. The user is given the tools to build objects, as well as the ability to add scripts to the objects in order to affect these objects' behavior. Although social interaction is emphasized rather than formal learning, SL has the ability to be embedded with educational objectives that support academic content and activities.

Particularly in higher education, virtual worlds like SL have proven attractive for a number of reasons. Researchers have been interested in the area of student engagement (Hearrington, 2010; Hornik & Thornburg, 2010; Meggs, Greer, & Collins, 2011; Mennecke, Hassall, & Triplett, 2008) and the formation of online community through the unique ability to enhance user presence in the virtual world (McKerlich, Rils, Anderson, & Eastman, 2011). Learning in the virtual world is also positively associated with course performance in higher education (Hornik & Thornburg, 2010). The affordances of the space allow novel ways to create content (deNoyelles, 2012), which supports multiple learning styles (Meggs et al., 2011). Students can draw tangible connections to subjects previously judged as abstract. For instance, Merchant et al. (2012) explored how students learned chemistry concepts by interacting with rotating models through their avatars in SL. Through interactions with learning objects, students receive "just-in-time" support and instant feedback about performance. In another case, Meggs et al. (2011) found that notecards placed strategically in SL aided students in making corrections to their thinking. Finally, students can interact with and learn informally from others who are present in the environment. All of these factors make open-ended virtual worlds a promising environment to support learners in higher education.

Although open-ended virtual worlds offer unique ways for users to project presence to the community, interact with content, and shape the environment, one consistent theme in the research literature is that learners report difficulties when participating in learning activities within virtual worlds (Mayrath, Traphagan, Heikes, & Trivedi, 2009; Mennecke et al., 2008; Sanchez, 2007). Using the technology acceptance model, Chow, Herold, Choo, and Chan (2012) found that perceived ease of use was an influential factor that affected the intention of students to use SL for learning. Difficulties concerning navigation and interaction with objects like media or notecards have also been documented (deNoyelles, 2012). In addition, issues with communication have been identified. Mennecke et al. (2008) found that students reported difficulties in the management of multiple conversations, and deNoyelles (2012) discovered that several students were unsure of the nature of social norms in the virtual world.

Although previous research suggests that the capability of open-ended virtual worlds to support engagement and learning is beneficial, it also identifies significant user challenges that may impede these benefits. For this reason, it is important to undertake a deeper exploration of the factors that might enhance the positive learning outcomes for students and reduce the difficulties commonly experienced. One common factor shown to play a role in learning and performance is self-efficacy (Bandura, 1997). Although self-efficacy has previously been investigated in the context of virtual worlds (Cheong, 2010; Merchant et al., 2012), this research seeks to explore the construct in greater depth by determining if students using SL in higher education perceive self-efficacy as multi-dimensional, consistent with findings in other content areas (e.g., Bong, 1997; Looney, Valacich, Todd, & Morris, 2006). Findings from this study will offer an insight into the critical instructional design issues that must be addressed before effective learning can occur in these unique environments.

Literature Review

Self-efficacy is the reflection of an individual's belief in his or her capabilities to complete tasks (Bandura, 1997) and has been shown to affect learning and performance outcomes in a variety of settings such as education (Pajares & Urdan, 1996; Schunk, 1991; Schunk & Gunn, 1986), organizational training (Gist, Schwoerer, & Rosen, 1989; Martocchio & Judge, 1997), computer training (Compeau & Higgins, 1995; Johnson & Marakas, 2000), and e-learning (Johnson, Hornik, & Salas, 2008; Sun, Tsai, Finger, Chen, & Yeh, 2008). In general, individuals with higher self-efficacy perform better, persist more in the face of obstacles, have higher learning outcomes, and are more motivated than individuals with lower self-efficacy (Gist & Mitchell, 1992; Marakas, Yi, & Johnson, 1998; Pajares & Valiante, 1997). This is because self-efficacy affects not only performance, but also cognitive processes, motivation, and feelings. Individuals with greater self-efficacy are more likely to view difficult tasks as challenges rather than threats, fostering motivation and engagement, persistence, and more effective use of coping mechanisms (Marakas et al., 1998; Pajares & Valiante, 1997). In contrast, a lower sense of self-efficacy undermines performance, weakens engagement, and leads to quicker abandonment of tasks (Bandura, 1989).

Self-efficacy estimates vary on three dimensions: magnitude, strength, and generality (Bandura, 1997). Magnitude focuses on whether an individual believes that he or she can complete the task. Strength reflects an individual's confidence at completing the various components of the task or at various levels of difficulty. Finally, generality is the extent to which self-efficacy on one task generalizes to other tasks or domains. Generality is particularly important when understanding how self-efficacy estimates on one task generalize to other related tasks, such as academic domains (Bong, 1997).

Self-Efficacy in Virtual Worlds

Self-efficacy has become of greater interest to researchers studying the educational applications of virtual worlds. Much of this research pertains to private educational worlds in K-12 settings such as Quest Atlantis and River City, and has focused on improving skills and self-efficacy through the use of virtual worlds. For example, Ketelhut and colleagues (Ketelhut, 2007; Ketelhut et al., 2010; Nelson & Ketelhut, 2008) have focused on how virtual worlds can be used to improve self-efficacy for engaging in scientific inquiry, and Zheng, Young, Brewer, and Wagner (2009) focused on how they can be used to improve self-efficacy regarding foreign language learning. Other researchers have focused on higher education settings, investigating how using virtual worlds can improve self-efficacy for learning chemistry (Merchant et al., 2012), second languages such as Chinese (Henderson, Huang, Grant, & Henderson, 2009), writing (Xu, Park, & Baek, 2011), and teaching (Cheong, 2010). A consistent finding from this line of research is that the use of these virtual worlds increases self-efficacy for the content delivered via the virtual world. However, these studies did not measure self-efficacy for virtual worlds – that is, student confidence in working in these worlds. One exception is Hearrington (2010), who found that virtual world self-efficacy was related to course learning efficiency. In addition, other studies have investigated self-efficacy for virtual worlds and its role in adoption decisions (Chow et al., 2012; Luse, Mennecke, & Triplett, 2013; Shen & Eder, 2009).

