Selecting a Virtual World Platform for Learning

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ABSTRACT

Like any infrastructure technology, Virtual World (VW) platforms provide affordances that facilitate some activities and hinder others. Although it is theoretically possible for a VW platform to support all types of activities, designers make choices that lead technologies to be more or less suited for different learning objectives. Virtual World platforms' capabilities can be characterized in terms of the extent to which they are multiple or special purpose and the degree to which they support incorporation of few or many knowledge resources. Matching these capabilities with a framework for characterizing instructional approach and learning objectives provides a basis for selecting, piloting, and advocating use of particular VW platforms in specific educational contexts.

Keywords: Virtual World, Taxonomy, Virtual Learning, Business Education, IS Education

1. INTRODUCTION

1.1 What is a Virtual World?

Virtual world platforms (VW) are software that enable users to interact with each other and with the software within a video game-like environment. This environment frequently exists 24/7 and persists even when users are not within it. These worlds can have realistic representations of buildings and rooms and earth-like terrain with natural vegetation, animals, or animated objects. In these VWs, people can meet, compete, collaborate, create, or socialize. The users themselves are frequently represented by three-dimensional (3D) characters known as avatars. Users primarily "see" the virtual worlds from a first-person perspective; that is, the images on the computer screen represent what the avatar would see within the virtual world. These avatars can be similar to the user or can be completely dissimilar. Via avatars, users of virtual worlds communicate via text, audio, or Webcam-enabled video (Bronack et al., 2008; Ives and Junglas, 2008; Messinger et al., 2009; Wagner, 2008).

Some of these worlds provide 3D record and replay capabilities and support use of applications such as word processors, spreadsheets, and whiteboards in-world. Others enable users to build homes, start businesses, or create art. Some of these worlds support privacy via security features. Still others allow users to fly virtual planes or perform virtual surgery. Yet others challenge users to perform quests and to attempt to stay alive and thrive within the VW. For example, in Second Life and EverQuest, users adopt avatars as second selves, develop friendships, create personal and professional networks, provide mutual help, have feelings, are attracted to other avatars, and even fall in love (Linden Labs, 2009; Sony Online Entertainment, 2009; Jensen, 2009, p. 13).

1.2 Virtual Worlds for Education

VWs show promise as a method for "enhancing, motivating, and stimulating learners' understanding of certain events, especially those for which the traditional notion of instructional learning have proven inappropriate or difficult," such as the teaching and learning of business ethics (Bares et al., 1998; Malone and Lepper, 1987; Pan et al., 2006). However, implementing a VW for education in isolation does not inherently enable learning (Lakkala et al., 2007). The use of VWs for education is further complicated by the variety of capabilities that different platforms provide. Therefore, in order to adapt these new technologies, careful pedagogical thought about how to integrate these capabilities with courses must occur (Lakkala et al., 2007).

As a first step in this direction, this paper outlines two capability dimensions about VWs and suggests a VWs taxonomy. The first capability dimension indicates whether a VW is multiple or special purpose. The second capability dimension contrasts few versus many embedded (or easily accessible) knowledge resources. The taxonomy is described by placing these two dimensions as perpendicular axes in Cartesian space (Figure 1). As a second step in this direction, this paper describes two pedagogical dimensions. The first pedagogical dimension contrasts types of teaching (Jonassen, 1991). The second pedagogical dimension contrasts types of learning (Smith and Ragan, 2005). Similarly, these two pedagogical dimensions can be placed perpendicularly in a Cartesian space to describe a pedagogies taxonomy. Further, it describes a process for selecting a VW, based upon matching quadrants of these VWs and Pedagogies Taxonomies. Finally, we report our experiences as we applied this process.

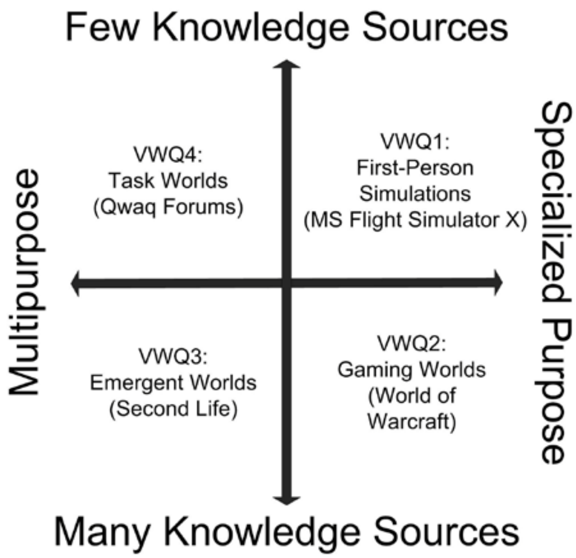

Figure 1. Four Types of VW and Examples

2. VIRTUAL WORLDS TAXONOMY

Although VW platforms all share some features, there is also significant variation among the available technologies. As with other systems, it is important that there be a good fit between the capabilities of technology and the goals and objectives of the application of the technology (Vessey and Galletta, 1991). Therefore, when applying VWs in support of educational activities, it is critical to have a reasonable fit between the affordances and constraints inherent in the VW platform and the instructional approaches and learning objectives that will be applied and achieved via that VW platform. In this section, we describe a VWs taxonomy, so that we can use this taxonomy to identify certain types of VWs as candidate platforms for learning. First we describe two varying design characteristics of VW, and then we describe four different types of VW that are defined by combinations of these design characteristics. See Figure 1.

