Explaining how students can learn the dispositional components of physical world actions by performing virtual world actions

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Abstract

Virtual worlds are an important educational technology for professional education because they enable students to take actions in a safe, simulated environment while adopting specific professional roles. For example, medical students can role-play as doctors in a virtual hospital built in Second Life and practise taking such physical world actions as examining patients, ordering laboratory tests, and prescribing medicines in the form of their virtual character or avatar. This bridging between the classroom and the workplace is especially important in universities where learning experiences may lack relevance to the workplace.

A major problem in the research literature is that virtual worlds are often conceived as platforms that offer students hands-on, tangible learning experiences that somehow involve their physical hand and body, even though students are controlling their avatar by merely pressing buttons. This is a problem because it is unclear how students might learn to perform physical world actions by performing the corresponding virtual world action. For example, it is unclear how pressing the Examine Abdomen button to examine a patient’s abdomen in a virtual hospital might help students learn the physical world action of physically palpating a human patient’s abdomen in an actual hospital. Intuitively, it seems unlikely that students can learn to physically palpate a human patient’s abdomen by pressing a button.

An explanation of this learning process is needed because the conception that virtual worlds offer students physical hands-on learning experiences requires clarification and because educators need to know which learning outcomes virtual worlds can be best used for. Without such an explanation, it is unclear whether students can or cannot learn to take physical world actions via virtual world role-plays.
In this thesis, an explanation of how students can learn to take physical world actions by performing virtual world actions was developed in two ways. First, a systematic literature review was conducted to identify all current learning theories underpinning empirical studies on virtual worlds for education from 2008 to 2015. This information-gathering phase focused on learning theories because learning theories provide a set of principles that explain how learning takes place.

Second, a philosophical inquiry was conducted to evaluate to what extent the explanations provided by the theories could explain the learning of physical world actions in virtual worlds. Following an examination of the assumptions underlying these theories, no theoretical explanation was found that plausibly explains how students can learn to take physical world actions such as palpating a patient’s abdomen by performing virtual world actions. Current explanations imply that students gain a physical experience of the physical world action when they perform the corresponding virtual world action. This explanation is implausible because students do not perform the virtual world action with the same physical movements as when they perform the physical world action, and hence are unlikely to gain the physical experience of the physical world action.

This thesis uses a conceptual methodology to develop an alternative explanation by relating John Austin’s speech act theory to the performance of virtual world actions. When certain conditions are met and certain social conventions are present, a particular virtual world action can mean the same action as its physical world equivalent, despite not being performed with the same physical movements. Students can thus learn to take physical world actions by acting with meaning in virtual worlds. By acting with meaning, students can learn the dispositional components of physical world actions or under which circumstances it is appropriate to perform particular actions. However, students cannot
learn the physical movements of physical world actions. Based on this alternative explanation, learning in virtual worlds is better explained as deriving from social conventions, rather than from physical experience.

This study makes a significant contribution to research in the field of educational technology because it provides a more plausible explanation of how performing virtual world actions can bring about the learning of the dispositional components of physical world actions. With this new explanation, educators can use virtual worlds to help students learn the dispositional components of physical world actions.
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“Puppet theater is a highly refined art, but it asks for something like a child’s, a clown’s, or a mad person’s relation to objects.”

- Kenneth Gross, *Puppet: an essay on uncanny life*
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Chapter 1: Introduction

Learning something real by doing something fake

A group of students pursuing a degree in environmental health have just participated in a role-play on accident investigation, interviewing witnesses of a warehouse accident and inspecting the accident scene (Falconer, 2013). The role-play took place in Second Life, a computer-based virtual world that can simulate the accident scene and allow students to investigate the accident in the form of a virtual character or avatar (a fuller description of virtual worlds will be given in later sections). In a post-simulation interview, one student described the learning benefit of this virtual world in the following way:

I am usually a “hands on” learner so I think that this helped in my understanding of real life scenarios even though it was fake. (p. 296; emphasis added)

This student’s comment encapsulates the gist of my thesis: how might students learn something useful in the real world by doing something fake?

After all, students undertake “fake” movements when they participate in virtual world role-plays. In the virtual world described above (Falconer, 2013), environmental health students do nothing more than press buttons on their keyboards to inspect the virtual accident scene, interact with equipment and objects, and take photographs of the warehouse. In what way might pressing buttons be “hands on”? In addition, students adopt the fake identity of a full-fledged investigator when they are merely students.
I was first drawn to the problem of how students might learn something real by doing something fake when I designed and developed the Otago Virtual Hospital with my colleagues Phil Blyth and Judith Swan (Blyth & Loke, 2014; Blyth, Loke, & Swan, 2010; Loke, Blyth, & Swan, 2012b). In this multi-user virtual world, a medical student role-playing as a junior doctor can learn to provide medical care to another medical student role-playing as a virtual patient. Similarly, students do nothing more than press buttons to control their avatars in order to examine the patient, to order laboratory tests, and to prescribe medicines (see Figure 1).

![User controlling her avatar in Otago Virtual Hospital](image)

**Figure 1. User controlling her avatar in Otago Virtual Hospital**

Students who trialled this virtual hospital expressed that what they learnt in this virtual world was useful for their physical world clinical practice (Loke et al., 2012b). However, it was unclear to me how students—by merely pressing buttons—might be learning clinical skills such as “physically” examining a human patient’s abdomen to look for abnormal hard masses. This procedure is normally done by physically feeling the patient’s abdomen for soft or hard areas. Intuitively, it seems
unlikely that students can learn or become competent in such physical world skills by pressing a button.

As an aside, I will use the expression “physical world” in lieu of “real world” in this thesis to minimise the ambiguity around what might count as “real”. As Twining (2010) highlighted, “physical world” is more precise because many students may well perceive both the physical world and the virtual world as “real” in the sense of existing as a thing and not imagined. For some students, their virtual world experiences may even be more “real” than their typical schooling experiences in the classroom, if “real” is taken in the sense of being closer to the professional workplace. The distinction between “physical world” and “virtual world” is hence more useful in this thesis.

This thesis aims to clarify how students might learn something real by doing something fake by developing an explanation of how role-playing in virtual worlds might bring about the learning of physical world knowledge and skills. Developing such an explanation mainly involves identifying and critically examining current explanations, and then integrating insights from other theories to explain learning in virtual worlds. This thesis is hence different from conventional theses that typically involve a literature review, empirical data collection and analysis.

The introductory chapter of this thesis is also longer than conventional introductions. As with all introductions, this introduction aims to map out the thesis for the reader and culminates with a description of the thesis’ structure. However, a number of preliminary ideas need to be explained first before the thesis’ structure can be understood. One such preliminary idea is the notion of “morphological disconnect” (de Castell et al., 2014, p. 338) (to be elaborated later). This thesis is broadly structured around explanations of how students learn physical world skills in virtual worlds
despite morphological disconnect. The explanation of these preliminary ideas has resulted in a longer than usual introduction.

This thesis is situated in the field of educational technology. In the next section, I will outline the field of educational technology and one major debate that has shaped the field: the debate between positive and pessimistic stances. An explanation of why this thesis adopts a pessimistic stance will then be given.

A brief history of the field of educational technology

The field of educational technology is mainly concerned with the use of technologies for effective learning and teaching (Reiser, 2001). What counts as a “technology” might be too wide-ranging to discuss within the scope of this thesis (e.g., print technology, lecture theatres, computers, the humble pencil), so I will adopt Reiser’s (2001) definition of “the physical means, other than the teacher, chalkboard, and textbook, via which instruction is presented to learners” (p. 55). In the history of the field, researchers have broadly explored four types of technology or instructional movement:

1. The visual education movement from the early 1900s (e.g., charts, slides and slide projectors, stereographs or three-dimensional photographs);
2. The audio-visual instruction movement from the 1920s (e.g., radio broadcasting, training films, instructional television);
3. Computers from the 1970s (e.g., Computer-Assisted Instruction or CAI such as drill and practice, computer simulations); and
4. The Internet from the 1990s (e.g., discussion boards, Massive Open Online Courses or MOOCs, mobile learning, multi-user virtual worlds).
The exploration of these technologies was accompanied by the creation of corresponding organisations and journals. For example, the Department of Visual Instruction was created in 1923 as part of the National Education Association (USA). Another organisation that was created was the Federal Communications Commission (USA) which set aside 242 television channels for educational purposes in 1952. Journals that were created included the *Journal of Computer Assisted Learning* in 1985 and *The Internet and Higher Education* in 1998.

The evolution of the field’s foci resulted in a few name changes. For example, the Department of Visual Instruction changed its name to the Association for Educational Communications and Technology in 1970. Launched in 1953, the journal *Audiovisual Communication Review* was renamed *Educational Technology Research and Development* in 1989.

The field of educational technology is an eclectic field that includes diverse disciplines (Jonassen, 2004). Once predominantly associated with educational psychology, the field has since assimilated other disciplines such as design, computer science, and philosophy. This diversity allows many lenses to investigate common topics, a key one being the use of technology to improve learning.

**No significant difference**

A key research question in the field is whether the use of such technologies as instructional television, computer-based drill and practice, and virtual worlds is effective for learning. To provide answers to this question, the earlier part of the field’s history was dominated by media comparison studies (Reeves, McKenney, & Herrington, 2011). In brief, media comparison studies are experimental studies comparing the use of a new technology either with no technology or with an old technology in terms of student outcomes. For example, Spencer (1977) compared the use of videotaped learning resources (new technology) with
that of audiotaped learning resources (old technology). For the study, an electronics theory course was developed in both videotaped and audiotaped formats. Students participating in the study used either of the two formats and took pre- and post-tests about electronics theory. The results of this study indicated that there was no statistically significant difference in students’ knowledge of electronics theory regardless of format used.

The finding of no significant difference was typical of media comparison studies in the field of educational technology, as Clark (1994) highlighted. Supporting the claim that technology use does not make a big difference in student outcomes, Tamim, Bernard, Borokhovski, Abrami, and Schmid (2011) reported in a second-order meta-analysis (encompassing 1,055 studies in the educational technology literature over 40 years) that the size of the difference in student outcomes between technology-enabled and non-technology-enabled learning experiences was small. The random effects mean effect size was only 0.35. Tamim et al. (2011) hence recommended for educational technologists to stop conducting technology versus no-technology studies because findings in such future studies will likely be similar (i.e., no significant difference and/or small effect size).

To explain why media comparison studies typically yielded no significant difference, Clark (1994) went on to make his key argument that technology does not impact on learning, but that teaching methods do. His argument and the debates that ensued were a milestone in the history of educational technology. I will explain his argument in the context of his questioning the methodological soundness of media comparison studies.

The premise of media comparison studies is that the different media are the independent variable and student learning is the dependent variable, while all other variables are held constant. However, in any realistic
educational context, Clark claimed that all other variables cannot be held constant during the study, notably the influential variable of teaching methods. I will illustrate how teaching methods cannot be held constant with a study. Alcoholado, Diaz, Tagle, Nussbaum, and Infante (2016) investigated the differences in student learning outcomes when using computers and pen-and-paper to solve identical arithmetic exercises. Over 14 sessions, one group worked on these exercises using computers (self-grading quizzes); another group using pen-and-paper. The variable of teaching method was not held constant in this study in at least two ways. First, although both groups were in the same class, each group had a different teacher. Granted, the teachers were rotated around groups over the 14 sessions to mitigate differences in teaching method, but the different teachers were likely to have taught in non-identical ways. Second, the group using computers received instant feedback from self-grading quizzes, while the group using pen-and-paper received delayed feedback in the form of an answer booklet. Therefore, the variable of teaching methods was not held constant in this study nor in the majority of media comparison studies, and media comparison studies are hence not methodologically sound.

As an aside, media comparison studies have since declined in favour of intra-medium studies that investigate the use of a single technology. One example of an intra-medium study is Chee, Loke, and Tan (2009) that studied the use of a video game in a social studies curriculum over a semester and reported significant changes in some elements of students’ attitudes towards societal values.