Measurement of Self-Efficacy

The measurement and focus of self-efficacy scales discussed in the research above illustrates a tension for researchers when assessing self-efficacy in a virtual world. That is, should self-efficacy be assessed on students' perceptions of their ability to have mastered the course content, the virtual world environment itself, or both? In addition, questions arise about how these different dimensions of self-efficacy relate to each other. Complicating the measure of self-efficacy is that it is a task-specific construct and items measuring the construct should reflect the task at hand (Bandura, 1997). Task-specific measures have been shown to be better predictors of task performance than more general measures (Marakas, Johnson, & Clay, 2007). In any course-related activity transpiring in a virtual world, students will assess their subject matter-specific ability (e.g., in chemistry, writing, and accounting) as well as their ability to navigate the environment. Therefore, understanding both domains of self-efficacy is likely to be necessary for realizing the expected benefits of delivering course content within virtual worlds.

Many tasks require students to combine skills from both of these domains. Consider, as an example, the accounting domain. Students taking an accounting course must be able to navigate and interact in the virtual world, be able to apply accounting principles, and may need to manipulate objects within SL to illustrate accounting principles. Because skills are drawn from multiple domains, self-efficacy estimates will need to reflect these broader skills. Thus, as Looney et al. (2006) note, task specificity does not imply domain specificity. Self-efficacy estimates can be *encapsulated* within one task domain or they can reflect a *combination* of skills from multiple domains (Looney et al., 2006). Applying the accounting example in Table 1, the first item represents a task-specific belief about navigating and working in the virtual world and is encapsulated within the virtual world domain (i.e., task-specific and domain-specific).

Table 1. *Form and domain(s) of self-efficacy items*

Item	Form	Domain(s)
I believe I have the ability to interact with objects in Second Life.	Encapsulation	Virtual World
I believe I have the ability to identify the debit parts of an accounting equation.	Encapsulation	Accounting
I believe I have the ability to manipulate a T-account in Second Life.	Combination	Virtual World, Accounting

The second item is also encapsulated, but within the accounting domain. Finally, the third item represents a cross-domain belief that reflects an assessment of both the student's belief in his or her ability to work within the virtual world, as well as the ability to complete an accounting task within this environment (i.e., task-specific, but not domain-specific). The same principles described here for the accounting setting would apply for any other subject context of interest to a researcher or instructional designer.

To fully assess self-efficacy within a virtual world learning environment, scales must be developed that focus on: (1) the virtual world environment, (2) the learning domain, and (3) a combination of the two. In addition, because the scales draw on different underlying skills, these scales should also reflect the differing tasks and domains. Therefore, research is needed that assesses the current state of self-efficacy scales used in the study of virtual world learning environments. A brief summary of these scales is presented in Table 2.

Table 2. *Previous self-efficacy scales used in virtual world learning environments*

Study	Scale Type	Domain
Cheong (2010)	Encapsulated	Teaching
Chow et al. (2012)	Encapsulated	Computing
Hearrington (2010)	Encapsulated	Virtual World
Henderson et al. (2009)	Encapsulated	Second Language
Ketelhut (2007)	Encapsulated	Scientific Inquiry
Ketelhut et al. (2010)	Encapsulated	Scientific Inquiry
Luse et al. (2013)	Encapsulated	Virtual World
Merchant et al. (2012)	Encapsulated	Chemistry
Nelson & Ketelhut (2008)	Encapsulated	Scientific Inquiry
Shen & Eder (2009)	Encapsulated	Computing
Xu et al. (2011)	Encapsulated	Writing
Zheng et al. (2009)	Encapsulated	Foreign Language

How a researcher measures self-efficacy is very important, and researchers have developed guidelines for the development of self-efficacy scales in general (Bandura, 2006) and specifically for the computing domain (Marakas et al., 1998). These recommendations include four main points: (1) Items should focus on an individual's ability to complete the task of interest, (2) Items should be task-specific rather than general in nature, (3) Items should avoid inappropriate anchoring or ordering of skills, and (4) Items measuring self-efficacy at a specific level should not contain items that reflect self-efficacy at another level.

Although many of the scales listed in Table 2 were well developed and met the four criteria in the context of their studies, this does not mean that the scales can be easily transferred to a new environment. Any technological environment is constantly evolving, and researchers should assess the appropriateness of existing scales, which may require the development of new self-efficacy scales (Marakas et al., 2007). A review of these previous scales reveals several potential issues. First, all of the previous scales are encapsulated and focus either on the learning domain or on the virtual world. Second, encapsulated scales do not capture the combination of skills necessary for completion of learning tasks within a virtual world environment. Third, the items used in previous studies do not capture the full set of virtual world environment skills necessary to succeed in the classroom.