2.1 Virtual World Design Characteristics

Like any software technology, VW platforms provide affordances that facilitate particular activities and hinder others (Bartle, 2004; Dishaw and Strong, 1999; Jakobsson, 2006; McGill and Klobas, 2009; Vessey and Galletta, 1991). While it is theoretically possible for a VW platform to support all types of educational initiatives, designers typically make choices that lead technologies to be more or less suited for different teaching and learning purposes (Dickey, 2003, 2005). Therefore, to frame our discussion about how VW platforms enable learning in different ways, we now present two design dimensions of VW platforms, and the resulting Cartesian space (Figure 1). The horizontal axis indicates the degree to which a VW platform is specialized or multipurpose. This dimension is reflected by the degree to which the nature of the task, goals, and objectives are embedded in the VW. Special purpose VW platforms incorporate details of the purpose into the infrastructure, and as a result are better able to support in-world evaluation, feedback, and performance reporting. However, in doing so they sacrifice the flexibility that is the strength of multipurpose VWs.

The vertical axis indicates the number of candidate information resources available to a user within the VW. For example, in gaming worlds and emergent worlds there are large social networks that allow individuals to access the knowledge that other social network members have. In gaming worlds, in addition to knowledge provided by other players such as gamemasters and knowledge bases, there is a very large amount of information that outlines the structure of the realms, what happens in realms, your character's abilities, non-player characters' (e.g., pre-programmed bots) traits, and what these characters can do physically as well as spells that they can cast. For example, in World of Warcraft, this knowledge is provided via prompts as you play the game, as well as via multiple onscreen information sources (Blizzard Entertainment, 2009). Additionally, gaming worlds have large internal knowledge bases.

In emergent worlds such as Second Life, in addition to text and multimedia knowledge bases as found in gaming worlds, traditional sources of information, such as libraries in new forms, are becoming available (Bell and Trueman, 2008; Linden Labs, 2009). An example has been developed by the Independent State of Caladon (an organization in Second Life). It has created a library at the University of Caledon Oxbridge. This library shows topics such as 19^{th} Century Children's Literature, and Poetry and Drama. These topics, shown as naturalistic billboards within a library of the future, then link to actual websites. Other examples of knowledge within Second Life are tutorials that are provided in various "departments" of the University of Caledon Oxbridge. These include the College of Money and Commerce and the College of Communication. Together these dimensions (general or specialized purposes and amount of knowledge within a VW) provide a framework for understanding the structure of the VW platform product space.

2.2 First-Person Simulation Worlds

Traditional simulation programs, such as flight simulators, (e.g., Microsoft Flight Simulator X) seek to provide a highly realistic environment in which users can practice certain activities (Microsoft, 2009). These VWs combine accurate models of phenomena and bounded information sources to create contexts in which users can experiment and receive rapid, realistic feedback while avoiding the cost and danger that would normally be associated with performing those activities in the "real" world. Information for completing the activity is generated within the VW, with little or no relevant information originating from elsewhere. Users may make mental models, but these mental models have to do primarily with interacting with the simulated real environment. While there is a long history of using computer-based simulations, the advent of VW-based simulations has an expanded range of activities that can be supported. In particular, the social aspects of VWs have lead the development of simulations for collaborative activities such as firefighting, police work, and military engagement.

2.3 Gaming Worlds

MMORPG (Massively Multiplayer Online Role-Playing Games) typically are alternative universes where players act in worlds based upon fantasy or science fiction. In these worlds, players interact with each other as well as non-player [pre-programmed] characters (NPCs). Players seek to progress through the game by completing activities such as vanquishing monsters or solving puzzles. Advancement within the game is the primary purpose of users' engagement with the system, and regular feedback is provided regarding their progress. Motivations for players to participate in these VWs include having meaningful social contact with others, being in a world of fantasy, and gaining status and earning a powerful position (Jensen, 2009). Information sources vary widely, from artifacts provided by game designers, to knowledge obtained from other players in one's social net, enabled via the game architecture. Two popular gaming worlds are EverQuest and World of Warcraft (Sony Online Entertainment, 2009; Blizzard Entertainment, 2009).

2.4 Emergent Worlds

While gaming VWs are clearly valued for their ability to support fantasy and skill development as one progresses from level to level, they are not built around the concept of users acting as creators. In contrast, emergent VWs focus on encouraging users to *create* their world. Linden Labs has developed Second Life, the most prominent VW in this product space (Linden Labs, 2009). Second Life allows users to create avatars, clothing, homes, and businesses. Second Life has continents and islands and an economy based on Linden dollars which can be converted to and from U.S. dollars (Linden Labs, 2009; Weber et al., 2008).

There is also significant social interaction that emerges and occurs in these worlds. Second Life users report that this VW enables communication, collaboration, and feelings of togetherness. When users enter Second Life they intend to socialize, shop, create, and attend professional activities and scientific meetings (Jensen, 2009). While there are ways to assess status and standing within an emergent VW—such as, amount of virtual property, in-world money, and avatar appearance—the purpose and basis for status emerges from the interaction of users, not from the VW designer intentions.

2.5 Task Worlds

More recently, VW platforms have moved from the purpose of entertainment or socializing to primarily supporting collaborative projects and other work-related tasks. While there have been attempts to use VWs such as Second Life for these types of activities, task-oriented VWs focus on enabling users to share work products, communicate, brainstorm, and use the same instance of an application, such as editing the same document. Some businesses have identified new employee orientation, facilities management, brand development, and product trials as applications of these task-oriented VWs (Ives and Junglas, 2008). Rather than imposing goals or providing feedback, these VWs enable bounded teams to work together, setting and monitoring their own objectives. One VW product that centers on supporting collaboration is Qwaq Forums, developed by Qwaq, Inc (Qwaq, 2009). In Qwaq Forums, users can build their collaboration spaces, specify and solve problems, and import, transform, and manipulate 3D models of products.