Underpinning Clark’s (1994) questioning of the methodological soundness of media comparison studies is his claim that teaching methods instead of media are the main influence on how well students learn. Clark likened teaching methods to the chemical ingredients of medicines that have a direct impact on treating diseases, and likened media to the route of
delivery of medication to people’s bodies (e.g., pills, intravenous drip) that does not influence the efficacy of the medicine. Therefore, because a single teaching method can be delivered via a variety of media (e.g., a self-study electronics theory course could be videotaped or audiotaped) and because teaching methods are the “active ingredient” impacting on how well students learn, Clark (1994) concluded that if any media comparison studies reported any significant differences in student outcomes and attributed these differences to the use of different media, then these studies must have confounded media with teaching methods. Accordingly, Alcoholado et al. (2016) did report significant differences in student learning outcomes between the group using the personal computer and the group using pen-and-paper, and attributed the difference to teaching methods, in particular instant feedback versus delayed feedback. Similarly, in a meta-analysis comparing online versus face-to-face classes, Means, Toyama, Murphy, Bakia, and Jones (2009) attributed the positive effects of online classes to the additional learning time and the different pedagogy and instructional content, instead of the delivery medium.

Clark’s (1994) conclusion that media and technology will never influence learning provoked numerous responses from fellow researchers who sought to defend the positive learning benefits of educational technology. Their responses illustrate how the majority of researchers in the field hold a positive stance that educational technology inherently improves learning and teaching.

A positive stance

Broadly, researchers made two arguments against Clark’s (1994) claim that technology does not influence learning. These two arguments are underpinned by the positive stance that technology does or will have a positive impact on learning. First, some researchers state that past
studies in educational technology have reported no significant differences in student learning outcomes because computer technology was then too rudimentary and was limited to delivering learning content to students. For example, Garrison, Anderson, and Archer (1999) argued that, with the advent of discussion boards, distance learners are now able to learn via social interaction and not just via content transmission. According to this argument, more advanced technologies have a greater potential to impact positively on student learning outcomes than older technologies.

About a decade later, Wheeler, Yeomans, and Wheeler (2008) made a similar argument with the advent of Web 2.0 technologies (e.g., wikis, blogs, YouTube), stating that such new technologies now allowed students to become content authors co-constructing knowledge with peers instead of mere content consumers. However, research into Web 2.0 technologies in higher education have revealed that “there is still no evidence that the promised revolution has been unleashed” (Palaigeorgiou, Triantafyllakos, & Tsinakos, 2011, p. 147).

One of the more recent technologies to go through this hype-disappointment cycle is the iPad, a tablet computer launched by Apple in 2010. A quick search in the ERIC Proquest database using the keyword “iPad” showed that publications about the iPad surged from 7 records in 2010 to 67 records in 2013, plateaued from 2013 to 2015, and then declined to 31 records in 2016. One such publication described the educational potential of the iPad in the following way (Berson, Berson, & Manfra, 2012):

The functionality offered by the iPad, with its mobility and ubiquitous applications, may be the spark to ignite a movement toward innovation that empowers and enriches students’ authentic, high quality learning experiences. (p. 91)
Almost predictably, this “hyperbole” (Mishra, Koehler, & Kereluik, 2009, p. 49) around the promise of the iPad was tempered by a systematic literature review of research studies on the iPad that once again found that there is currently no evidence that the use of this new piece of technology resulted in better student learning outcomes (Nguyen, Barton, & Nguyen, 2015).

Indeed, throughout the history of the field of educational technology, with the advent of each major new technology, researchers have repeatedly inflated expectations of new technologies and then observed a modest impact on teaching and learning practice (Cuban, 2001; Mishra et al., 2009; Reiser, 2001; Selwyn, 2011). Despite these sobering findings, many researchers in educational technology still persist in maintaining the positive stance that more advanced technologies can improve student learning outcomes, “unthinkingly” (Selwyn, 2012, p. 216) associating the new with progress. In the educational technology literature, regularly-used fixed expressions such as “technology-enhanced learning” and “computer-assisted learning” reflect the positive stance that technology will inherently enhance and assist in learning (Selwyn, 2011).

The advent of virtual worlds also evoked a similar positivity. When virtual worlds first emerged, they were also positioned as a promising new technology that has “infinite imaginative educational possibilities” (Salmon, 2009, p. 526). Similarly, Morgan (2013) highlighted the quasi-boundless nature of its educational possibilities: “The potential for utilizing this medium in the history classroom has largely been untapped, but offers nearly limitless possibilities for both educators and students” (p. 549). This hyperbole positions virtual worlds as an infinitely powerful technology that is simply waiting to be tapped.

Instead of perpetuating this positive stance or agreeing wholly with Clark (1994) that this new technology has no bearing on learning, I specify in
this thesis the possibilities as well as the limitations of virtual worlds. I will explain why in the next section on adopting a pessimistic stance.

The second argument against Clark’s (1994) claim that technology does not influence learning goes as follows: some researchers state that, even with the availability of more advanced technologies, many studies in educational technology yield no significant difference in student outcomes because these studies still feature traditional didactic teaching methods. In brief, these researchers believe that there is no significant difference because the potential of the technology has been “untapped” (not because the technology is flawed in any way). Instead, they recommend constructivist uses of these technologies because they believe that constructivist approaches where students actively make meaning of the phenomena under study are more likely to generate significant improvements in student learning outcomes. For example, these researchers lament how many teachers still use discussion boards for merely delivering instructional content or “information pumping” (Tan & Hung, 2002), even though discussion boards are capable of supporting more constructivist teaching approaches such as students sharing their diverse perspectives on the phenomenon under study. These researchers (e.g., Jonassen, 1996; Kozma, 1994; Roblyer, 2006) claim that there will likely be positive and significant differences to student learning if students were actively learning with technology (e.g., writing blog entries to track a group project) instead of passively learning from technology (e.g., reading content from a teacher’s blog).

However, the claim that constructivist approaches are beneficial for all learning contexts can be questioned. Kirschner, Sweller, and Clark (2006) highlighted that empirical studies over 50 years indicate that constructivist approaches are less effective and less efficient than traditional didactic instruction. From an international education perspective, Schweisfurth (2011) highlighted that constructivist
approaches might be a Western construct that is irrelevant to non-Western cultures of learning. In any case, even Piaget (1970), a leading voice advocating for constructivist approaches, called for teachers to strike a balance between constructivist and traditional didactic approaches:

Since every discipline must include a certain body of acquired facts as well as numerous research activities and activities of rediscovery, it is possible to envisage a balance being struck between the different parts of be played by memorising and free activity. (p. 78)

Despite this, many researchers in educational technology persist in recommending constructivist uses of technologies as being better than didactic uses, maintaining that the use of educational technology will yield positive student outcomes if the power of technology were harnessed in the right way.

Selwyn (2011) laments how “this inherent positivity has become an all-encompassing—if not hegemonic—feature of educational technology scholarship” (p. 713) which threatens to reduce educational technology research to an excessively interest-driven endeavour to “sell” technology (Selwyn, 2012, p. 213). Instead, he recommends that researchers in educational technology adopt a pessimistic stance. This is the stance that I adopt in this thesis and that will be described in the next section.

A pessimistic stance

A pessimistic stance in educational technology scholarship expects nothing at the outset; it does not expect technology to be able to enhance learning. By the same account, a pessimistic stance is open to all possibilities, accepting that technology might or might not have a significant impact on learning. In his editorial “In praise of pessimism—
the need for negativity in educational technology”, Selwyn (2011) describes the pessimistic stance in the following way:

I would like to argue that a pessimistic stance is the most sensible, and possibly the most productive, perspective to take [in educational technology scholarship]. As such, I am advancing an approach that simply accepts education, technology and society as it is—for better and (more often) for worse. It is important to note here that I am not arguing for the adoption of a dogmatic blanket negativity towards education and technology. In its purest sense, pessimism still allows room for an acceptance that specific things are getting better. However, it also acknowledges the fact that life has long remained the same for most people in most circumstances, and that many social inequalities will continue to persist regardless of changes elsewhere. Thus at one level, the pessimistic educational technologist is simply one who adopts a mindset that is willing to recognise—and work within—the current and historical limitations of educational technology rather than its imagined limitless potential. (…) Perhaps the overriding change that this entails is shifting the field away from asking “state-of-the-art” questions about technology and towards asking questions that can be described as being concerned with the “state-of-the-actual.” In other words, educational technology scholarship should look beyond questions of how technology could and should be used and instead asking questions about how technology is actually being used in practice. (pp. 714-715; emphases in original)

In this thesis, I adopt a pessimistic stance in that:

- I accept that learning in virtual worlds might or might not have a significant impact on learning;
• I specify what students can learn in virtual worlds and what they cannot learn (in Chapters 3 and 7), instead of adopting the positive stance that virtual worlds “offer opportunities for education that are almost limitless” (The New Media Consortium, 2007, p. 6; emphasis added);
• I identify all plausible explanations of how this learning takes place while challenging overly optimistic, implausible explanations (in Chapters 2 and 3); and
• I provide an alternative explanation of a specific aspect of virtual world learning where implausible explanations were given in the past (in Chapter 4).

The above statements will make more sense once I provide a fuller description of my thesis. In the next section, I will describe virtual worlds in more detail and then provide a narrative account of how a role-play can take place between medical students in the Otago Virtual Hospital. Based on this narrative account, some implausible claims about how students learn in virtual worlds will be highlighted using selective examples from the literature. After that, I will conclude this chapter by outlining how I will develop an alternative explanation of learning in virtual worlds in my thesis.

Virtual worlds for education

In this thesis, “virtual worlds” refer to computer-based, multi-user virtual environments that simulate events in the physical world. Virtual worlds can simulate such events as the provision of medical care in hospitals (Blyth & Loke, 2014), the operation of tower cranes at construction sites (Guo, Li, Chan, & Skitmore, 2012), and the ordering of food in restaurants (Henderson, Huang, Grant, & Henderson, 2012).
Students participate in such simulated events via their digital character or avatar. By controlling their avatar using a keyboard and mouse, students can make their avatar move within the virtual world, interact with other avatars and virtual objects.

A variety of virtual worlds such as Second Life, Active Worlds, River City, and Quest Atlantis have been used for educational purposes. Currently, the most frequently used virtual world for education is Second Life (Wang & Burton, 2013), a virtual world developed by Linden Lab and launched in 2003. Most of the examples in this thesis will hence be based on Second Life.

Virtual worlds evolved from text-based multi-user virtual environments that have been in existence since the late 1970s (Wang & Burton, 2013; Yee, 2014). One example of such a virtual environment is ADVENT, a text-based adventure game created by Will Crowther in 1976. In this game, players type certain words to move around (e.g., “go in”) and to perform actions (e.g., “get gold”). In response, the game will give gamers textual feedback (e.g., “There is a shiny brass lamp nearby”). Advances in graphics and computing technologies have enabled more realistic graphical depictions of users and spaces in virtual worlds.

The importance of virtual worlds for learning is shown by the attention devoted to the topic in the academic literature. A number of special issues have been published on virtual worlds for education (de Freitas and Veletsianos, 2010; Lee, Dalgano, and Farley, 2012; Twining, 2010) and conferences dedicated to the topic continue to be organised (e.g., 10th Virtual Worlds Best Practices in Education conference, 2017; 9th International Conference on Virtual Worlds and Games for Serious Applications, 2017).

In 2007, the New Media Consortium predicted in their Horizon Report that virtual worlds will be widely adopted in higher education by 2009-
2010 (The New Media Consortium, 2007). First published in 2004, the annual Horizon Report is frequently used by educators, researchers, and policy-makers to identify technologies that have a large impact in education and that are likely to be widely adopted by educational institutions. In terms of its use in the research literature, a quick word count of all journal papers published in the Australasian Journal of Educational Technology from 2008 to 2014 reveals that “Horizon Report” appears in 24 out of 489 papers (5%). In the 2007 Horizon Report, virtual worlds were given a time-to-adoption horizon of two to three years. This means that the 27 members of the 2007 Advisory Board (mostly academic and information technology leaders from higher education institutions), having surveyed existing teaching practices and reviewed the literature, judged that virtual worlds were likely to be used by a large number of educational institutions by 2009-2010.