The present study focuses on the articulation of three dimensions of self-efficacy needed to assess estimations in the virtual world. They are *Virtual World-Environment Self-Efficacy* (VWE-SE), *Learning Domain Self-Efficacy* (LD-SE), and *Virtual World-Learning Domain Self-Efficacy* (VWLD-SE). These terms are defined and discussed below.

Virtual World-Environment Self-Efficacy

VWE-SE is a reflection of an individual's belief in his or her ability to successfully navigate and interact with others in the virtual world. Skills typically required in this setting are the ability to walk around the "classroom" area, flying to different parts of the island or buildings within the island, and generally moving about the learning area. In addition, students need to be able to interact with other students or the instructor's avatar in order to communicate and receive assistance. Thus, the ability to interact with objects and communicate with avatars is salient. Individuals with higher VWE-SE will feel more confident that they can navigate (i.e., walk or fly) through the classroom, interact with others in the environment, and interact with other objects within the classroom. In addition, they may feel more confident in approaching and engaging with other avatars, enabling more opportunities for social interaction and collaborative building. Note that this dimension of self-efficacy does not include any learning domain estimations, instead focusing only on navigating and interacting in the virtual world. If a student is unable to control his or her avatar in these ways, he or she will not be able to successfully complete learning domain tasks that are embedded within the virtual world learning environment.

Learning Domain Self-Efficacy

LD-SE reflects an individual's belief in his or her ability to complete salient tasks in a particular learning domain. Previous studies have found that self-efficacy for learning domains such as accounting (Cheng & Chiou, 2010) and computer training (Gist et al., 1989) is related to learning outcomes. It is important to note that just as the computing environment is very broad, so are the environments of various content areas. Researchers must measure only the tasks of interest in their specific study, rather than sampling from all potential domain items. This principle is illustrated using accounting as a content domain. There are thousands of tasks that an accountant can complete, but the most basic task or skill for introductory accounting students to develop is the ability to properly identify the debit and credit part of a transaction. Therefore, in the context of this study, LD-SE focuses on the students' ability to understand and correctly identify debits and credits of an accounting transaction.

Virtual World-Learning Domain Self-Efficacy

Beyond the ability to navigate and interact within the virtual world learning environment, students must also be able to "manipulate" and "use" the learning objects embedded within the environment to accomplish specific learning domain tasks. Students draw on skills from both the virtual world environment and from the learning domain. It is the combination of these skills that differentiate it from either VWE-SE or LD-SE. Therefore, VWLD-SE reflects the ability of a student to move about the virtual world, interact with learning objects, and apply content-specific concepts to those objects.

Method

Participants

Research took place in a financial accounting course taught in the Spring 2011 semester at a large public university in the Southeastern United States. This course is the first course required of all business majors, serving as a prerequisite for more advanced business and accounting courses. The course was taught in a video-streaming format, in which the 772 enrolled students had the option to attend a class or watch the classroom presentation via streaming video. Concerning attendance, 36% of the students indicated that they attended the face-to-face class regularly, with the other 64% participating online.

Several assignments incorporating SL were required in the course. Students were given a survey after completing these assignments and received nominal course credit for participating. A total of 486 students completed the survey, resulting in a 63% response rate. The sample contained more males (56%) than females (44%) and the mean age was 21.9 (*SD* = 3.95). The sample was representative of the broader student population at the University (64% White, 14% Hispanic-American, 13% African-American, 6% Asian-American, and 3% other). Participants were fairly experienced users of computers, with 77% indicating that their experience was advanced or better. In addition, 82% of the sample indicated that they had basic or better skills using the Internet. Finally, 83% of the sample indicated they had basic or better skills related to gaming.

Context

As an introductory course, Financial Accounting focuses on basic accounting concepts such as the accounting equation, debits and credits, as well as accounting for common items that appear on the balance sheet, income statement, and cash flow statement. SL was utilized as a supplement to the course and was geared heavily towards the accounting equation, one of the foundational learning concepts in financial accounting. The formula for the accounting equation is *Assets = Liabilities + Stockholder's Equity*. Within the realm of financial accounting, adjustments to the variables in the equation (i.e., Assets, Liabilities, and Stockholder's Equity) are described using the terms *debit* and *credit*. The basic rule of accounting is that the equation must always be *in balance*, meaning the two sides of the equation need to be equivalent. An increase in an asset account (i.e., a debit) requires either an equal increase in a liability or equity account, or a decrease in another asset account (i.e., a credit), and vice versa. Understanding this fundamental equation is important, because the formula and relation between the accounts becomes more complicated when considering the accounts that compose the equity variable. If students do not understand these basic but abstract concepts, they are destined for early withdrawal, failure, or a semester of considerable time and effort (often in pursuit of simply earning a passing grade).

To help students better understand the accounting equation, a model of the abstraction was developed by the instructor in SL (Figure 1). This model, which resided in the SL region called [ReallyEngagingAccounting](), allowed students to visualize how a debit or credit would affect an account type (asset, liability, or equity) by visualizing the change to the equation. By visually experiencing the change to the model, the impact of the increase or decrease on the accounting equation could transform from an abstract algebraic expression to something tangible that could be seen, touched, and interacted with. This 3D model allowed the students to interact with the various parts of the accounting equation (assets, liabilities, equity). Students used the text chat functionality to communicate with the equation. For example, a student could type the word "debit" followed by "$10,000" and the account type (asset, liability, or equity) into the text chat box. The impact of that entry on the equation would be visually displayed on the 3D asset (Figure 2). Students also received text-based feedback, that is, communication from the model, such as "Assets debited, standby for an increase."