3. PEDAGOGIES TAXONOMY

In this section, a pedagogy's taxonomy is described, so that the educator, ostensibly, you, can use this taxonomy to identify certain types of VWs as candidate platforms for learning. Initially, however, in Tables 1, 2, and 3 below, human activities that can be enabled via education, are described. Human activities are described because it is important to understand which exact abilities you are targeting. After human activities are described, a pedagogy's taxonomy is provided.

With regard to the human activities discussed in Tables 1, 2, and 3, all VWs support social interactions that serve as the drivers for and results of affective activities. VWs also provide some type of simulation of the physical world in which psychomotor activities can be, at least to some degree, practiced. However, since VW platforms differ significantly with respect to how they handle purposes and information, they vary widely with respect to their ability to support different types of cognitive activity. For this reason, our discussion of the fit between learning objectives, instruct-

Activity	Description
Knowing	Memorizing/remembering a concept
Comprehending	Translating/interpreting a concept
Applying	Using knowledge to solve a problem
Analyzing	Decomposing a concept to its parts
Synthesizing	Creating a unique whole from parts
Evaluating	Judging the value of an object

Table 1: Cognitive (Intellectual) Human Activities
(adapted from Bloom 1956/1984).

Activity	Description
Attending	Sensing other's feelings
Responding	Exhibiting an emotion in response to stimulus or phenomenon
Valuing	Holding a conviction as the positive worth of a stimulus or phenomenon
Organizing	Handling value conflicts by structuring one's beliefs
Internalizing	Choosing behavior based upon one's values

Table 2: Affective (Emotional) Human Activities
(adapted from Krathwohl, et al., 1964).

Activity	Description
Perceiving	Sensing one's physical environment
Readying	Becoming disposed to act
Coached Acting	Acting prompted by cue or example
Mechanical Acting	Essentially correct acting that has become habitual
Complex Acting	Quick, accurate, efficient, and automatic acting
Adaptive Acting	Acting that transforms based upon environment or context

Table 3: Psychomotor (Physical) Human Activities
(adapted from Simpson, 1972)

tional approaches, and VW capabilities will focus primarily on cognitive activities.

We will now describe two dimensions that can be used to delineate four pedagogy types (Figure 2). The first dimension represented by the vertical axis (Learning Objective), indicates the relative focus an educator has on a student learning a procedural skill(s) or declarative knowledge. The second dimension, shown as the horizontal axis (Instructional Approach), indicates the relative viewpoint the instructor will use when developing, implementing, and evaluating the educational experience.

3.1 Learning Objectives Dimension

In order to help a student learn a procedural skill, an educator must first demonstrate and describe the skill, emphasize difficult aspects of the skill, and show the skill in increasingly complex scenarios. The educator must also correct incorrect applications with explanations, references to templates, ratings, and, when possible, video or audio feedback. As the learning session concludes, the educator should re-review the major components of the skill, relate the skill to problem solving, and emphasize the utility, reliability, and benefits of the skill. As the educator assesses the student's practicing of the skill, s/he should consider whether the procedure was applied to the correct decision, the procedure's components were applied appropriately and in the correct sequence, and whether common (and uncommon) errors were avoided (Smith and Ragan, 2005, p. 202). When students learn procedural skills in this fashion they are learning "how-to" knowledge.

A related, but distinct, type of knowledge is "what is" or "that is" knowledge. This type of knowledge is known as declarative knowledge and it enables human activity as well. To develop a learner's declarative knowledge, an educator should first introduce the learner to the knowledge domain. One way to do this is to expose the student to novel, conflicting, and perhaps paradoxical events. Another approach is to interject personal and emotional aspects into the learning process. These techniques provide abrupt changes in stimuli that help the student begin to learn new declarative knowledge. In addition to these types of approaches, the educator should also begin to show the utility of and relate the knowledge to other knowledge.

Some of the least complex declarative knowledge types are labels, names, facts, and lists. The student can learn these by practicing categorizing, combining and parsing concepts, recognizing patterns, and simplifying the representations of large amounts of information. As students learn more complex forms of declarative knowledge, they will create and use metaphors and analogies, compare and contrast concepts, hypothesize cause and effect, use images, frame concepts, and create mental maps of concepts. To help with this process, instructors should present examples and non-examples and ask students to apply the above operations. Further, educators should create environments where students can reflect, identify critical attributes, and discuss their developing declarative knowledge. Educators should help students clarify their cognitive structures and see applications of the knowledge (Smith and Ragan, 2005, p. 169, p. 186). Thus, there are two major types of learning objectives, developing procedural skills and understanding declarative knowledge. See Figure 2.

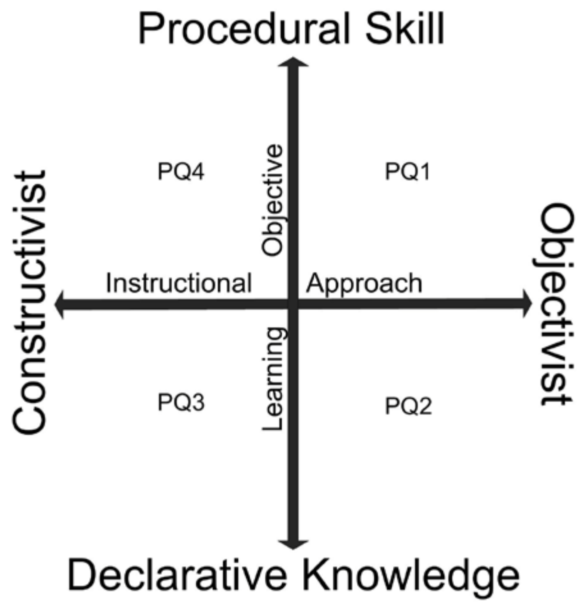

Figure 2. Pedagogy's Taxonomy

3.2 Instructional Approaches Dimension

An instructor who takes an objectivist viewpoint instructs as if there is one objective reality, which has entities, properties, and relations, and which can be modeled and learned. This instructor teaches as if thoughts are constrained by and reflect an external reality. This archetypical educator believes meaning is separate from the student and that thought and knowledge are "correct" when they reflect and represent an external reality (Jonassen, 1991, p. 9). Objectivism encapsulates two other types of instructional approaches: behaviorist and cognitive. *Behaviorism* holds that learning is about conditioning behavior while *cognitive* indicates that mental activities are at the foundation of behavior and learning.