It is difficult to give the exact number of educational institutions that have actually used or are using virtual worlds. One estimate can be derived from the Second Life Educators Directory, a list of educational institutions that have registered as participating in Second Life. As of January 2017, 152 educational institutions are registered in the Second Life Educators Directory (Linden Research, 2013).

Despite the 2007 Horizon Report’s predictions, teaching in virtual worlds has not become mainstream and the interest in using virtual worlds for teaching has plateaued in recent years (Gregory et al., 2015). However, this interest is likely to be reinvigorated by the growing popularity of virtual reality technologies that can extend the functionality of virtual worlds such as letting users physically imitate the same movements as those used to perform the physical world action via head-mounted displays. Such virtual reality technologies will be described more fully in Chapter 3.
One reason for the interest in using virtual worlds for education is that virtual worlds can be used for a wide range of educative purposes. In her scoping study, de Freitas (2008) listed such purposes as building social networks, playing team-building games, and training for specific professions. In this thesis, I focus on the latter: the training of professionals-to-be such as doctors, teachers, and social workers. In virtual worlds for professional education, students—in the form of avatars—act out specific professional roles by taking appropriate actions during the course of virtual scenarios. In so doing, it is thought that students can learn to become doctors, teachers, and social workers. Used in this way, virtual worlds can serve as a bridge between the classroom and the workplace.

**A bridge between classrooms and workplaces**

To become professionals, students need to learn how to act and not just develop conceptual understanding. As Shulman (2005) wrote:

> Professional education is not education for understanding alone; it is preparation for accomplished and responsible practice in the service of others. It is preparation for “good work.” Professionals must learn abundant amounts of theory and vast bodies of knowledge. They must come to understand in order to act, and they must act in order to serve. (p. 53)

Virtual worlds are often used for professional education because they allow students to act in a simulated professional environment. Two features of virtual worlds make them a suitable bridge between the classroom and the workplace. First, virtual worlds can mimic physical world professional contexts, replicating the workplace and its practices (Salmon, 2009; Warburton, 2009; Whitton, 2012). For example, virtual worlds have been used to mimic clinical practices in hospitals (Blyth & Loke, 2014; Conradi et al., 2009), teaching practices in classrooms
(Dalgarno, Gregory, Knox, & Reiners, 2016) and home visiting in social work (Wilson, Brown, Wood, & Farkas, 2013). As stated earlier, the focus of this thesis is on developing professionals who are learning to act in their eventual professional worlds.

As an aside, my focus on professional education also led me to abandon an initial line of inquiry around the playing of a video game. I initially thought that understanding how gamers play video games might help me understand the learning processes underpinning virtual world role-plays. I thought this because video games and virtual worlds are similar in that they both involve acting as a virtual character and solving problems in virtual scenarios. I hence embarked on an ethnographic case study of a novice gamer learning how to play a role-playing video game. Ethical consent was sought and granted. I observed and recorded the gamer playing the video game *Heroes of Ruin*. I chose *Heroes of Ruin* because it was a well-rated video game (hence challenging enough to maintain the participant’s interest) and involved mild fantasy violence in the form of slaying imaginary monsters (hence less likely to put off potential participants who might object to real-world violence). However, as I realised that my focus was on professional education and not people learning for any purpose, it dawned on me that *Heroes of Ruin* was a fantasy world and the ethnographic case study would hence not provide answers to how students learn to become professionals in the physical world. In particular, the slaying of imaginary monsters is not a useful professional skill in the physical world. I hence did not pursue this line of inquiry.

The second feature of virtual worlds that make them a suitable bridge between the classroom and the workplace is that virtual worlds allow students to act in their professional roles and then play out the consequences of their virtual world actions within the virtual world, not in the physical world. By confining these consequences within the virtual
realm, it has been argued that virtual worlds allow students to apply their professional knowledge and skills in safety (Dalgarno & Lee, 2010). This is particularly useful when practising such skills in the physical world would be unsafe (e.g., firefighters evacuating people from a building that is about to collapse) or unethical (e.g., non-certified medical students having full responsibility for patients). Virtual worlds let students “interact with objects too big, too small, too far away, too expensive, or too dangerous for the classroom” (Nadolny, Woolfrey, Pierlott, & Kahn, 2013, p. 980). While interacting with these objects, students can make mistakes that do not have material consequences in the physical world, and learn from their mistakes in a safe environment (Dalgarno & Lee, 2010).

Because of these two features, virtual worlds are often seen as a suitable bridge between the classroom and the workplace (Gonczi, 2013; Wilson et al., 2013). This bridging is needed because university-based learning has often been criticised to be lacking authenticity or relevance to the workplace. Biggs and Tang (2007), for example, criticise universities’ continued emphasis on declarative knowledge (factual knowledge and information that lecturers can tell students about), at the expense of functioning knowledge that can launch “informed decision makers and performers into the workforce” (p. 136). According to them, functioning knowledge enables people to function and act in the workplace. In this thesis, I focus on this functioning knowledge in the context of professional education. By letting students apply their professional knowledge and skills in simulated role-plays, it is thought that virtual worlds allow students to learn this functioning knowledge.

One virtual world that allows medical students to act as doctors is the Otago Virtual Hospital (Blyth and Loke, 2014; Blyth et al., 2010; Loke et al., 2012b). A description of this virtual hospital will be provided in the next section to illustrate how a particular virtual world mimics a physical
world professional context and how it allows students to act in their professional roles.

**Otago Virtual Hospital**

The Otago Virtual Hospital is a multi-user virtual world in which medical students role-play as doctors in the form of avatars and provide medical care for a virtual patient within the emergency department. Figure 2 provides a screenshot of the virtual hospital; a two-minute video showing doctors taking the patient’s medical history is available at http://bit.ly/xZoNet.

![Figure 2. Role-play in Otago Virtual Hospital involving two doctors, a patient (seated) and a relative (back to reader)](image)

Here is a narrative account of how a virtual world role-play can take place between two or more medical students. The students first log into the Otago Virtual Hospital and “land” as avatars in a virtual waiting room where they decide who will play the doctor and who will play the patient. Their tutor can also assign the roles. If more than two students are participating, one will play the patient while the others can become a
team of doctors. The students are then given role-appropriate clothes to “dress” their avatars up, such as scrubs for the doctor and street clothes for the patient. In addition, the student playing the patient is given a brief script (available at http://bit.ly/o8vUDQ), which highlights that she will play Gertrude MacFarlane who has been more tired than usual and a little short of breath on exertion, for example. Students playing the doctor are given a standard hospital triage form (available at http://bit.ly/rbxI50), which highlights the patient’s problems and provides the patient’s vital signs upon entering the hospital. The students then “teleport” to the virtual hospital where the scenario begins.

Typically, the doctor starts by taking the medical history of the patient. Verbal communication in the Otago Virtual Hospital is carried out via text chat, so the doctor takes the patient’s medical history by “speaking” with the patient via text chat (as displayed at the bottom left corner of Figure 2). To develop a better understanding of the patient’s problems, the doctor can “physically” examine the patient. This is done by clicking various buttons. For example, clicking the Examine Chest button allows students to listen to a series of heart sounds. This procedure is normally done in the physical world by placing a stethoscope on a human patient’s skin and listening over a few spots. In addition, the doctor can develop a better understanding of the patient’s problems by ordering laboratory and radiology tests. For example, clicking the Head X-ray button orders an X-ray of the patient’s head; clicking the View Results button displays the requested X-ray image on the computer screen.

After the doctor forms a diagnosis, the doctor negotiates a treatment plan with the patient via text chat. Once the treatment plan is agreed on, the doctor can prescribe the appropriate medicines, again by clicking on the appropriate buttons. Finally, the doctor types a patient handover note, detailing key information for the medical team taking over. The scenario
then ends and the two students teleport back to the waiting room where they can conduct a debrief.

There is some evidence that the Otago Virtual Hospital can serve as a bridge between the classroom and the workplace. A group of medical students who trialled the virtual world role-play reported that the role-play provided them with opportunities to make clinical decisions relevant to their professional practice (Loke et al., 2012b). Such opportunities are typically lacking in their current medical education. In addition, Roy, Walker, Blyth, and Wilkinson (2014) examined the construct validity of role-playing in the Otago Virtual Hospital and reported that the clinical reasoning required in such a role-play resembles clinical reasoning in the physical world. Therefore, it is possible that students can learn clinical reasoning relevant to their professional practice by practising it in this virtual world.

Other empirical studies on other virtual worlds have also yielded some evidence that students can learn physical world knowledge and skills by role-playing in virtual worlds. A general picture of this evidence will be provided in the next section.

**Some evidence of learning**

There is some evidence from empirical studies that students can develop their professional knowledge and skills by participating in virtual world role-plays. However, Wang and Burton (2013) reported that the majority of such empirical studies are small to medium scale exploratory case studies with limited generalisability of findings. Therefore, the literature does not currently provide clear and definite evidence that learning in virtual worlds results in the learning of professional knowledge and skills; rigorous research about how learning in virtual worlds influences student outcomes continues to be limited (Henderson et al., 2012). Nonetheless, I will provide below a general picture of some evidence
about how learning in virtual worlds led to the learning of professional knowledge and skills using selective examples from the literature.

First, students can develop professional knowledge, which can be subdivided into specific professional knowledge and general awareness about issues related to the profession. There is some evidence that learning in virtual worlds results in gains in specific professional knowledge. Farra, Miller, Timm, and Schafer (2013) conducted an experimental study comparing nursing students’ knowledge gain in disaster management via conventional web tutorials versus a Second Life simulation of a disaster experience. The simulation group demonstrated higher knowledge scores on the immediate post-assessment as well as on a post-assessment two months after the learning experience. Both assessments comprised 20 multi-choice questions about disaster management. In another study, Dib and Adamo-Villani (2014) compared engineering students’ knowledge gain about sustainable building via a computer-based role-playing game versus existing learning methods of lectures and tutorials. The game group demonstrated significant gains in procedural knowledge (knowledge about how to do things), but not in declarative knowledge (factual knowledge and information about building sustainability).

There is also some evidence that learning in virtual worlds results in awareness of issues about the profession. In a study undertaken by Nadolny et al. (2013), students played the role of research scientists collecting measurement data in a virtual laboratory in a virtual salmon hatchery, where they practised ethical decision making about genetic modification. After the virtual world learning experience, students reported an increased awareness of ethical issues related to genetic modification. In another study undertaken by Wilson et al. (2013), social work students undertook a home assessment by visiting a virtual client in her virtual home. After the virtual world role-play, students reported an
increased awareness of issues of safety and personal biases when home visiting.

Next, students can develop professional skills, which can be sub-divided into self-efficacy in performing professional tasks and the actual performance of professional tasks. There is some evidence that learning in virtual worlds results in higher self-efficacy in completing professional tasks. Self-efficacy has been defined as people’s personal beliefs about their capability to complete a particular task (Bandura, 1997). These feelings of competency are thought to influence people’s choice of activities (e.g., low self-efficacy results in task avoidance) and persistence (e.g., high self-efficacy results in high persistence in a learning task). As such, self-efficacy theory is a theory about raising one’s self-efficacy in performing particular tasks, and not directly about actually performing particular tasks (see Chapter 3 for an in-depth description of self-efficacy theory). In a study undertaken by Levine and Adams (2013), social work students participated in a virtual world role-play where they conducted a case management intake, gathering information and assessing the needs of their virtual clients. After the virtual world learning experience, these students reported a higher self-efficacy in case management. In another study undertaken by Henderson, Huang, Grant, and Henderson (2012), foreign language students practised ordering food in Mandarin in a virtual restaurant. After the learning experience, these students reported a higher self-efficacy in language performance.