Figure 1. *Accounting equation model in Second Life*

Figure 2. *Asset increase with accompanying text feedback*

Students interacted with this model to reinforce their understanding of the equation, as well as to complete course assignments. The first assignment had students learn the chat commands required to interact with the model, and the next two assignments had students interact with the model to complete various accounting transactions pertinent to the course. Completing the assignments using the 3D accounting equation model allowed the students to first develop their understanding of the accounting equation (the first assignment) and then to develop their understanding of how it could be used to record basic accounting transactions (the second and third assignments). Figure 3 illustrates the 3D accounting equations in use by students on the ReallyEngagingAccounting island. In addition to the accounting equation models, a second type of model was also constructed in SL, called the *T-account*. A T-account, also known as a *ledger*, is a representation of an account and is commonly used in financial accounting courses to distinguish the effects of a debit or credit on a specific account balance. In the model built within SL, students' avatars were able to walk onto a T-account and turn it into a debit or credit (interacting with the equation through their simulated bodies). They were then given various accounts and had to determine what was needed to either increase or decrease the account balance (debit or credit) and walk to the proper side (debit or credit) of the T-account. For example, if the T-account displays "increase in building," then the student would need to walk to the debit side of the equation. Students received text-based feedback from the model as they made their choices (Figure 4).

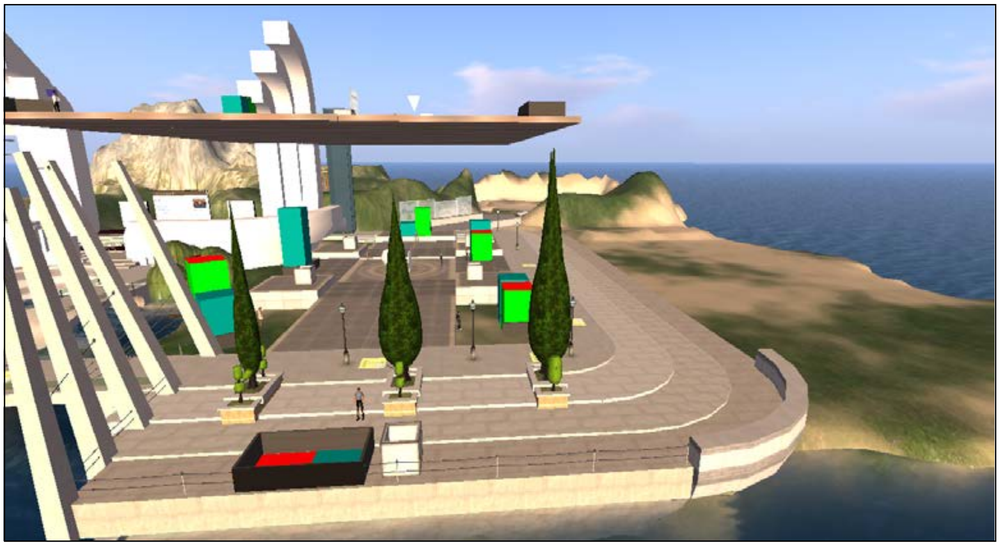

Figure 3. *A view of the accounting equation models in use by students*

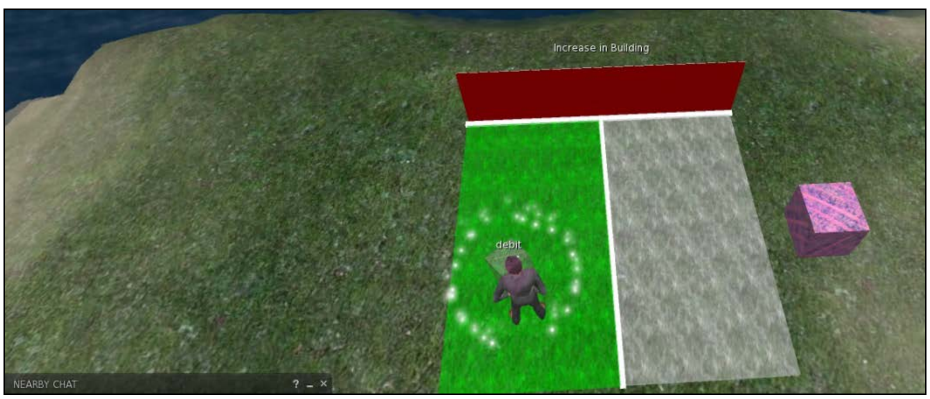

Figure 4. *Overhead view of T-account with green indicating a correct response*

In addition, students had the option to work with a tutorial 3D accounting equation (Figure 5). Through this learning tool, students had the opportunity to gain knowledge of the basic accounting equation. These models were designed to help a student learn basic accounting equations. They could interact with these tutorial models and, for example, learn how to record a collection of cash on account. The accounting equation tutorials were similar in appearance to the 3D accounting equations and used the same commands. However, unlike the accounting equations, they incorporated a heads-up-display (HUD) that would prompt the student for the necessary action needed, such as which accounts were affected and whether they required debits or credits. Students interacted with these models using a combination of menu selections and text chat. The tutorial also provided feedback to student responses in order to confirm that the correct choice had been made, or to provide the student with additional help and a request to try again until the student identified the correct choice (i.e., debit/credit and/or the correct type of account affected by a transaction).