In contrast, an instructor that takes a constructivist viewpoint teaches as if reality is created by the learner. S/he provides symbols which the student uses to construct his/her world, as opposed to using symbols to represent the world. In the constructivist frame, thought grows from experiences in the physical and social worlds, but a students' meaning is more than what is in reality. Further, this archetypal teacher believes meaning is developed by the learner and that every learner creates their own unique understanding (Jonassen, 1991, p. 9).

Referring to Figure 2, by using learning objectives and instructional approaches as two axes we can also create a typology for pedagogies:

PQ1: Procedural Skill/Objectivist
PQ2: Declarative Knowledge/Objectivist
PQ3: Declarative Knowledge/Constructivist
PQ4: Procedural Skill/Constructivist

As an educator, if you are interested in your students learning a procedural skill that is highly defined and it is important that your student, in the future, apply this skill as it is known, objectively, your interests are represented by Pedagogies Quadrant 1, that is, PQ1. If you are interested in your students learning a well-bounded declarative knowledge domain that reflects a particular external situation or scenario, your interests are represented by Pedagogies Quadrant 2, that is, PQ2.

If you are interested in your students learning an ambiguously bounded declarative knowledge domain, or you believe it is inappropriate to imply to students that there is one objective knowledge and have the goal of students working together to develop their own knowledge, as opposed to adopting a given perspective, then your interests fall in line with Pedagogies Quadrant 3, that is PQ3. Finally, if you are interested in your students learning a procedural skill but you believe the skill needs to be developed internally by the student, instead of being learned through incremental practice with reductionist exercises, your beliefs fall in line with PQ4, Pedagogies Quadrant 4.

4. MAPPING PEDAGOGY TYPES TO VW TYPES

4.1 Relationships among Pedagogy Types and VW Types

VW platforms facilitate certain activities and hinder others. As a result, certain types of VWs are better suited for supporting certain types of pedagogy. Recall (Figure 1) that the VW product space can be segmented into four quadrants:

VWQ1: First-Person Simulations
VWQ2: Gaming Worlds
VWQ3: Emergent Worlds
VWQ4: Task Worlds

First-Person Simulations do have embedded knowledge, but provide a focused information stream and specialized feedback that immerse users in a highly realistic, but bounded environment. Further, these simulations are very specialized and can rarely be used for more than one purpose. Gaming worlds incorporate many information resources (in-world artifacts, other in-world players, links to external information, etc.), but are also special purpose and focused upon users advancing within a VW.

Emergent worlds are highly configurable, with many utilities that allow their users to alter the world and allow the “physical” and social worlds within a particular platform to emerge, both in the sense of the artifacts in the world, as well as in the sense of social interactions creating societies and cultures. Task worlds, like emergent worlds, are also highly configurable. However, unlike emergent worlds, task worlds tend to focus on helping people accomplish tasks. An example task could be a virtual meeting where attendees can work on the same work product, yet have a “physical” and proximal presence—which helps immerse them within a single common problem.

The pedagogies typology (Figure 2 and below) can

PQ1: Procedural Skill/Objectivist
PQ2: Declarative Knowledge/Objectivist
PQ3: Declarative Knowledge/Constructivist
PQ4: Procedural Skill/Constructivist

be used select a VW design quadrant (Figure 1) that is appropriate for a particular pedagogy. Further, there are types of virtual education that map to the VW typology quadrants (Figure 3). The mapping is below. We discuss examples of these next.

PQ1 → VWQ1 ⇔ Training Simulations
PQ2 → VWQ2 ⇔ Educational Games
PQ3 → VWQ3 ⇔ Learning Communities
PQ4 → VWQ4 ⇔ Virtual Situations

Figure 3. Four Types of VW and Example Educational Uses

4.2 Training Simulations

If you are interested in your students learning a procedural skill that is highly defined and it is important that your students, in the future, apply this skill as it is known, objectively, that is, you are interested in PQ1, you should use a VW that is specialized and which has focused knowledge resources embedded within the VW, that is, VWQ1. This type of educational VW can be referred to as Training Simulations and corresponds to First-Person Simulations.

Three-dimensional virtual Training Simulations are often special purpose. They also provide a bounded set of information and knowledge resources that are relevant to the focal task. The U.S. Marine Corp Training and Education Command uses a 3D virtual training aid to teach trainees how to operate and maintain weapons (Batstone, 2008).

Medical schools are beginning to use virtual simulations to teach minimally invasive surgery (Gallagher et al., 2005). The instructional approach of training simulations is objectivist. This is because the goal of the training is the learning of a known body of knowledge, external to the learner’s procedural skill. Also, the simulation does not need many knowledge sources, since the learner is applying previously learned knowledge in a finite number of scenarios where s/he can recognize situations where skill can be applied, recall the activities and their sequence in the skill, recognize and perform decision-making activities, recognize when processing activities, and recognize when skill has been applied to his or her ability.