Evidence about the actual performance of specific professional tasks learnt from virtual worlds is rare and only one study in a systematic literature review (Loke, 2015) provided evidence that learning in a virtual world led to behavioural transfer to the workplace. Bertram, Moskaliuk, and Cress (2015) conducted an experimental study in a police academy in Germany. In the study, the researchers compared two groups
of police trainees learning how to coordinate teams in emergency situations. One group learnt this task via virtual world role-plays; the other group via existing learning methods, namely lectures and workshops where the trainer demonstrated how to coordinate teams. Two weeks after the learning experience, to evaluate behavioural transfer to the workplace, both groups of trainees performed two team coordination tasks in the physical world. One was a simpler task of searching for a target person in a known training area while communicating with the helicopter crew; the other a more complex task of searching for a target person in an unknown woodland while communicating with the helicopter crew. Both groups performed equally well in the simpler task, but the virtually trained group performed better in the more complex task.

In other studies, students merely expressed that learning in a virtual world can potentially lead to behavioural transfer to the workplace, without actually demonstrating such evidence. In a study undertaken by Dalgarno et al. (2016), pre-service teachers role-playing as teachers get to try out different teaching strategies with a class of primary school pupils in a virtual classroom. For example, the teacher-avatar has to move around the classroom to show his or her awareness of what is going on in all parts of the classroom. When asked about the value of learning in such a virtual world in their teacher education, 46% of the participants expressed that the virtual world role-play helped to develop their skills in moving around the classroom.

Given above is a general picture of some evidence that learning in virtual worlds can result in the learning of professional knowledge and skills. This thesis does not aim to provide more of such evidence. I accept that learning in virtual worlds can result in some learning of professional knowledge and skills and aim instead to develop an explanation of how the learning described above might have occurred.
I was first drawn to the problem of explaining how this learning takes place when I realised that some claims made in the current literature about how students learn in virtual worlds are implausible. I will describe these claims in the next section before justifying why they are implausible.

Implausible claims

While writing about learning in virtual worlds, some researchers have made claims that assume that the virtual world experience is very similar to the physical world experience. These claims relate to two main ideas:

1. that students undergo an embodied experience in virtual worlds that corresponds with the physical world experience; and
2. that students learn-by-doing in virtual worlds in the sense that they learn a physical world task by doing the corresponding virtual world task.

Claims that students undergo an embodied experience

Some researchers have claimed that students in virtual worlds undergo an embodied experience of the target physical world experience. For example, virtual worlds are often portrayed as learning environments where students can undertake “embodied practice” (Taylor, 2002, p. 60) and “embodied learning tasks” (Dalgarno & Lee, 2010, p. 19). As “simulations of embodied experience” (Gee, 2008, p. 254), virtual worlds are thought to involve students “as fully embodied persons” (Chee, 2007, p. 16) as opposed to their sole cognitive involvement. In this sense, “embodied” means involving the physical body as opposed to involving only the mind.

Some researchers have suggested that embodiment is what makes virtual worlds unique among other educational technologies (e.g., discussion
boards, blogs, multimedia content). As evidence of this, when Dalgarno and Lee (2010) identified unique characteristics of virtual worlds, they included three characteristics related to embodiment:

1. embodied actions (e.g., moving around the virtual world, manipulating virtual world objects);
2. embodied verbal communication (e.g., text or voice chatting with other avatars); and
3. embodied non-verbal communication (e.g., activating different bodily gestures of the avatar).

Reinforcing the view that the student’s physical body is involved when learning in virtual worlds, other researchers have suggested that virtual worlds offer students tangible “concrete experiences” (Wehner, Gump, & Downey, 2011, p. 280) because virtual worlds are by nature “concrete and tangible” (Chow, 2016, p. 1). Other suggestions have been made that the experience of virtual world is somehow tangible or perceptible by touch. Farley (2014) claimed that virtual worlds offer “hands-on learning” (p. 326) that would cater for kinesthetic learners who prefer to learn via “physical actions” (p. 326). Leggette et al. (2012) claimed that virtual worlds offer students “real-world, hands-on experiences” (p. 125). Wilson et al. (2013) claimed that virtual worlds provide their social work students with “a hands-on opportunity to practice home visiting skills” (p. 426). These claims suggest that acting in the virtual world somehow involves the student’s physical hand and body.

To be sure, students do undergo a certain physical bodily experience while role-playing in virtual worlds: they undergo the physical experience of pressing buttons in order to make their avatar act within the virtual world. However, this is different from the physical experience of students acting on the virtual world with their own body, which is what the above claims seem to suggest (e.g., that practising home visiting
skills in the virtual world gives students a hands-on opportunity of practising home visiting skills). The above claims are implausible because students learning in virtual worlds do not execute the same physical movements needed to complete the physical world action. As described in the narrative account of a role-play in the Otago Virtual Hospital, when students perform a chest examination in the virtual world by pressing buttons, they do not execute the same physical movements of performing a physical chest examination on a human patient. The two physical experiences are different physical experiences, and involve the student’s physical body in different ways.

In contrast to desktop virtual worlds such as Second Life, being “embodied” does mean involving the physical body in fully immersive virtual environments (see Figure 3). In fully immersive virtual environments such as cave automatic virtual environments (CAVEs), users’ bodies are physically immersed in or surrounded by the virtual environment and, by virtue of that, users are physically embodied in the virtual environment. Because their physical bodies are immersed in the virtual environment, what they do physically (e.g., move their head) often corresponds with what they do in the fully immersive virtual environment (implications of this emerging technology for learning will be discussed in Chapter 3).
In this case, being “embodied” involves the physical body in that students are given a tangible or physical form in the virtual environment. However, this fully immersive experience (featuring the correspondence between what the user does physically and what the user does in the virtual environment) is not what desktop virtual worlds can offer (Blascovich & Bailenson, 2011). Therefore, the nature of desktop virtual worlds where students control their avatar “remotely” using keyboards and mice requires another meaning of “embodied”.

From their work on desktop virtual game worlds, Chee and Tan (2012) give this other meaning in the following way:

Students’ learning is mediated by engagement in play via a material, digital game world (...) The player’s experience is embodied, by virtue of being represented in the game world by his avatar, and the
player is embedded, or immersed, in the virtual space of the game world. (p. 188; emphasis added)

So, while learning in desktop virtual worlds such as Second Life, students can be said to be “embodied” in the sense of being graphically represented or given a visible form by an avatar on the computer screen. This meaning foregrounds the avatar’s body and not the student’s physical body.

However, many researchers still conflate the student’s body and the avatar’s body by suggesting that students—instead of their avatars—are physically embodied and physically immersed in desktop virtual worlds, when this is not the case. For example, in the passage that quoted above, Chee and Tan (2012) claimed that “the player is... immersed in the virtual space” (p. 188), although students are neither physically embodied nor physically immersed in the desktop virtual world. Instead, the player’s avatar is the one immersed in or surrounded by the virtual environment.

This conflation of the student and the avatar is also reflected in how some researchers write about avatars in desktop virtual worlds. For example, some researchers describe the avatar’s actions in the virtual world as “learners’ actions” (Fardinpour & Heinz, 2012, p. 214) and “a student’s in-world actions” (Chodos, Stroulia, King, & Carbonaro, 2014, p. 26), as if the student and avatar were one and the same thing. This does not acknowledge that, strictly speaking, the in-world actions are performed by the avatar and not the student.

As an aside, I speculate that this conflation of student and avatar can be traced back to the original definition of “avatar” in Hinduism: the descent of a deity to Earth during which the deity or spirit “occupies” the physical body of an avatar and acts through the avatar. In transposing the notion of “avatar” from the spiritual world to the educational technology world, certain connotations of the original meaning have been conserved that do
not apply to desktop virtual worlds, notably the “inhabiting” of the virtual world avatar with one’s physical body.

In earlier publications, I too have conflated the student and the student’s avatar by claiming that a desktop computer simulation was immersive, as if the student was surrounded by the virtual environment instead of the avatar (Loke et al., 2009). The idea that students can immerse themselves in desktop virtual worlds is so intuitively appealing that Johnson and Levine (2008) entitled their article “Virtual worlds: Inherently immersive” without further justifying how desktop virtual worlds might be inherently immersive. So well entrenched is the idea that desktop virtual worlds are immersive that Beaumont, Savin-Baden, Conradi, and Poulton (2014) felt it necessary to coin the abbreviation “IVW” (p. 125) (immersive virtual worlds) to label desktop virtual worlds.

As with “embodied”, it is important to clarify the meaning of “immersed” because immersion is also thought to be a unique characteristic of desktop virtual worlds among other educational technologies. As mentioned earlier, educational technologies are traditionally classified either into technologies that students learn from or learn with, and virtual worlds are thought to be part of a unique category of technologies that students learn in (Schrader, 2008), environments inside which students do things.

Again, I distinguish two meanings of “immersed”. Being “immersed” can mean that users’ bodies are physically immersed in, or surrounded by, the virtual environment, such as in fully immersive virtual environments. Another meaning of being “immersed” is that students are psychologically engrossed or engaged in the role-play, that they are undergoing “psychological immersion” (Dalgarno & Lee, 2010, p. 14). I will address this possibility in Chapter 3. Table 1 summarises the multiple meanings of
“immersed” and “embodied”, and what each meaning entails in terms of physical correspondence.

**Table 1. Multiple meanings of “immersed” and “embodied”**

<table>
<thead>
<tr>
<th>Context</th>
<th>“immersed”</th>
<th>“embodied”</th>
<th>Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully immersive virtual environments</td>
<td>Physical body surrounded by or “submerged” in virtual environment</td>
<td>Given a tangible or physical form in the virtual environment</td>
<td>Correspondence in terms of physical movement</td>
</tr>
<tr>
<td>Desktop virtual worlds</td>
<td>Psychologically engrossed or engaged in role-play (physical body separate from virtual world)</td>
<td>Given a visible or graphical form (that is physically separate from the user)</td>
<td>Lack of correspondence in terms of physical movement</td>
</tr>
</tbody>
</table>

In desktop virtual worlds, students are definitely not physically embodied nor physically immersed. Therefore, researchers who claim that students undergo an embodied experience in desktop virtual worlds should clarify in what ways students are embodied.

The first implausible claim that students undergo a physical embodied experience in desktop virtual worlds has been described. I will now describe the second implausible claim.
Claims that students learn-by-doing

Many researchers including myself have claimed that students learn-by-doing in virtual worlds in the sense that they learn an action X in the physical world (\(X_{\text{PW}}\)) by doing the action X in a virtual world (\(X_{\text{VW}}\)). Such researchers include Dede (1995) who claimed that the mechanism underlying learning in virtual worlds was “learning-by-doing” (p. 46). In addition, Hew and Cheung (2010) positioned virtual worlds as “experiential spaces” (p. 37) where students act on the virtual world in order to “learn by doing” (p. 37). My colleagues and I also drew upon experiential “learning by doing” (Loke et al., 2012b, p. 565) to explain the instructional design of the Otago Virtual Hospital.

The Otago Virtual Hospital is but only one of the numerous virtual worlds adopting a learning-by-doing pedagogical approach. Here are two other such virtual worlds. In Park’s (2012) study, students role-play as policy-makers in a virtual village in Second Life, organising policy hearings and managing public comments for a policy campaign. Reflecting a learning-by-doing approach, it is envisaged that these students will learn how to formulate communication policies by formulating communication policies in the virtual world. Park (2012) clearly stated that their “students can learn [communication policy] by ‘doing policy’” (p. 45) in the virtual world. In a study undertaken by Dalgarno et al. (2016), pre-service teachers teach a lesson to a group of pupils in a virtual classroom. Also reflecting a learning-by-doing approach, it is envisaged that these pre-service teachers will learn how to teach by teaching in the virtual world.