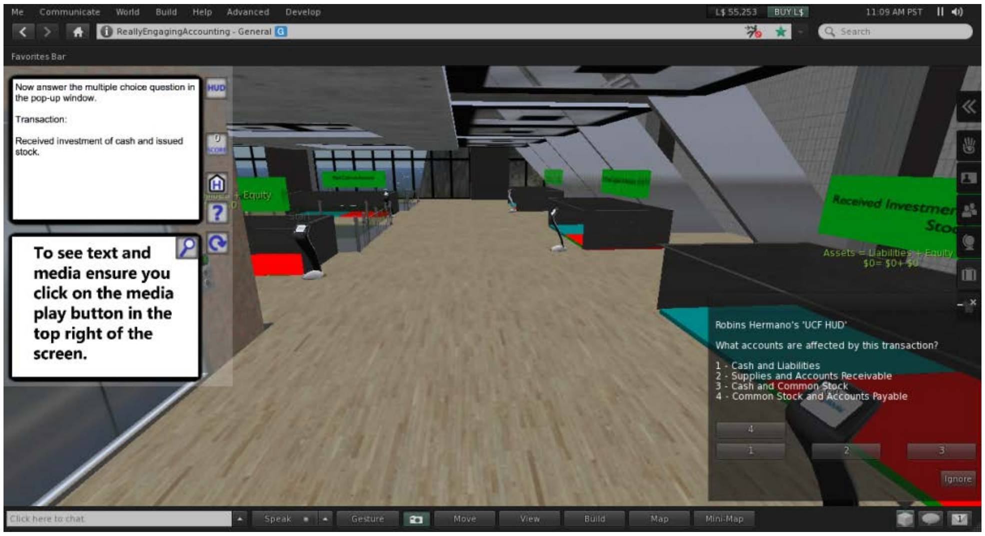

Figure 5. *Tutorial accounting equation*

An autonomous orientation was developed to instruct students on all aspects of the learning models described above. This orientation included instructions on how to use the HUD along with the learning models (the 3D accounting equation, how to create notecards, how to submit the notecards for grading, and how to use the T-account model). The first assignment using the 3D accounting equation model was scheduled two weeks from the start of the course and after the lecture on the first chapter. The second assignment was scheduled two weeks later after lectures on how to record basic accounting transactions, followed immediately by the first exam. Because the T-account model required students to have learned the majority of the accounting transactions taught in the course, the assignment was completed a few weeks before the final exam. All assignments were submitted individually, although it was possible for students to work on them in groups depending on when they accessed SL and if other students were working on assignments. The instructor was also present in SL while students were completing assignments and could answer questions from students at that time. Students could also interact with each other and the instructor in SL through both text and voice-based chat.

Scale Development and Data Analysis

The measures for this study were constructed based on the self-efficacy scale construction methods described by Bandura (2006) and Marakas et al. (1998). Specifically, the four recommendations referenced in the "Measurement of Self-Efficacy" section were the main focus. Items were developed to assess participants' beliefs in their ability for working in the virtual world environment, to complete accounting tasks, and to complete accounting tasks in the virtual world environment.

A series of potential items were developed and then reviewed and discussed by the authors, leading to an initial pool of items. Each question stem began with "I believe I have the ability to …" followed by a description of the task. In order to assess strength and magnitude, the response format for each question ranged from 0 (*Can't do*) to 100 (*Totally confident*) in increments of 10. The question stem and response format is consistent with many other self-efficacy measures (see, for example, Hardin, Fuller, & Davison, 2007; Johnson, 2005; Johnson & Marakas, 2000; Yi & Hwang, 2003). Based upon this review, items were updated and refined. Next, the items were reviewed by two additional experts and revised accordingly, leaving a final set of 20 candidate items. (Complete scale items are included in the Appendix.)

The psychometric properties of the scales were assessed with several validated techniques. First, the domain sampling properties of the items were assessed to index construct validity through the calculation of the Measure of Sampling Adequacy (MSA) (Kaiser, 1968). The index derives from a Guttman theorem that specifies that if one has an adequate item set for a specified domain, the inverse of the correlation matrix will approach an identity (Guttman, 1953). As the MSA approaches 1.0, the psychometric sampling properties improve and the investigators have an indication that procedures such as factor analysis will yield verifiable results. As the index decreases, the validity of the data comes into question. An MSA of .5s or .6s indicates lack of domain representation. After this procedure, the reliability (internal consistency) of the items comprising each factor was assessed with coefficient alpha (Cronbach, 1951).

Second, to assess the dimensionality of the scales, Guttman's (1953) image analysis was employed. In this procedure, there are two parts of the dataset: "that which can be predicted from the rest of the variables in the set (the image) and that which is not predictable from those variables (the anti-image)" (Dziuban & Moskal, 2011, p. 238). The images are similar to common factors, and the anti-images are similar to unique factors (Desjardins, 2010). Finally, the scale items were factor analyzed, and items were assessed as to their loadings on the theorized constructs.

Results

The results indicate that the MSA for the data was .95, supporting adequate psychometric properties. In addition to the MSA analysis, image components were assessed and retained according to the eigenvalues of the item correlation matrix and transformed with the promax procedure (Hendrickson & White, 1964). Eigenvalues greater than 1 were retained, consistent with the recommendations of Kaiser (1960). Table 3 presents the results of this analysis, which supports the three theorized dimensions (VWE-SE, LD-SE, and VWLD-SE). Each item loaded more highly on its associated factor than on the other factors, and all loadings exceeded .40. Finally, the coefficient alpha reliability estimates for these scales were .95 for VWE-SE, .91 for VWLD-SE, and .81 for LD-SE, indicating that each of the self-efficacy scales exhibited acceptable reliability. Specific results for each of the self-efficacy dimensions relevant for virtual world learning are discussed below.