4.3 Educational Games

If you are interested in your students learning a well-bounded declarative knowledge domain that reflects a particular external situation or scenario, that is PQ2, you should use a VW that is specialized but that has many knowledge resources, in other words, VWQ2. Platforms within the VWQ2 quadrant are best suited to help students perform processes that help them learn and explore the implications of complex systems of declarative knowledge. These educational games correspond to gaming VWs.

WolfQuest is a single- or multiplayer game that allows the player to become a male or female wolf. It allows the user to choose its own unique fur. Further it allows users to experiment with varying degrees of strength, speed, and stamina. The world the wolf user experiences is a mountain in Yellowstone National Park. Users learn multiple types of declarative knowledge, including learning visually about meadows and forests. Users learn how wolves follow scents, and about the eating habits of wolves, since the wolf avatars must hunt elk, eat snowshoe hares, and chase away coyotes from elk carcasses in order to stay alive. Users learn how wolves communicate by using wolf howls and behaviors to communicate with other users. Finally, users learn from other users via use of text chat. The purpose of this educational game is to help users learn declarative information about (and develop empathy for) wolves (Minnesota Zoo and Eduweb, 2005–2009).

4.4 Learning Communities

If you are interested in your students learning an ambiguously bounded declarative knowledge domain, or you believe it is inappropriate to imply to students that there is one objective knowledge and you have the goal of students working together to develop their own knowledge, as opposed to adopting a given perspective, that is, your chosen pedagogy is within PQ3, then you should use a VW that is multipurpose. You should also use a VW that supports the embedding of many knowledge and information resources. Learning communities are VWs that fulfill these criteria and are well supported by emergent VW in the VWQ3 quadrant.

Using their Presence Pedagogy and the Active Worlds VW platform, educators at Appalachian State University and Clemson University have created a learning community, the AET Zone, where distance learners and instructors capitalize upon the presence of others, share tools and resources, and foster reflective practice as they create collaboratively (Activeworlds, Inc., 1997–2009; Appalachian State University, 2009; Bronack et al., 2008).

At the Fuqua School at Duke University, professors are using ProtonMedia's ProtoSphere. ProtoSphere is a VW that supports traditional learning but in a virtual format. ProtoSphere has a campus, NPCs that act as instructors, and scenarios that user-controlled avatars can enter and interact with. Educators at Fuqua are using ProtoSphere to connect geographically distributed students and business partners to create a "mixed reality" or "blended learning environment," using a combination of live video and the ProtoSphere VW (ProtonMedia LLC, 1998–2009; Virtual World News, 2007).

4.5 Virtual Situations

If you are interested in your students learning a procedural skill but you believe the skill needs to be developed internally by the student, instead of being learned through incremental practice with reductionist exercises, that is PQ4, then you should use a VW, such as the task-oriented VW, which supports students practicing responding to ill-structured virtual situations. These VWs are represented by VWQ4.

The University of Maryland's School of Engineering teamed up with Forterra, Inc. and used its OLIVE product to create a simulation where users represented by avatars could collaboratively practice responding to a highway emergency using information recently learned (University of Maryland, 2007; Forterra Systems, Inc., 2004-2009).

Quest Atlantis is a VW where children age 9 to 12 and teachers interact on the mythical continent, presented as "a world in trouble in the hands of misguided leaders" (Barab et al., 2007, p. 3; Indiana University Learning Sciences, 2009). Students engage each other in the VW, and in the process, learn that they can be social actors for change in Atlantis, as well as in the real world.

5. USES IN INFORMATION SYSTEMS (IS) LEARNING

In this section we describe how different types of VW may be used in IS education, using the two taxonomies described earlier. There are four types of VWs in our VWs taxonomy:

VWQ1—First-Person Simulations
VWQ2—Gaming Worlds
VWQ3—Emergent Worlds
VWQ4—Task Worlds

There are also four types of pedagogies in our pedagogies taxonomy:

PQ1: Procedural Skill/Objectivist
PQ2: Declarative Knowledge/Objectivist
PQ3: Declarative Knowledge/Constructivist
PQ4: Procedural Skill/Constructivist

Also, recall that:

PQ1 → VWQ1 ⇔ Training Simulations
PQ2 → VWQ2 ⇔ Educational Games
PQ3 → VWQ3 ⇔ Learning Communities
PQ4 → VWQ4 ⇔ Virtual Situations

We now describe information systems education application examples of training simulations, educational games, learning communities, and virtual situations. We show how a training simulation can be used to help a student learn how to capture requirements. Then, we discuss how an educational game can help a student learn about how IS can impact the business. Next, we describe how a learning community, in an emergent VW, can facilitate students learning about new technologies. Finally, we close by indicating how a virtual situation, in a task-oriented VW, can help students learn project management skills.

5.1 Learning How To Capture Requirements

One way to use VWs that are within the First-Person Simulation quadrant (VWQ1) would be to provide an environment that allows students to practice skills they have learned about understanding a business process and capturing requirements. A commonly agreed upon body of knowledge exists regarding how to understand business processes and capture requirements by investigating artifacts and interviewing stakeholders (International Institute of Business Analysis, 2009; The Joint Task Force on Computing Curricula et al., 2004). The fact that these worlds limit the available knowledge resources will help the student to focus on what they have learned prior to entering the VW. At the same time, a highly structured software product (based upon objective knowledge) can be used to help the student recognize situations where skill can be applied, recall the activities and their sequence, recognize when activities are decision making or processing oriented, and recognize when skill has been applied to one's ability (Smith and Ragan, 2005, p. 190). In fact, one research group has already developed 3D-immersive software that allows students to practice systems analysis (Kendall et al., 1996).