The instructional design of these virtual worlds assumes that students learn X by doing X. The validity of this instructional design hinges on the idea that \(X_{\text{VW}}\) corresponds with \(X_{\text{PW}}\). However, as mentioned above, doing \(X_{\text{VW}}\) does not correspond to doing \(X_{\text{PW}}\) in terms of physical movement.
Therefore, researchers who claim that students can learn-by-doing in virtual worlds should clarify in what ways $X^{VW}$ corresponds to $X^{PW}$.

Overall, the two implausible claims that students undergo a physical embodied experience and learn-by-doing in virtual worlds assume a higher degree of correspondence between the virtual world and physical world experience than is possible. Subsequently, these questionable claims underpin certain explanations about how students learn in virtual worlds, making these explanations equally implausible and questionable (I will elaborate on these in Chapter 3).

In the next section, I will justify why a more plausible explanation is needed for research in the field of educational technology.

Why an explanation is needed

For virtual worlds to serve as a bridge between the classroom and the workplace, it is expected that what students learn in virtual worlds would transfer into their target performance at the workplace. Using the study by Bertram et al. (2015) cited above, it was expected that what the police trainees learnt in the virtual world would transfer into their actual performance of the team coordination task in the woodland.

In turn, to maximise the likelihood of transfer of learning from the virtual learning context to the target physical world context, there needs to be a high degree of correspondence between what students do while learning (the learning performance) and what they are expected to do at the workplace (the target performance).

At this point, I clarify that in this thesis the term “correspondence” is not used to evoke broader philosophical theories such as the correspondence theory of truth, but simply in its everyday sense of “similarity” and “matching with”.
I also use the term “correspondence” to better differentiate my conception of transfer of learning from the extreme view of Thorndike and Woodworth (1901) for whom transfer depends on “identical elements” in both performances (p. 558). It would be untenable to adopt such an extreme view to explain learning in virtual worlds, because virtual worlds cannot be identical to the physical world. For example, making the avatar run by clicking a mouse is not identical to running in the physical world. Such an extreme view would imply that students could never learn physical world skills by role-playing in virtual worlds.

My conception of learning is closer to what Perkins and Salomon (1988) describe as transfer via “hugging” (p. 28). In their description, students maximise the likelihood of transfer when they engage in a learning performance that approximates the target performance, when they do something that comes close to the target performance. To illustrate what hugging is, Perkins and Salomon (1988) gave the example of teaching anatomy to medical students by asking students to make diagnoses about case studies rather than by asking them to listen to lectures describing the human anatomy. According to Perkins and Salomon, diagnosing case studies approximates or corresponds with the target performance required of doctors better than listening to lectures does. This is because they believe that diagnosing case studies provides stimulus conditions that are sufficiently similar to diagnoses in actual clinical practice.

Even though I have described the basic process of learning as “transfer”, I acknowledge that the notion of transfer has often been critiqued (e.g., Lave, 1988; Lobato, 2006; Packer, 2001). However, the type of transfer expected from role-playing in virtual worlds is near transfer, which is a lot less controversial than far transfer (Perkins & Salomon, 1992). In brief, far transfer involves transfer between very different contexts (e.g., learning football tactics by playing chess); near transfer involves transfer between very similar contexts. For example, there is a high enough
degree of correspondence between the learning performance of passing a football off a concrete wall and the target performance of passing a football during matches, hence near transfer from the former to the latter is very likely. I take near transfer to be an unproblematic and basic process of learning. I am referring to near transfer in my discussion about correspondence.

Transfer of learning requires high degree of correspondence

I will now formulate a general principle of correspondence. To maximise the likelihood of transfer of learning from the virtual learning context to the target physical world context, there needs to be a high degree of correspondence between performing an action $X$ in a virtual world ($X^{\text{VW}}$) and performing the action $X$ in the physical world ($X^{\text{PW}}$). The principle holds that:

$$\text{if doing } X^{\text{VW}} \text{ corresponds sufficiently to doing } X^{\text{PW}}, \text{ then people can learn to perform } X^{\text{PW}} \text{ by performing } X^{\text{VW}}.$$

Here is an example of when the principle of correspondence is satisfied. In the Otago Virtual Hospital, medical students have to practise the thinking process of differential diagnosis, which consists of mentally eliminating improbable diagnoses based on feedback from the patient and laboratory test results. Practising differential diagnosis in the virtual world corresponds sufficiently to doing it in the physical world: Roy, Walker, Blyth, and Wilkinson (2014) examined the construct validity of role-playing in the Otago Virtual Hospital and reported that the clinical reasoning (including differential diagnosis) required in such a role-play resembles clinical reasoning in the physical world. Therefore, students can learn differential diagnosis by doing it in a virtual world.

However, in many cases of learning in virtual worlds, the principle of correspondence is not fully satisfied because of the lack of
correspondence between the virtual world learning performance and the target performance in the physical world. The performance of a “physical” chest examination in the Otago Virtual Hospital offers one such example. This lack of correspondence is due to a “morphological disconnect” (de Castell et al., 2014, p. 338) between what students physically do and what their avatars do on the screen.

**Morphological disconnect results in lack of correspondence**

In desktop virtual worlds, there is often a disconnect between what students physically do and what their avatars do: when students press the appropriate buttons to run/jump/kick, their button presses are translated into the actions of running/jumping/kicking on the screen. De Castell et al. (2014) coined this translation a “morphological disconnect” (p. 338).

De Castell et al. (2014) articulated the difference between the user experiences in desktop virtual worlds and fully immersive virtual environments (e.g., CAVEs) very well. They described the desktop virtual world experience as *simulation* and the fully immersive virtual experience as *imitation*.

In desktop virtual worlds, students *simulate* physical world actions on a computer screen. When students press the appropriate buttons to run/jump/kick, their button presses are translated into the actions of an avatar running/jumping/kicking on the screen. These actions are simulated as if they were the actual physical world actions. In desktop virtual worlds where students simulate actions, there is considerable morphological disconnect between what students do physically and what their avatars do in the virtual world.

In contrast, in fully immersive virtual environments, students physically *imitate* physical world actions with their own bodies, given that students exercise the same physical movements as those used to perform the
physical world action. They undertake physical movements in the virtual environment that are just like the actual physical world action. In fully immersive virtual environments, there is less morphological disconnect between what students do physically and what their avatars do in the virtual world.

According to de Castell et al. (2014), the distinction between simulation and imitation has important implications for the transfer of learning to workplaces: “This distinction between as if [simulation] and just like [imitation] is... central to whether and how a [virtual world] can bridge the transfer-of-training gap between learning and application” (p. 347).

In desktop virtual worlds, the morphological disconnect between what students physically do and what their avatars do poses a problem for learning professional knowledge and skills because a lack of correspondence would decrease the likelihood of transfer of learning to the workplace. In turn, if the likelihood of transfer were low, then virtual worlds would serve as a poor bridge between classrooms and workplaces.

Therefore, where there is considerable morphological disconnect (e.g., the “physical” chest examination), it is currently unclear how and whether students can learn the desired physical world actions by performing virtual world actions. An explanation is needed so that educators are clearer about which learning outcomes virtual worlds can be best used for and which learning outcomes virtual worlds are not suitable for.

Granted, students are not expected to learn all aspects of professional knowledge and skills through virtual world role-plays. However, if students are tasked to examine a patient’s chest in the Otago Virtual Hospital (Loke et al., 2012a), it is implied that students are expected to learn something about chest examination through the virtual world role-play. Despite such an expectation, it is currently unclear how and
whether students learn this. The assumption is that educators would ask students to do a task only if they knew that students would learn something from doing the task.

The literature provides more examples where students are tasked to perform virtual world actions with considerable morphological disconnect. In Garrett’s (2012) study, trainees practise the correct procedures to evacuate from a virtual underground mine. In the course of the scenario, trainees are required to regulate their “physical” exertion (walking faster or slower) by pressing buttons on their keyboard. There is considerable morphological disconnect between walking faster or slower and pressing buttons. In Wilson et al.’s (2013) study, social work students conduct home visits in Second Life. In the course of engaging with the client during the virtual home visit, students are required to move to suitable “physical” locations in the virtual home, for example, seated on the couch beside the client or standing at the table by pressing the arrow keys. Again, there is considerable morphological disconnect between moving around the house and pressing buttons. In Dalgarno et al.’s (2016) study, pre-service teachers teach a lesson to a group of pupils in a virtual classroom. In the course of teaching, these pre-service teachers are expected to manage disruptive students by moving their teacher-avatar “physically” near the disruptive student.

In all the above examples, it seems implausible that students can learn to perform the physical world action (e.g., examining the patient’s chest, walking at a slower pace, moving near the disruptive student) via a virtual world role-play because of the lack of correspondence between doing $X_{VW}$ and doing $X_{PW}$. As argued earlier, the claims that students can undergo a physical embodied experience and can learn-by-doing in a straightforward manner are implausible. If it happened that students cannot learn these physical world actions by performing virtual world
actions, then virtual worlds should not be used to achieve these learning outcomes.

**A more plausible explanation**

Greater attention needs to be paid to developing a more plausible explanation of how students learn in virtual worlds. This is important for two reasons that I develop in subsequent paragraphs.

First, developing such an explanation can help educators determine what their students can learn from virtual world role-plays and subsequently align the virtual world role-play with the intended learning outcomes. Such an explanation can be drawn from learning theories (which will be elaborated in Chapter 3).

In this thesis, learning theories are taken to be a set of principles offered to explain how learning takes place (Schunk, 2004). Examples of learning theories used in educational technology research are behaviourism, cognitivism, constructivism, and social constructivism (Hung, 2001). Learning theories explain the mechanisms or processes underlying particular learning experiences (Mayes & de Freitas, 2004; Suppes, 1974). If educators knew which learning mechanisms apply to a particular learning experience, they would be better able to determine what their students can and cannot learn from that experience. I will illustrate the link between theoretical mechanisms and what students can learn using the example of Skinnerian teaching machines.

Skinnerian teaching machines are mechanical devices invented in 1957 that administered multi-choice questions at different difficulty levels according to the student’s level of understanding. The theoretical mechanism underpinning these teaching machines is operant conditioning (Skinner, 1965). According to operant conditioning, students can acquire particular behaviours based on the types of reinforcement they get.
Knowing this, theoretically informed educators would use teaching machines to develop their students’ ability to repeat transmitted information, but not to develop their ability to act creatively in new situations. If educators want their students to learn to act creatively in new situations and if learning to act creatively in new situations is an intended learning outcome, then they should teach using constructivist approaches (Piaget, 1970).

In the area of virtual worlds for education, if educators knew which learning mechanisms apply to virtual world role-plays, they would be better able to determine what their students can learn from the virtual world learning activity and subsequently align this activity with the intended learning outcomes. Learning is more likely to be effective if the learning outcomes and activity are aligned because of a higher consistency throughout (Biggs & Tang, 2007). Using a hypothetical example: if it happened that students can learn how to examine a human patient’s chest via a virtual world role-play (by pressing buttons), then it is reasonable for educators to use the virtual world role-play as a way for their students to learn the outcome of examining a patient’s chest. This is reasonable because there would be alignment between the intended learning outcome and the virtual world role-play. However, if it happened that students cannot learn how to examine a patient’s chest via a virtual world role-play, then educators cannot expect their students to achieve this learning outcome solely by participating in a virtual world role-play.

The second reason for developing an explanation of how students learn in virtual worlds is to clarify the widespread conception that virtual worlds offer students a “hands-on” (Farley, 2014, p. 326) learning experience. The type of hands-on learning offered by virtual worlds does not appear to be the same physical hands-on learning offered by practical courses. An example of such practical courses is the New Zealand Diploma in Cookery, which offers students a learning experience with “lots of hands-
on cooking” (Otago Polytechnic, 2017, para. 1) where they get regular opportunities to cook dishes in training kitchens. Such a physical hands-on learning experience is not what virtual worlds can offer because students learning in virtual worlds do not execute the same physical movements needed to complete the physical world action. Developing a more plausible explanation of how students learn in virtual worlds, one that does not assume a physical embodied experience, would clarify in what way the virtual world learning experience might be hands-on.