Table 3. *Pattern matrix for the self-efficacy items*

	VWE-SE	**VWLD-SE**	**LD-SE**
Reliability (Alpha)	.95	.91	.81
Eigenvalues	13.09	1.65	1.13
Question Stem: *I believe I have the ability to…*			
1) Walk around the classroom.	**.91**	-.11	.11
2) Navigate the classroom.	**.87**	.04	-.01
3) Fly around the classroom.	**.83**	-.10	.04
4) Move around the classroom.	**.82**	-.05	.17
5) Communicate through Second Life.	**.72**	.11	.03
6) Interact with objects in Second Life.	**.64**	.25	-.01
7) Use text-based chat in Second Life.	**.62**	.10	.12
8) Have my avatar gesture.	**.60**	.19	-.17
9) Review course lectures in Second Life.	**.47**	.27	-.12
10) Use voice chat in Second Life.	**.47**	.16	-.14
11) Turn in assignments to the homework box using Second Life.	**.45**	.27	.11
12) Manipulate the accounting equation in Second Life.	.10	**.94**	-.13
13) Use the accounting equation in Second Life.	.12	**.84**	.01
14) Manipulate T-accounts in Second Life.	.12	**.84**	-.06
15) Use credits to interact with the accounting equation.	-.04	**.81**	.21
16) Use debits to interact with the accounting equation.	.01	**.81**	.19
17) Use a T-account.	.06	**.58**	.30
18) Use the accounting equation to record transactions.	.22	**.50**	.21
19) Properly identify the debit part(s) of a transaction.	-.04	.344	**.71**
20) Properly identify the credit part(s) of a transaction.	-.05	.38	**.69**
MSA = .95 Residual MSA = .64			

Note. VWE-SE = Virtual World Environment Self-Efficacy; VWLD-SE = Virtual World-Learning Domain Self-Efficacy; LD-SE = Learning Domain Self-Efficacy.

Dimension 1: Virtual World-Environment Self-Efficacy (VWE-SE)

The first dimension focuses on self-efficacy for the basic skills that are necessary for students to navigate and complete tasks in the virtual world environment. The items with the highest pattern coefficients included elements of avatar control such as walking, navigating, flying, and moving around the classroom. Additional items focused on communicating with others using text, voice, and avatar body language. Finally, interaction with objects in SL, such as the lectures and homework box, were also associated with this dimension. It is important to note that all items loading on this dimension are encapsulated within the virtual world, and do not combine with skills from other domains.

The three items with the lowest pattern coefficients included reviewing course lectures, using voice chat, and turning in assignments to the homework box. Although viewing course lectures in SL was an option provided to students, the majority indicated that they did not typically do this, and were more likely to either view them in class or via the web. Regarding voice chat, students were able to complete their assignments over a period of time, resulting in a variability concerning the number of other avatars that were simultaneously present at any given time. In most instances, when other avatars were present and chose to interact, they primarily engaged in text chat rather than voice. Finally, submitting assignments via the homework box is one of the many different ways that assignment content can be collected, and is not subject-matter specific.

Dimension 2: Virtual World-Learning Domain Self-Efficacy (VWLD-SE)

The second dimension, VWLD-SE, focuses on the ability of students to use and manipulate the learning objects embedded in the virtual world to accomplish domain-specific tasks. Items loading on this dimension focused on manipulating and using the accounting equation in SL, using credits and debits to interact with the accounting equation in SL, and manipulating the T-account model in SL. A learner's belief in his or her ability to interact with the accounting models in the virtual world is an important and distinct form of self-efficacy not previously assessed. It provides evidence that a self-efficacy uniquely exists, which reflects a combination of skills from both the virtual world and learning domains.

Dimension 3: Learning Domain Self-Efficacy (LD-SE)

The third dimension is self-efficacy within the learning domain, which focuses on the particular learning domain skills of interest. In this study, the focus is on belief in the ability to identify the debit and credit part of a transaction, the accounting skills of interest in the course. As noted with the first dimension, these items were encapsulated within the learning domain of interest (accounting) and did not include skills involving the virtual world. Identifying this factor is consistent with previous research in virtual world learning environments and reiterates the importance of understanding how using these virtual worlds can improve domain-specific efficacy estimations in chemistry, Spanish, word processing, and so on (see, for example, Ketelhut, 2007; Merchant et al., 2012).

Correlations: Relationships among Self-Efficacies

An exploratory investigation of the relationship between self-efficacy scales and several variables that may be related to self-efficacy estimations was undertaken. The results are summarized in Table 4. Consistent with the analysis above, the evidence further supports the discriminant validity of the scales. Kenny (2012) suggests that a correlation of 0.85 or larger indicates poor discriminant validity. All of the correlations in this model are below this threshold, suggesting that these factors, although related, remain empirically distinct constructs. Not surprisingly, LD-SE and VWLD-SE were more strongly related than LD-SE and VWE-SE.

Table 4. *Correlations among variables*

Variable	**1**	**2**	**3**	**4**	**5**	**6**
VWE-SE	1					
VWLD-SE	.74***	1				
LD-SE	.64***	.83***	1			
Computer Skills	.16**	.12*	.10*	1		
GPA	.01	.08	.10*	-.09	1	
Performance	.07	.24***	.23***	-.11***	.48***	1

Note. VWE-SE = Virtual World Environment Self-Efficacy; VWLD-SE = Virtual World-Learning Domain Self-Efficacy; LD-SE = Learning Domain Self-Efficacy; GPA = Grade Point Average.
*$p < .05$. **$p < .01$. ***$p < .001$.