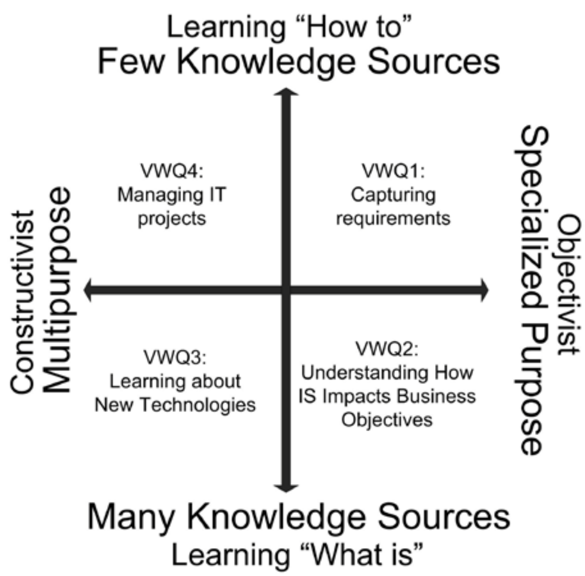

Figure 4. IS Education Applications and VWs

5.2 Understanding How IS Impacts Business Objectives

Declarative information about the relationships among organizations as well as their objectives and ISs and their configurations and how these ISs support the business are common in IS management texts (Haag and Cummings 2008; Laudon and Laudon 2007; Ross et al. 2006). Hence, it is possible and appropriate to use an objectivist viewpoint when helping students learn these relationships. VWs provide a new and interactive way to help students learn this material. This educational approach is congruent with VWQ2 within the VW taxonomy. In WolfQuest, learners take in information, create hypotheses, and experiment by interacting with the wolf's setting. In the process, these learners develop knowledge about the wolf and its environment.

Similarly, IS students, in an Information Systems Quest VW, could take in information about alternative information systems configurations and their linkages to business processes and goals and find the most optimal informational systems and the corresponding businesses. Students currently learn about different IS configurations/types by studying seemingly static figures in textbooks that compare and contrast stovepipe ISs and enterprise systems.

It may be possible to help these students develop deeper knowledge about how ISs, when configured in particular ways, can cause businesses to become more profitable, efficient, or responsive. For example, students could engage a quest for the "most optimal" IS by dynamically and interactively analyzing how the reliability, accuracy, and availability of functionally separate information systems (stovepipes) and functionally integrated ISs (enterprise systems) support or inhibit customer relationships, value chains, or change management processes.

5.3 Identifying Uses for New Technologies

Moving to VWQ3, information systems management educators at several institutions or at a large university could use emergent VW to enable students to develop learning communities that circle around understanding what bleeding or leading edge technologies exist (declarative knowledge) or are developing, and then brainstorm about how these technologies might be used to help businesses achieve their objectives. For example, in one course the authors have taught, students met virtually at several points during a virtual teams and collaboration course and were able to develop a learning community that interlinked Germans and Indians. Consequently, they discovered a possible use of an augmented reality software package that could be used to help customers "imagine if" automobiles and furniture were appropriate for their lifestyle (Robbins and Butler, in press). It was possible for these students to use these many tools because the VW platform was not specialized and allowed other software to be accessed from within it. This is similar to what we've described about how Second Life (an emergent VW) has leveraged libraries from within its space.

5.4 Learning How to Manage IT Projects

Finally, an IS educator that wanted students to practice managing an information technology (IT) project, and in the process develop their own mental model of IT project management might use a task-oriented VW (VWQ4). In this VW, a virtual client scenario could be presented. Student teams, playing the role of various IT team members (e.g., project manager, software engineering lead), would work together to practice applying skills they've learned in class (e.g., developing a work breakdown structure, sequencing work activities, creating a budget). They would apply these skills using the multipurpose tools that are available in-world or that can be placed in-world (Robbins and Butler, in press). However, use of this task-oriented VW would be most appropriate if the educator believes that the students should develop their own knowledge, by practicing and transforming information they have received from their instructor and the instructor believes that use of embedded knowledge resources is not essential (or perhaps detrimental) to the students learning "how to" manage a project.

6. GUIDELINES AND OUR EXPERIENCES

In this section we indicate guidelines for implementing the process outlined in this paper. We do this by referring to our own VW selection. But first we will provide context. We are business administration professors that specialize in teaching and researching management information systems. We are piloting a task-oriented VW, Qwaq Forums, as a tool for helping undergraduate and graduate students' problem solving and collaborative skills generally, and project management and systems analysis skills specifically (Qwaq, Inc., 2009). Within Qwaq Forums, we are developing and testing a virtual situation to help students learn project management skills.

The project management skills that the students will use within the VW are taught and learned in IT project management courses targeted specifically to undergraduate business as well as MBA students at the University of Pittsburgh. Similarly, the systems analysis skills are introduced in our management information systems survey courses and taught more comprehensively in dedicated systems analysis and design courses at both the undergraduate and graduate levels. However, for brevity, we will limit our examples to the selection of Qwaq Forums, as a tool to support the development of knowledge, through the practice of project management skills, within a virtual situation.

6.1. Step 1: Articulate Your Learning Objectives

The first step, you, as an educator, should take is to understand what types of cognitive activities you seek to enable. In our case, the cognitive activities that are necessary in applying project management skills include knowing, comprehending, applying, analyzing, synthesizing, and evaluating. Next, we provide six examples from our pilot, one for each of these cognitive activities.