Developing such an explanation involves theorisation because learning theories explain the mechanisms or processes underlying particular learning experiences. There is a general lack of interest in theorisation in educational technology research. The majority of educational technology research tend to focus on investigating whether the educational use of a particular technology is effective without theorising how this happens (Oliver, 2013). In most educational technology research, “theory almost seems to be an afterthought” (Reeves, McKenney, and Herrington, 2011, p. 58).

This general lack of interest in theorisation is evident in research on virtual worlds for education. Savin-Baden et al. (2010) conducted a literature review of research work on virtual worlds and highlighted how most researchers do not explicitly explain how learning in virtual worlds might help their students achieve the intended outcomes. Another literature review of empirical studies on Second Life also revealed that most studies focus on practical and not theoretical issues (Wang & Burton, 2013). As such, there is currently no explicit theoretical rationale for using virtual worlds for education (Savin-Baden et al., 2010).

Not having an explicit theoretical rationale is not a problem per se. A problem arises when research work and teaching practice are underpinned by assumptions that are both tacit and questionable. This is
the case for the majority of educational technology research that is implicitly underpinned by the questionable view that technology in itself causes learning, when no such causal effects can be attributed to technology (Oliver, 2013). Similarly, most researchers investigating simulation-based learning assume that simulation in itself causes learning, when more robust theorisation is needed to establish how this learning might happen (Hopwood, Rooney, Boud, & Kelly, 2016). In Chapter 3, I will identify and examine such tacit and questionable assumptions in the current research on virtual worlds for education. Research on educational virtual worlds should be underpinned by an explicit and sound explanation of how virtual world learning takes place. I develop such an explanation in this thesis.

Systematic literature review

Before embarking on developing a theoretical explanation of learning in virtual worlds, I needed to identify all the theories that researchers currently use to explain how students learn professional knowledge and skills via virtual world role-plays. This information-gathering phase in Chapter 2 was necessary because having a list of all the theories allowed me to evaluate the corresponding theoretical explanations in Chapter 3 in order to specify what about learning in virtual worlds was adequately and inadequately explained. The aspect of learning that was inadequately explained was the aspect for which an alternative explanation was developed in Chapters 4 to 6.

These theories were identified by means of a systematic literature review (Bearman et al., 2012), which is a research approach that:

1. begins with a specific review question (e.g., what are all the theories that researchers currently use to underpin empirical studies on virtual worlds?);
2. identifies all relevant studies using transparent inclusion-exclusion criteria (e.g., empirical and not conceptual studies); and then
3. summarises the studies to provide insights into the review question.

In brief, I searched three databases for empirical studies on virtual worlds for education between 2008 and 2015, identified 109 relevant journals papers out of 719 papers, and found ten theories that underpin empirical work on virtual worlds for education. The systematic literature review is fully described in Chapter 2.

This information-gathering phase was a necessary pre-requisite to the next phase in developing an alternative explanation, which was carried out by means of a philosophical inquiry.

**Philosophical inquiry**

The development of an alternative explanation involved a critical evaluation of the explanations given by the theories found in terms of how applicable their learning mechanisms are to virtual worlds (Chapter 3). Once the aspect of learning that was inadequately explained was isolated, a more plausible explanation was developed by relating John Austin’s speech act theory to the performance of virtual world actions (Chapters 4 to 6).

This next phase in developing an alternative explanation was carried out by means of a philosophical inquiry (Burbules & Warnick, 2006; Golding, 2008). Broadly, I engaged in “complex thinking” (Golding, 2008, p. 194) in the form of reasoning, inquiry, and making judgements. Specifically, I undertook two moves that Burbules and Warnick (2006) call the “prototypical ‘moves’” (p. 501) of a philosophical inquiry:

1. clarify the meanings of terms; and
2. uncover hidden assumptions.

First, to clarify the meanings of terms, I analysed important terms in the research literature to show their multiple uses and meanings. This involved distinguishing the multiple meanings of a term. One such term that has multiple meanings is “immersed”. As illustrated above, after analysing the term, two distinct but different meanings are possible: being physically immersed; or being psychologically engrossed. The different meanings have different implications on how researchers think learning happens in virtual worlds.

This analysis is useful because problems are often caused when people use the same terms in different ways. Once again using the example of “immersed”: the conflation of the two meanings of “immersive” is undesirable because it can result in the implausible explanation that students learn physical world knowledge and skills in virtual worlds by virtue of being physically immersed in desktop virtual worlds, when they are visibly not physically immersed.

Once the multiple meanings of the term are clarified, certain ill-considered uses of the term can be rejected (e.g., “embodied” in the sense of being given a physical form in the virtual environment) and better uses of the term that apply to desktop virtual worlds can be recommended (e.g., being given a graphical form in the virtual environment). In the case of “embodied”, clarifying that students are not physically embodied in desktop virtual worlds made me realise that a more plausible explanation is needed that does not assume students’ physical embodiment in the virtual environment.

The second way to enact complex thinking involves the uncovering of hidden assumptions. One such example was the uncovering that Deweyan experiential learning theory (Dewey, 1938) assumes a physical experience that desktop virtual worlds cannot offer students. I will
outline the assumption here and provide more details in Chapters 3 and 4. In order for learning to happen, Dewey (1896) assumed that there was an embodied “sensori-motor coordination” (p. 358) between the learner and her immediate environment. This learner-environment transaction is said to yield the physical experiences that are needed for learning to happen. The problem is: even though Deweyan experiential learning theory hinges on the provision of such a physical experience (that desktop virtual worlds cannot provide), experiential learning theory remains the most frequently used theory to explain learning in virtual worlds (see Chapter 2).

This uncovering of assumptions is useful because it isolates assumptions that are implausible and questionable (e.g., the assumption that students gain a physical learning experience in virtual worlds is implausible). Knowing that the premise of Deweyan experiential learning is physical experience and that physical experience is not something that desktop virtual worlds can offer students made me realise that I needed to find a non-physical basis of learning by doing something in desktop virtual worlds. In Chapter 4, I develop a more plausible explanation whose basis is derived from social conventions, rather than from physical experience.

Primarily, a philosophical inquiry is suitable for this thesis because the problems that I am trying to resolve are philosophical in nature. Golding (2008) stated that “[philosophical] problems occur not because of the lack of knowledge, but because of an inability to make sense of something or to see how our ideas can hang together and make sense” (p. 195). In this thesis, the general problem concerns the idea that students can learn physical world actions (e.g., examine a human patient’s chest) by physically doing something different in virtual worlds (i.e., pressing buttons). As elaborated above, this idea does not make intuitive sense because of the morphological disconnect between the two actions. If two actions are not performed with the same physical movements, how might
they count as the same action? Fundamentally, to bring about the learning of physical world skills, virtual world actions and physical world actions need to correspond in terms of being the same action in some way.

The problem of establishing how a particular virtual world action and its physical world equivalent might count as the same action despite morphological disconnect is philosophical in nature because it cannot be answered by gathering empirical facts. Two empirical studies have been conducted on the Otago Virtual Hospital to determine how the virtual world role-play might be similar to professional practice, but they still do not provide answers as to how the two actions might count as the same action despite morphological disconnect. This is to be expected because empirical questions on their own are not meant to provide answers to theoretical issues.

In a study undertaken by Roy, Walker, Blyth, and Wilkinson (2014), three groups of 12 people of differing medical experience (Year 3 medical students, Year 5 medical students, and qualified doctors) participated in a virtual world role-play. The qualified doctors performed significantly better than the student groups in various aspects of clinical reasoning (e.g., making accurate and full diagnoses, constructing a safe patient management plan). The study hence concluded that the clinical reasoning required in such a virtual world role-play is similar in nature to that required in professional practice. However, gathering more empirical data about students’ in-world performance will not explain how a particular virtual world action and its physical world equivalent might count as the same action despite morphological disconnect.

In another study undertaken by Loke et al. (2012b), 11 medical students who participated in a virtual world role-play were interviewed regarding how the virtual world learning experience might be useful for developing their professional practice. The students expressed that the virtual world
role-play allowed them to do three things that were particularly useful for their professional practice. They made clinical decisions that affected the virtual patient, adapted the generic patient care framework to the situation at hand, and provided medical care to the patient throughout the whole process (from the time the doctor first meets the patient until the time the doctor admits or discharges the patient). This empirical study helped to identify the broad areas where the virtual world learning experience is similar to professional practice. However, gathering more data by interviewing students about their learning experience will not explain how a particular virtual world action and its physical world equivalent might count as the same action despite morphological disconnect. Developing this explanation requires complex thinking, not gathering data.

Instead of undertaking another empirical study, I resolved this philosophical problem by relating John Austin’s speech act theory to the performance of virtual world actions. Based on speech act theory, I show that virtual world actions can correspond with physical world actions in terms of filling the same performative function when certain conditions are met. A particular virtual world action and its physical world equivalent can then count as the same action despite morphological disconnect.

By clarifying the meanings of key terms, uncovering the assumptions of current theories, and relating another theory to virtual world actions, I develop a more plausible explanation that “transform[ed] a problematic situation into a unified or meaningful whole” (Golding, 2008). This new explanation is more plausible because it does not assume that students gain a physical learning experience in virtual worlds. Instead, this explanation is premised on social conventions that are observable in everyday life (Austin, 1962) and can be integrated with Deweyan
experiential learning into a unified whole (Loke & Golding, 2016) (see Chapter 5).

I develop this new explanation over the course of my thesis. I will now describe the structure of this thesis.

Structure of thesis

This thesis is divided into two main parts. Current explanations of learning in virtual worlds are described and examined in Part 1 (Chapters 2 and 3). A more plausible explanation is developed in Part 2 (Chapters 4, 5, and 6).

In this chapter (Chapter 1), I described the morphological disconnect between the virtual world and physical world experiences and explained how this disconnect poses a problem for explaining how students might learn professional knowledge and skills via virtual worlds role-plays. Using selective examples from the literature, I also illustrated how, despite this morphological disconnect, some researchers in the area of virtual worlds for education (including myself in previous work) explain learning in virtual worlds using implausible claims that the virtual world learning performance corresponds physically with the physical world target performance. A more plausible explanation is hence needed.

The selective nature of the examples in Chapter 1 provides an incomplete picture of how researchers currently explain how learning takes place in virtual worlds. A more comprehensive description is needed of all the ways researchers explain this learning.

In Chapter 2, to identify all plausible mechanisms that explain learning in virtual worlds, I describe a systematic literature review of theories used to underpin empirical studies on virtual worlds for education. Ten theories were found that underpin empirical work on virtual worlds for
education. These theories are (in decreasing order of frequency): experiential learning theory; situated learning theory; social constructivism; constructivism; presence theory; flow theory; projective identity model; self-efficacy theory; community of inquiry framework; and transactional distance theory.

In Chapter 3, the explanations given by the theories found are critically evaluated in terms of how applicable their learning mechanisms are to virtual worlds. As explained in Chapter 1, if educators knew which theoretical explanations are applicable to virtual worlds and which are not, they will have a better understanding of what their students can and cannot learn via desktop virtual world role-plays.

Following this evaluation, I conclude in Chapter 3 that current theoretical explanations adequately explain how students learn two things via virtual world role-plays: verbal interactions and thinking processes. However, they inadequately explain how getting students to perform particular virtual world actions (e.g., clicking the Examine Chest button) might help students to learn the physical world equivalent (e.g., physically examine a human patient’s chest).

An alternative and more plausible explanation is needed to explain how performing such virtual world actions might bring about the learning of professional knowledge and skills. To be more plausible, this alternative explanation should not assume that students undergo a physical sensorimotor experience of the physical world action in the virtual world. This alternative explanation is developed in Chapters 4 to 6.