The results further suggest that self-efficacy for learning within the virtual world environment is positively related to self-reported computer skills ($r = .16$, $p < .05$ for VWE-SE; $r = .12$, $p < .05$ for VWLD-SE). In addition, both VWLD-SE and LD-SE were positively related to course performance ($r = .24$, $p < .001$; $r = .23$, $p < .001$), suggesting that the higher the learners' self-efficacy for both accounting tasks and accounting tasks within SL, the higher their course performance as measured by numeric exam scores. However, course performance was not related to self-efficacy for working in the virtual world environment ($r = .07$, n.s.). Finally, the relations between self-efficacy and GPA (grade point average – a reflection of academic knowledge and skill) were investigated. Only LD-SE was related to GPA ($r = .10$, $p < .05$).

Discussion

An important finding from this study is that in higher education settings, self-efficacy within open-ended virtual worlds should not be conceptualized as a singular construct. Rather, the findings suggest that self-efficacy is multidimensional, and that each dimension is important if researchers are to fully understand how students can maximize the benefit from using virtual worlds to learn. Specifically, this study identified three dimensions of self-efficacy: virtual world-environment, virtual world-learning domain, and the learning domain. Although related, each dimension provides important and distinct information to researchers and instructional designers. For example, a belief in the ability to control an avatar in the virtual space (VWE-SE) is not only distinct from a belief in the ability to master the learning domain content (LD-SE), but also from using the avatar to interact with a learning object to accomplish a learning task (VWLD-SE). These results indicate the benefit of leveraging virtual worlds as a tool for delivering course content as long as students are confident in their ability to interact with the learning models designed to be used in such environments, as students' VWLD-SE and LD-SE were positively related to course performance. That is, students with increased VWLD-SE and LD-SE had higher exam scores.

Although distinct, the self-efficacy estimates identified in the study were related. This suggests that there is a positive relationship between the confidence students have related to their ability to use the virtual world environment itself and their confidence in their use of the learning objects to learn particular learning domain concepts. As important, if not more so, the relationships indicate that if students have low confidence in their ability to interact within the virtual world in general (i.e., to walk, fly, touch objects, chat, etc.), it may interfere in their ability to use the virtual world to learn the domain-specific content crucial to mastering the subject. As Bandura (1997) noted, the more that tasks are perceived to share characteristics, the more likely that self-efficacy will generalize between them, which can explain why students perceive a relation between VWE-SE and LD-SE as correlated, even though "objectively" the relation between the two is weak. The relationship between LD-SE and VWLD-SE is the strongest, suggesting that perceptions of the knowledge of the content are related to the perceptions of the ability to apply this knowledge made possible through the learning objects in the virtual world.

This study also demonstrates the importance of utilizing multi-dimensional self-efficacy scales when investigating learning in virtual world learning environments. Conceptualizing self-efficacy in multiple dimensions allows for a more accurate assessment of a person's perception of his or her ability to use the virtual world without encapsulating assessment into either the learning domain or into the virtual world learning environment. As illustrated through the lack of statistically significant relation between VWE-SE and course performance, simply measuring an individual's efficacy for working in a virtual learning environment (VWE-SE) or his or her efficacy for learning academic content (LD-SE) will reduce the researcher's understanding of how learning is occurring within the virtual world. Given that this study utilized a factor-analytic statistical approach to analyzing the data, it is encouraged for researchers to further examine these relations utilizing additional statistical techniques such as structural equation models to replicate and further confirm these relations.

Armed with a more complex understanding of self-efficacy in virtual worlds, educators and researchers can better support learners in the virtual world. Consider for example, improving usability, identified by Chow et al. (2012) and Merchant et al. (2012) as an important construct. Students need to be able to navigate, communicate with others, and interact with objects in the virtual world classroom before they will successfully interact with virtual world-mediated tasks and content. It is important to gauge students' prior experience with virtual worlds in order to help determine background knowledge in this setting (Wang & Hsu, 2009). Understanding how multiple types of self-efficacy can affect usability of these classrooms is also important. Prior research from information systems has shown that self-efficacy affects the adoption of systems as well as students' perceptions of the usability of these systems (Venkatesh & Davis, 1996; Yi & Hwang, 2003). By understanding the three dimensions of student self-efficacy, instructors can better tailor the training students will need to feel efficacious in controlling their avatars in the virtual space and completing learning tasks.

Findings from this study underscore the importance of designing virtual world environments that provide varying types of orientation for the learner, beginning with an overview of basic skills necessary to use the environment in general and moving on to the methods necessary for interacting with the learning content objects. Because of the powerful effects of enactive mastery experiences (Bandura, 1997), it is important to provide students with early opportunities to succeed when developing these training tutorials. Within SL, there are many locations dedicated to the first type of orientation that are freely accessible to any avatar; thus for the designer, focus can be on providing orientations specific to learning content objects. For instance, the subjects in this study were encouraged to learn about the content within the virtual world environment using orientations that autonomously instructed students on how to interact with the 3D accounting equation, T-account, and the various other objects necessary for completing assignments. Although beyond the scope of this paper, it is the authors' belief that this orientation was a necessary component of the self-efficacy beliefs reported by the students in this study.