Students need to remember that there are several knowledge domains, such as project scope management, project time management, and project budget management (Project Management Institute, 2009). Additionally, students need to be able to comprehend that project time management is largely about developing and managing a schedule. Students will apply skills they've learned in class, such as the critical path method, to determine minimum duration of the project. In order to develop the work breakdown structure, students will need to analyze the scope of the project. Using subsidiary plans (scope, time, budget, risk, quality, etc.) students should synthesize a master project management plan. Finally, students should be able to evaluate their work prior to submitting it for feedback.

The next step, after understanding what activities you would like to support, is to determine your primary type of learning objective. Are you primarily interested in students developing procedural skills or gaining declarative knowledge (Smith and Ragan, 2005)? In our case, the learning objectives that we seek to teach in our project management courses are primarily procedural skills such as developing a work breakdown structure. However, it should be noted that there are some declarative aspects, such as understanding the relationships of work breakdown structure packages and schedule activities. However, most of our effort is focused upon students learning "how to" manage projects.

We want our students to learn how to develop plans that consider software functionality and features, available monies, time, quality, performance, risk, and human resources, as well as other factors. In this frame, we are interested in our students learning how to make tradeoffs between scope, time, quality, and performance. We are interested in our students practicing identifying and solving real problems in a virtual situation and to address the actual challenges they come across in this situation. Additionally, we are interested in our students developing quality and performance metrics as well as anticipating and planning in order to avoid and mitigate risks.

Finally, we are interested in our students practicing collaborating, selling their plan, being flexible, and incorporating feedback while staying focused. Note that these target learning objectives are primarily procedural skills. This information indicates that we should not consider VWs within VWQ2 (Educational Games within the Gaming VW product space) and VWQ3 (Learning Communities within the Emergent VW product space) because these VWs are best used to enable the learning of declarative knowledge. In fact, at this point in our process we had focused on VWs represented by VWQ1 (Training Simulations within the Simulation VW product space) and VWQ2 (Virtual Situations within the Task VW product space).

6.2 Step 2: Choose Your Instructional Approach

After articulating the activities you will enable and the learning objectives you seek, and subsequently eliminating VWs in either the top or bottom two quadrants of the VWs Taxonomy, you should consider whether you believe that the student should embed objectified knowledge from the world such as the Project Management Body of Knowledge, published by the Project Management Institute, or whether the student should construct knowledge about the world, based upon their interactions with the world (Project Management Institute, 2009; Jonassen, 1991). If you believe the former, you are taking an objectivist standpoint; otherwise, you are indicating a constructivist view. When you choose either a constructivist or objectivist viewpoint, you will eliminate VWs related to one of the two VW quadrants that are left. We now continue to describe our process.

As indicated, we are interested in students developing their procedural ability to manage information technology projects. We also are supporting our students' knowledge construction by asking our students to develop their own mental models of the procedures they believe appropriate, based upon their practice in the virtual situation we are developing and piloting. We believe this is a valid approach because we believe that while objective standards such as the PMBOK exist, which we share in lectures, each project manager has/will develop(ed) and determine(d) his/her own unique mental model of project management. Towards this end we ask our students to develop their own early versions of their mental models of project management.

Since we are teaching and our students are learning (primarily) procedural skills and our students are constructing their own mental models of project management, that is, we were within PQ4, we focused on VWs that are within task-oriented VW, those represented by VWQ4. At this point we stopped considering any Simulation, Gaming, or Emergent VWs from VWQ1, VWQ2, or VWQ3.

6.3 Step 3: Choose Your VW

After you have focused on a particular VW quadrant, you should begin to look at the varying characteristics and features of various VWs within that product space. These traits should be compared by understanding which of these support the scaffolding and assessment you require. Educational scaffolding entails supporting a learner during the educational process, so that s/he will be able to learn what they could not without support. Scaffolds can help the learner become engaged in learning a knowledge or skill, simplify the learning task, or help the student stay focused. Scaffolds can also point out the critical features in knowledge domains, reduce the student's frustration, or help the student identify alternative ways of learning the material (Puntambekar and Hubscher, 2005, p. 2).

Before we progress, we now describe the virtual situation we are developing within Qwaq Forums to help students learn information technology project management (Qwaq, 2009). The virtual situation we are developing is actually not based upon an information technology project. Instead, we have chosen a non-IT project because many of our students are new to the management information systems major. In our virtual situation, we ask the students, in teams, to develop a project plan that will serve as the basis for managing the co-location of six separate medical device manufacturing facilities (and their embedded processes and personnel) into one facility, over the period of six months, without disrupting and or delaying any sales' fulfillments.

In order to develop scaffolds for our students learning, we are placing specially developed artifacts within our project management virtual situation. Therefore, our VW needs to support the embedding of these artifacts. For example, one of our artifacts, a "poster" on a virtual wall in the vice-president of sales' office, will outline the three steps to selling a product. We are placing this poster on the wall in the virtual situation so that students will have an implicit reference point as they think about how they will obtain executive management's buy-in regarding their suggested project plan. Indeed, Qwaq Forums, the VW we are currently assessing, does provide the ability to post images on virtual walls or within interactive multiuser "panels" within virtual rooms.

A VW should also support an educator's assessment needs. Assessment support with a VW can be a decision-making scoring system based upon an underlying model, such as those associated with simulations or gaming VWs. These kinds of assessments can generally only be implemented in VWs associated with the objectivist viewpoint (VWQ1 and VWQ2). Assessment in a VW could also be video/audio recording that allows the instructor to watch the collaborative behaviors of the students in the VW or it could focus on allowing students to change their VW as they solve the problem at hand. In our case, we are interested in using a record and replay feature of a VW to step students and the instructor through recorded practice sessions after the students perform the learning activity. For example, the instructor and the students could discuss what was going through their minds at various points during their practice sessions. Subsequent to these team discussions that occur privately with an instructor, the instructor will lead class discussions about decision making processes that occurred.