In Chapter 4, I relate Austin’s (1962) speech act theory to the performance of virtual world actions in order to explain how performing virtual world actions might correspond with the physical world equivalent. This correspondence is necessary because, as explained in Chapter 1, to maximise the transfer of learning from the virtual learning
context to the target physical world context, a high degree of correspondence is needed between the learning performance and target performance.

Based on speech act theory, when the conditions for successfully executing performatives are met, virtual world actions correspond with physical world actions in terms of filling the same performative function. The two actions then mean the same action. Therefore, when students do $X^{\text{VW}}$, they get to do $X^{\text{PW}}$ semantically (not physically) in the sense that they get to act with meaning.

However, “acting with meaning” is not a commonly-used expression and it may be difficult to visualise what acting with meaning involves. I will hence provide an empirical illustration of acting with meaning in Chapter 6.

It was previously unclear how getting students to perform virtual world actions might help them learn the physical world equivalent. Based on this alternative explanation, getting the opportunity to do $X^{\text{PW}}$ semantically in a virtual world helps students learn $X^{\text{PW}}$. Thus, the basis of learning by doing something in desktop virtual worlds is better explained as deriving from social conventions, rather than from physical experience.

In Chapter 5, I reply to Austin’s (1962) potential objection to my claim that virtual world actions performed in the context of make-believe virtual role-plays can function as performatives. Austin stated that, if performed in the context of theatre, all performatives are ineffective. They are ineffective because they are hollow and void (these terms will be explained in Chapter 5). If virtual world role-plays are like theatrical performances (e.g., in the sense that medical students are pretending to be doctors and their virtual world actions have no material effect on the physical world), and if all theatrical performatives are ineffective, then
all virtual world actions are also ineffective and cannot function as performatives. In turn, if virtual world actions cannot function as performatives, then there is insufficient correspondence between the learning performance and target performance. With insufficient correspondence, it remains unclear how role-playing in virtual worlds might bring about the learning of physical world actions.

In Chapter 5, I build an argument that virtual world actions are only partially void and hollow, and that virtual world actions are sufficiently real for some physical world learning to take place. I conclude that virtual world actions can therefore function effectively as performatives, even though they are make-believe to a certain degree.

In Chapter 6, I clarify the meaning of “acting with meaning” (an expression first coined in Chapter 4) in the context of Perkins et al.'s (1993) dispositional theory of thinking. I show how dispositions are necessary for professional practices, and how acting with meaning constitutes performing the dispositional components of intelligent behaviour. After this, I show how virtual worlds offer students opportunities to demonstrate these dispositional components that correspond sufficiently with that in the physical world, and conclude that students can learn these dispositional components via virtual world role-plays.

In Chapter 7, I present the overall conclusions and recommendations from my thesis. This includes a summary of what students can and cannot learn via desktop virtual world role-plays as well as corresponding recommendations about designing virtual worlds for learning.
Part 1: Current explanations of learning in virtual worlds
Chapter 2: Theories underpinning studies about virtual worlds

Introduction

In the previous chapter, I presented the problem of morphological disconnect between the virtual world and physical world experiences. Using selective examples from the literature, I illustrated how, despite this morphological disconnect, some researchers in the area of virtual worlds for education (including myself in previous work) explain learning in virtual worlds using implausible claims that the virtual world learning performance corresponds physically with the physical world target performance.

The selective nature of the examples in Chapter 1 provided an incomplete picture of how researchers currently explain how learning takes place in virtual worlds. A more comprehensive description is needed of all the ways researchers explain this learning.

To identify all plausible mechanisms that explain learning in virtual worlds, I describe in this chapter (Chapter 2) a systematic literature review of theories that have been used to underpin empirical studies on virtual worlds for education. This chapter comprises a justification of the systematic literature review, a description of the method, and a report of the findings.

Purpose of systematic literature review

The main purpose of this systematic literature review is to find out which theories are used to explain how virtual world experiences might bring about the learning of physical world knowledge and skills. Knowing what
these theories are will provide a more comprehensive description of how researchers currently explain learning in virtual worlds.

My literature review differs from previous literature reviews on virtual worlds for education in several ways. First, this literature review aims to identify the current theories used to underpin educational virtual worlds, while most others sought to identify the current educational uses of virtual worlds (de Freitas, 2008; Hew & Cheung, 2010; Kim, Lee, & Thomas, 2012). For example: de Freitas (2008) found out that virtual worlds are used for role-plays, socialisation, and training; Hew and Cheung (2010) that virtual worlds are used as communication spaces, simulations of space, and experiential spaces. I am less interested in the variety of uses of virtual worlds for education, and more interested in the variety of ways educators explain how learning takes place in virtual worlds.

Four other literature reviews are similar to my review in that they also sought to identify learning theories used to design educational virtual worlds. All four reported the predominance of experiential learning, social constructivist, and constructivist theories (Dass, Dabbagh, & Clark, 2011; Mikropoulos & Natsis, 2011; Savin-Baden et al., 2010; Wang & Burton, 2013).

However, they are different from this review in three ways. Firstly, Savin-Baden et al.’s (2010) review was not a systematic literature review and hence did not use all available articles. Secondly, two of the reviews are different in scope. Wang and Burton (2013) limited their search to publications on Second Life and excluded other similar virtual worlds such as Active Worlds, River City, and Quest Atlantis (included in my review). The review by Mikropoulos and Natsis (2011) was broader and included other virtual reality applications such as head-mounted displays and haptic systems. Such virtual reality applications are excluded in my
review because such sophisticated technologies are currently not readily available to most educators and students.

Thirdly and most importantly, none of the four reviews focussed on how well the theories explain virtual world learning. In Chapter 3 of this thesis, I will build on the findings from my review in Chapter 2 and examine how well the theories identified explain virtual world learning. Other reviews do not do this. Instead, Dass et al. (2011) and Mikropoulos and Natsis (2011) focussed inversely on how well the affordances of virtual worlds support the kinds of learning prescribed by theory-informed instructional design. For example, given that virtual worlds allow multiple users to converse with each other, Dass et al. (2011) and Mikropoulos and Natsis (2011) focussed on how well virtual world group discussions might support social constructivist instructional designs.

Method

This systematic literature review was conducted at two junctures. In 2013, I carried out a systematic literature review of journal papers published from 2008 to 2012. The results were published in the Australasian Journal of Educational Technology (Loke, 2015). Then in 2016, to keep this thesis current, I extended the systematic literature review by including journal papers published from 2013 to 2015. It is notable that this extension of the literature review did not yield any new theories beyond those reported in Loke (2015).

At both junctures, three databases were searched using “virtual world*” and “education (subject)” as keywords. I limited results to:

- papers from 2008 to 2015 (eight years seemed a reasonable scope to answer my research question, especially given Wang and Burton’s (2013) finding that empirical work on virtual worlds became prevalent only from 2008);
- peer-reviewed conference proceedings and journal papers (to maximise quality); and
- papers written in English.

The search yielded 295 papers from ERIC Proquest, 416 from Academic Search Complete, and 101 from PsycINFO, or a total of 719 distinct journal papers (taking overlaps of papers into account). The choice of these databases was appropriate because of their subject specialisation: ERIC Proquest is a database specialising in educational research; PsycINFO specialises in research in psychology and the behavioural sciences. These databases also include the ten top-ranking educational technology journals according to citation-based bibliometrics (Atkinson, 2012). All three databases are widely used in the educational technology field. Other researchers in the field frequently use these databases for their literature reviews (e.g., Hew & Cheung, 2010; Wang & Burton, 2013).

All 719 abstracts were read to select relevant papers according to the criteria given in the next paragraph. When the abstracts did not provide enough information for me to make a selection (which was the case about 30% of the time), I read the papers in full. A total of 109 relevant papers were selected. These 109 papers came from a wide range of sources, being published in 68 different journals (see Appendix A for list of journals).

Journal papers were judged to be relevant based on the following five criteria:

1. The research work involved virtual worlds defined as computer-based, multi-user virtual environments that simulate events in the physical world, and in which students perform actions via an avatar controlled using keyboards and mice. As elaborated in Chapter 1, such desktop virtual worlds are the focus of this thesis. Discarded papers included research work involving mixed reality applications
where physical and digital objects interact in real-time (e.g., Mateu, Lasala, & Alamán, 2015), motion-sensing laparoscopic simulators (e.g., Sumitani et al., 2013), commercial video games situated in fantasy worlds (e.g., Voulgari, Komis, & Sampson, 2014; Zhao & Linaza, 2015), and mobile phone games (e.g., Lemcke, Haedge, Zender, & Lucke, 2015).

2. The papers reported empirical research work, not conceptual work. Discarded conceptual work included papers speculating about the educational potential of virtual worlds (e.g., Ferguson, Davidson, Scott, Jackson, & Hickman, 2015), meta-analyses (e.g., Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), and literature reviews (e.g., Nussli & Oh, 2014). For my systematic literature review, I selected empirical studies because the authors of empirical research work are able to articulate the specific theory underpinning the learning process in their virtual world and give concrete examples of how specific theoretical ideas were put into practice. Both the articulation of the theory used and concrete examples will provide insights into the process of learning to do X\textsuperscript{PW} by doing X\textsuperscript{VW}, which is the main learning process I am examining in this thesis. One example of such an empirical study is Mathews, Andrews, and Luck (2012). Mathews et al. (2012) stated explicitly that their Second Life project was underpinned by experiential learning theory. They then went on to give concrete examples of how their students learnt by engaging in both a primary learning experience (students’ firsthand experience of role-playing in Second Life) and a secondary learning experience (students’ reflection on their firsthand experience). Primary and secondary learning experiences are key ideas in experiential learning theory that Mathews et al. (2012) exemplified in their project. Only empirical studies can provide such information and examples.
3. The research work involved virtual worlds that were used to support student learning. The process of student learning is the main concern of this thesis. Other empirical studies were located that had other foci besides the process of learning and these studies were hence excluded. Discarded papers included surveys of teachers’ acceptance of virtual worlds for teaching (e.g., Tseng, Tsai, & Chao, 2013), narrative accounts of teachers’ own lived experiences using virtual worlds for research purposes (e.g., Fitzsimons, 2013), and papers documenting the development of new technologies such as virtual agents within virtual worlds (e.g., Mascarenhas, Dias, Prada, & Paiva, 2010).

4. The virtual worlds in the papers were used for the learning of mainstream curricular goals (e.g., clinical reasoning in the medical curriculum, energy conservation in the engineering curriculum, patient assessment in the social work curriculum). As elaborated in Chapter 1, my main concern is the training of professionals-to-be such as doctors, teachers, and social workers, and how they achieve curricular goals by role-playing in virtual worlds. Other empirical studies were located that focussed on non-curricular goals and these studies were hence excluded. Discarded papers included empirical work in which virtual worlds were used to develop young people’s life transition skills such as self-confidence and empathy (e.g., Devlin, Lally, Sclater, & Parussel, 2015), to help students to quit smoking (e.g., Woodruff, Conway, & Edwards, 2008), and in which researchers sought to understand virtual world users’ generic visual-motor skills and navigational abilities (e.g., Walkowiak, Foulsham, & Eardley, 2015; Welch & Sampanes, 2008).

5. The virtual world learning process involved learners learning to do $X^{PW}$ by doing $X^{VW}$, which is the main learning process I am examining in this thesis. There were other empirical studies that focussed on other learning processes and these studies were hence
excluded. Discarded papers included empirical work where students were learning in virtual worlds by listening to lectures (e.g., Okutsu, DeLaurentis, Brophy, & Lambert, 2013; Prude, 2013), by visualising phenomena such as fluid flow and human anatomical structures (e.g., Djukic, Mandic, & Filipovic, 2013; Liu et al., 2013), and where computer science students were learning to program parts of a virtual world by “directly” programming parts of the virtual world (e.g., Girvan, Tangney, & Savage, 2013; Pellas & Kazanidis, 2015). In the latter case, I use the word “directly” because no transfer of learning to a physical world context was expected. The computer science students were doing in the virtual world exactly what they were expected to do upon graduation (i.e., $X^{VW}$ was identical to $X^{PW}$).