Given that LD-SE emerged as its own dimension, the idea that perceptions of self-efficacy are domain-specific and conceptually distinct from the virtual world environment is supported. This reiterates the idea that supporting students in learning the content is related yet distinct from the technological platform used. Learning can, and should, take place through multiple media. The virtual world classroom is simply one technological platform. Because of self-efficacy generality, it is likely that if students have a high sense of self-efficacy regarding the content and have demonstrated they can successfully perform accounting tasks in one environment (e.g., the virtual world classroom), their sense of LD-SE should also remain high in other technological domains (e.g., Excel). However, instructors interested in integrating virtual worlds in instruction must realize that teaching discipline-specific content in the environment is not enough to guarantee learning of content. The other two dimensions of self-efficacy, virtual world-environment and virtual world-learning domain, must be considered. This will help students perceive control of their own functioning in the virtual world, approach the tasks as challenges to be mastered, and persist in the face of difficulties. Therefore, instructors should be aware of potential efficacy reducing impacts when moving to another technological domain and should work to ensure that technology problems do not negatively impact estimations of LD-SE.

These results provide future directions to researchers and educators into the specific design characteristics that must be considered to better enable the benefits expected when using virtual worlds. For instance, by focusing on VWE-SE, an instructor needs to provide support to students concerning navigation, communication with others, and interaction with objects. By focusing on VWLD-SE, instructors can better understand the effectiveness of the designed learning objects with respect to the content domain, which provides insights for improvements. As previous studies focusing on the use of virtual worlds to support learning have not investigated self-efficacy estimation with this level of specificity and depth, this study can help provide a needed baseline that future researchers can expand upon to investigate more deeply how meaningful learning can occur in virtual worlds.

Finally, given the few validated research inventories specific to virtual world learning, the survey used in this study provides a more well-rounded assessment of students' self-efficacy levels. Distributing this survey allows an instructor to immediately diagnose students for possible "trouble areas" regarding self-efficacy. For instance, before an activity in SL takes place, the survey results could help the instructor assess where the students will need extra support. If students have high VWE-SE, then the instructor can focus on the content and the specific learning tasks within the virtual world instead. The survey can also be useful after activities in the virtual world take place, in order for the instructor to gauge if (and how) the dimensions of self-efficacy change over time. It is important to emphasize that some items need to be task-specific given the learning domain in question.

Although the authors believe the findings of this study are powerful and expand the understanding of the role of self-efficacy in virtual world learning environments, there are a number of limitations to this study that must be mentioned. First, the sample consisted of students in one section of a specific accounting course in one university in the Southeastern United States. Therefore, the sample may not be representative of all students in the US or the world. In addition, there are contextual variables such as the content area, design of the SL activity, or teacher that could have affected the results. Thus, the findings of this study should be replicated with other students and in other educational contexts before generalizations are made. In addition, because this is a survey, only perceptions are gathered. However, whether real or imagined, students perceive a relationship between their ability to learn the content and the ability to control their functions in virtual worlds. These results are rooted in correlations, which help predict relationships of the dimensions, but do not demonstrate cause. It is recommended that additional experimental research be undertaken to better understand the reciprocal relationship of the factors in the model.

The progressive next step for this line of research focuses on issues of task performance. Although this study illuminates the dimensions of self-efficacy in this environment, it is important to further examine how these dimensions predict key learning outcomes such as performance, engagement, and reactions to learning, as well as how students approach learning. Future research also includes an assessment of how specific pedagogical strategies guide students to gain self-efficacy. For instance, in the present study, the instructor created a tutorial to prepare students to use the various accounting learning models (equation and T-accounts). When students used these tutorials, questions about how to use SL in general were reduced dramatically.

Conclusion

Virtual worlds offer novel experiences not realized in other learning technologies. Therefore, researchers need to both build upon sound training and learning pedagogy principles and to think more broadly about the factors that affect learning success in these environments. Building upon previous research on training, computing, e-learning, and virtual worlds, this study confirms that self-efficacy is an important construct to measure when examining learner performance in open-ended virtual worlds. It also provides evidence that self-efficacy regarding virtual world learning is more complex than previous researchers have assessed and consists of multiple dimensions. Learners must be able to perceive the ability to navigate the virtual world environment, learn domain specific content, and apply this domain specific knowledge to tasks within the environment. The richness enabled in these environments requires the development of scales that reflect this richness. By conceptualizing self-efficacy as multidimensional, and illustrating their relations to course outcomes, this study helps researchers and instructional designers create more effective virtual world learning opportunities for students.

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Appendix: Survey Items Pertaining to Self-Efficacy

Each item begins, "I believe I have to ability to" followed by the particular activity. The following numerical scale indicates strength of self-efficacy:

- 0 (*Can't do*)
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
- 90
- 100 (*Totally confident*)

Items:

1) Walk around the ReallyEngagingAccounting classroom.
2) Fly around the ReallyEngagingAccounting classroom.
3) Move around the ReallyEngagingAccounting classroom.
4) Effectively navigate the ReallyEngagingAccounting classroom.
5) Interact with objects in Second Life.
6) Communicate effectively with others in Second Life.
7) Use text-based chat in Second Life.
8) Use voice chat in Second Life.
9) Review course lectures in Second Life.
10) Have my avatar gesture.
11) Use the accounting equation to help me record business transactions.
12) Use a T-account.
13) Properly identify the debit part(s) of a transaction.
14) Properly identify the credit part(s) of a transaction.
15) Manipulate T-accounts in Second Life.

16) Use the accounting equation in Second Life.
17) Manipulate the accounting equation in Second Life.
18) Use debits to interact with the accounting equation.
19) Use credits to interact with the accounting equation.
20) Turn in assignments to the homework box, using Second Life.

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