Alternatively, the instructor, if invited, could visit the private virtual team room used by a particular team and review various versions of work products students have left in-world, and leave feedback for students, written on the wall or embedded in the work product. Various versions of work products can exist in-world since task worlds in VWQ4 (such as Qwaq Forums) tend to allow files and work products to be created, manipulated, saved in incremental versions, and left in-world.

6.4 Step 4: Pilot for Utility, Viability, and Sustainability

To recap, in order to select a VW, you should first determine the human activities you seek to enable, then identify your primary learning objectives and their type (procedural skills vs. declarative knowledge), and then determine your preferred instructional approach (constructivist vs. objectivist). This information will help you select a VW quadrant in the VWs Taxonomy. Then, within this quadrant, you should review the extant VWs based upon their ability to fulfill the scaffolding and assessment needs that you have. The VW that best fulfills these needs should be selected and then piloted for utility, viability, and sustainability.

In the case of training simulations and educational games, because of their high reliance on an underlying objective model, which is built into the VW when it is developed, the amount of configuration that can occur will be minimal. For example, in the case of training simulations, perhaps time limits, or limits on variables that change based on the underlying model may be set. Another example of a configuration setting in objectivist VWs may be the setting of the minimum diastolic blood pressure of a virtual patient to be 60 mmHg (millimeters of mercury). In this example first-person training simulation, a software trigger would then indicate that the virtual patient NPC should begin dying and therefore virtual resuscitation techniques need to be employed by actual students represented by avatars.

However, in the case of emergent VWs and VWs that support virtual situations, the amount of configuration can be significant. For example, in our project, we are developing many artifacts and placing these artifacts in-world to scaffold our students' learning. Our current scaffolds include lists of heuristics, pictures of ideal processes, and spreadsheets with sample metrics. This kind of configuration is possible in emergent and task worlds because these types of VWs are built to evolve as the users (that is, us or our students) change. In the case of emergent VWs, perhaps you would like to include utilities that will enable students to "reach out" to each other, for example, via introduction bots, that is, preprogrammed avatars that seek and find other students' preprogrammed avatars, so that students can then connect personally.

In our case, to help with our configuration of our task-oriented VW for a virtual situation, we have engaged a facilities design firm to develop a collaborative virtual problem-solving space for our students that has some familiar aspects of our physical building (wood paneling, glass walls) while at the same time providing more problem-solving support than is currently supplied in our physical team rooms. For example, in each of our team rooms there are large amounts of workspace similar to but more functional than traditional whiteboards. We are also creating virtual client facilities where students will visit and interview stakeholders, who will be represented by avatars with behind-the-scenes actors that are actually faculty or industry professionals with experience in the role they are playing in the virtual situation.

However, utility is not the only aspect that should be considered when one assesses a VW for learning. Technical viability and sustainability are also vital. These include considering software support, security, bandwidth, appropriate use, human subjects research, intellectual property (IP), and budget appropriations. We will speak to these in a general sense. Many commercial products provide technical support for installation, training for use, and offsite delivery of the VW. For example, Qwaq Forums, ProtonMedia, and Forterra Systems all provide these services (Forterra Systems, 2004–2009; ProtonMedia LLC, 1998–2009; Qwaq, 2009). To address security, some VW platforms can be served behind an organization's firewall.

With regard to bandwidth requirements, the typical wired network we used successfully was 10 Mb to the desktop and 10 Gb to the campus backbone. We do not recommend using wireless networks as we found degraded VW experiences. In fact, we also had trouble using older wired networks on our campus (when we also had our wireless capabilities on our laptops disabled). However, while we had some poor experiences primarily with wireless networks, we had several global tests (e.g., India-to-Pittsburgh, Prague-to-Pittsburgh, and Paris-to-Pittsburgh) that were highly successful. We also frequently and successfully interacted in our VW instance with virtual project members in West Virginia, Maryland, and Silicon Valley. This indicates that as one assesses different VWs for functionally utility, s/he should also be very thorough in their technical testing as well. Of course as VWs become more streamlined and wireless services become more powerful, wireless should support VWs in a stronger fashion.

Moving from technical to organizational or administrative issues, inappropriate use of the software should be handled as per an organization's electronic citizenship policy. Any research with human subjects should be approved by your institution's Institute Review Board. All software development by the organization's community should be considered the IP of the organization and counsel should be involved in determining how to protect these rights. With regards to charging for the use of VW, discussions will need to consider the costs and benefits of providing an organization-subsidized/free service versus a fee-based cost recovery service.

7. CONCLUSION

VW platforms vary on at least two dimensions. These are specificity of VW purpose and amount of embedded or accessible knowledge readily available to users. Similarly, pedagogies can vary on two dimensions. These are constructivist versus objectivist instructional approaches and learning procedural skills versus understanding declarative knowledge. We have shown that where certain types of pedagogies are pursued, certain types of VWs are appropriate.

Most VW are embryonic and are changing rapidly. At the same time, higher educational organizations are adapting to a changing environment. Therefore we believe it is important that IS educators experiment with leveraging VWs and their affordances to enable learning. In this vein we have provided two related taxonomies and a process that can help IS and other educators select VWs that they can then assess for feasibility within their educational organizations. While we know that there are additional dimensions that describe VW design attributes, and that these dimensions will likely be related to pedagogical variations, we hope that this small step in helping others to learn how to select a VW for learning will be helpful.

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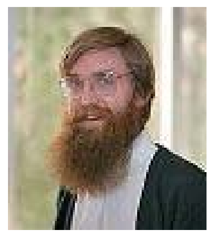

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