The unit of analysis was the individual paper. As each relevant paper was read, the following information was recorded in a summary table: first author; paper’s title; year of publication; journal’s name; and underpinning theory/ies (see Appendix B for the full list of papers and their corresponding theories).

To qualify as the underpinning theory, the theories had to be explicitly stated as underpinning the virtual world learning activity, for example:

- “The educational strategy [of this virtual world] is based on constructivist learning theory and experiential learning principles” (Cook, 2012, p. 521; emphasis added);
- “our research [was] guided by an experiential learning pedagogy” (Mathews, Andrews, & Luck, 2012, p. 21; emphasis added);
- “Similar to River City and Quest Atlantis, [Second Life, the platform used in this project] provides a potentially optimal environment for situated learning by having students work on authentic problems in
simulated real-world contexts” (Mayrath, Traphagan, Heikes, & Trivedi, 2011, p. 127; emphasis added); and

- “We incorporated the action-reflection-response strategy... into culture learning, which represents an experiential approach to culture learning” (Shih, 2015, p. 414; emphasis added).

Where there was ambiguity about the theories used (e.g., when authors stated that students were engaged in “active learning” or “hands-on learning” with no further precision), it was coded that no explicit theory was used.

Nine of the theories found are variations of more foundational theories. For example, problem-based learning is a variation of the more foundational experiential learning theory, in the sense that problem-based learning is an instructional approach that is derived from or based on Deweyan experiential learning theory (Hmelo-Silver, 2004). To further summarise the data, the following nine theories were coded as the more foundational learning theory they are derived from. These nine theories were each only used in one paper.

1. Problem-based learning is derived from experiential learning theory according to Hmelo-Silver (2004) and was coded as such.
2. Computer-supported collaborative learning is derived from social constructivism according to Stahl, Koschmann, and Suthers (2006) and was coded as such.
3. Salmon’s five-stage model of e-tivities is derived from social constructivism according to Salmon (2007) and was coded as such.
4. Deutschmann and Panichi’s (2009a) task design framework is derived from social constructivism according to Deutschmann and Panichi (2009) and was coded as such.
5. Distributed cognition is derived from situated learning theory according to Greeno (2006) and was coded as such.
6. Activity theory is derived from situated learning theory according to Greeno (2006) and was coded as such.
7. Ecological psychology is derived from situated learning theory according to Greeno (2006) and was coded as such.
8. Barab, Gresalfi, and Ingram-Goble’s (2010) theory of transformational play is derived from experiential learning theory and the projective identity model according to Barab et al. (2010) and was coded as such.
9. Pedler’s (2007) action learning process is derived from experiential learning theory according to Pedler (2007) and was coded as such.

It is acknowledged that some of the above examples may be more accurately classified as learning approaches instead of theories. Given the aim to identify all plausible mechanisms that explain learning in virtual worlds, I opted to be more inclusive in what constitutes a “theory” at this stage so as not to exclude potential explanations. For the purpose of this thesis, I term any account of the mechanism by which learning occurs to be a learning theory.

The findings from the systematic literature review will be reported in the next section.

Findings

Ten theories were used in the 109 relevant papers. Of the relevant papers, 34 were not explicitly underpinned by any theory. Of the 75 remaining papers, 125 explicit statements about the theories used were located. There were more statements of theories used (125) than there were papers (75) because some papers were underpinned by more than one theory. From the 125 explicit statements, 10 different theories that underpin virtual worlds for education were identified (see Figure 4 for
the distribution of theories and Appendix B for the full list of papers and their corresponding theories).

**Figure 4. Distribution of theories underpinning empirical work in virtual worlds for education**

These findings concur with four previous literature reviews that also reported the predominance of experiential learning, social constructivist, and constructivist theories in virtual worlds-related work (Dass et al., 2011; Mikropoulos & Natsis, 2011; Savin-Baden et al., 2010; Wang & Burton, 2013). This review contributes to the literature by revealing a fuller range of theories: experiential learning theory; situated learning theory; social constructivism; constructivism; presence theory; flow theory; projective identity model; self-efficacy theory; community of inquiry framework; and transactional distance theory. Notably, it reveals the relatively frequent use of presence theory, a theory that is absent from previous literature reviews.

This review also reveals the distribution of theories underpinning empirical work in virtual worlds for education. Compared to other theories, four learning theories were used much more frequently:
experiential learning theory; situated learning theory; social constructivism; and constructivism. These four learning theories are so important that they were the only theories found in the papers published in 2013-2015, with the exception of one paper which used self-efficacy theory. Previous literature reviews did not indicate the distribution of theories and their relative importance.

Knowing which theories were not used is as informative as knowing which were used. Hung (2001) identified four major learning theories used to guide educational technology integration: behaviourism, cognitivism, constructivism, and social constructivism. My review reveals that cognitivism and behaviourism were not used in the literature to underpin virtual worlds for education. I will briefly describe cognitivism and behaviourism before speculating on why they were not used in the literature (the theories that were used in the literature will be described in detail in Chapter 3).

Cognitivism is a learning theory that focusses on mental processes that help people learn and remember (Roblyer, 2006). Such processes include how people receive information through sensory receptors (e.g., seeing the amber traffic light) and retrieve previously stored mental representations for use in reasoning tasks (e.g., remembering that the amber traffic light means to slow down) (Hung, 2001). Cognitivism holds that learning happens when learners change the way information is represented in their mind (Friesen & Feenberg, 2007). For example, after reading a guide on New Zealand road code, I learn something when I change the way I represent speed limit road signs: from being the point at which I should reach the speed limit, to being the point from which I can start accelerating towards the speed limit.

Using cognitivism as a theoretical lens, the role of teachers is hence to support the effective processing, representation, and manipulation of
information by the students’ brain (Friesen & Feenberg, 2007). One example in supporting effective information processing is to divide an instructional video into smaller chunks so as not to overload students’ working memory (Clark, 2008).

I speculate that cognitivism was not used in the literature on virtual worlds for education because the cognitivist emphasis on “inner” mental representations and mental processes is very different in nature from the emphasis in virtual role-plays on the “public” performance of actions. Cognitivism would therefore provide a poor explanation of how students learn by taking actions during the course of virtual scenarios.

Behaviourism is a learning theory based on Skinner’s stimulus and response model (Hung, 2001). It holds that people learn target behaviours by being conditioned to respond in a certain way based on a certain stimulus (Roblyer, 2006). One example of such a behavioural response is how car drivers might slow down (response) when they see the amber traffic light (stimulus). It is believed that such a behavioural response is conditioned by positive reinforcement (e.g., a pedestrian thanking the driver for slowing down) as well as negative reinforcement (e.g., a $150 fine for running a red light).

Using behaviourism as a theoretical lens, the role of teachers is hence to deploy a series of reinforcements to shape desired behaviours (e.g., gold stars for listening quietly, punishments for interrupting the lesson). This learning theory is deterministic in the sense that students are expected to produce the same response (e.g., listen quietly) every time they are exposed to the same sort of situation where they had previously received reinforcement (e.g., a gold star).

I speculate that behaviourism was not used in the literature on virtual worlds for education because this theory has generally fallen out of favour among educational researchers for likening human beings to
animals: “Skinnerians extend Descartes’ theory of animal nature to human nature: people, like animals, are conceived to be predictable physical mechanisms” (Kukla & Walmsley, 2006, p. 5). Conceiving human beings as predictable physical mechanisms who are passively conditioned by environmental stimuli, Skinnerians are unable to account for many kinds of human behaviours that educational researchers value. Notably, behaviourism is unable to explain how students can develop their capacity to act creatively in new situations (Kukla & Walmsley, 2006).

Behaviourism was not used in virtual worlds-related work even though this theory is highly relevant to some virtual worlds, particularly when video gaming aspects are incorporated. For example, Dib and Adamo-Villani (2014) designed a game-like virtual world in which engineering students can develop their understanding of building sustainability practices by role-playing as consultants who are tasked to help constructors improve their buildings’ performance in terms of energy conservation and water efficiency. Dib and Adamo-Villani incorporated video game design features such as having multiple levels with increasing difficulty and a rewards system associated with level advancement.

The rewards system works in the following way: students get rewarded by being able to “level up” (from working on residential homes, to schools, and then to more complex healthcare buildings) when they successfully perform a number of pre-determined tasks. Such tasks include changing building fixtures to low water consumption ones or recycling water when water consumption in the building is too high.

Although Dib and Adamo-Villani (2014) stated that their virtual world was underpinned by constructivism and experiential learning theory, it is clear that their virtual world’s rewards system was designed based on behaviourism. Using the lens of Skinnerian operant conditioning (Skinner, 1965), the reward to level up can be conceived as a
reinforcement to condition students to perform particular tasks related to building sustainability, based on the behaviourist model of stimulus – response – reinforcement. In this case, the stimulus can be the high water consumption, the response the recycling of water, and the reinforcement the leveling up. Granted, the reward to level up also depends on other factors, but the tasks of changing fixtures and recycling water directly contributed to levelling up every time water consumption was too high in this virtual world.

A parallel can be drawn with online role-playing games that are underpinned by behaviourism. Yee (2014) studied massively multiplayer online role-playing games (MMORPG) such as Everquest and stated that the way the game’s rewards system shapes gamers’ behaviour is best explained by Skinnerian operant conditioning. When gamers kill a pre-determined number of monsters, for example, they get to advance from a Level 1 game character to a more powerful Level 2 game character. Being able to level up their game characters serves as a reinforcement to condition gamers to kill monsters, based similarly on the behaviourist model of stimulus - response - reinforcement. In this case, the stimulus can be the appearance of monsters, the response the killing of 15 monsters, and the reinforcement the leveling up.

Therefore, for virtual worlds that incorporate video game features such as levelling up, I contend that behaviourism provides a suitable theoretical lens and should be used to explain some aspects of learning in these virtual worlds.

Another finding from this systematic literature review is that no explicit theory was used in 34 papers (27%), supporting observations that many educators only use implicit theory or do not use theory at all when designing teaching innovations in virtual worlds (Savin-Baden et al., 2010). In the related field of game-based learning (including virtual game
worlds), a meta-analysis showed that an overwhelming 86% of studies published between 1971 and 2009 were not explicitly underpinned by any learning theory (Wu, Hsiao, Wu, Lin, & Huang, 2012).

Conclusion

To provide a more comprehensive description of how educators currently explain learning in virtual worlds, a systematic literature review was conducted to identify the learning theories used to underpin empirical studies on virtual worlds for education. Ten theories were found that underpin empirical work on virtual worlds for education from 2008 to 2015. These theories are (in decreasing order of frequency): experiential learning theory; situated learning theory; social constructivism; constructivism; presence theory; flow theory; projective identity model; self-efficacy theory; community of inquiry framework; and transactional distance theory.

In the next chapter, I will critically evaluate the explanations given by these theories regarding how applicable their learning mechanisms are to virtual worlds.
Chapter 3: Explanations applicable to virtual worlds

Introduction

In the previous chapter, I described a systematic literature review from which I identified ten theories that underpin virtual worlds-related work. In this chapter, I will critically evaluate the explanations given by the theories found in terms of how applicable their learning mechanisms are to virtual worlds. As elaborated in Chapter 1, if educators knew which learning mechanisms are applicable to virtual worlds, they will have a better understanding of what their students can and cannot learn via virtual world role-plays.

I will critically evaluate these theoretical explanations in the three groups shown in Table 2. The first group consists of transactional distance theory and the community of inquiry framework. They are useful in analysing particular learning experiences, but do not attempt to explain how students might learn to do $X^{PW}$ by doing $X^{VW}$.

The second group consists of five learning theories that do attempt to explain how students might learn to do $X^{PW}$ by doing $X^{VW}$. They are: experiential learning theory; situated learning theory; constructivism; social constructivism; and self-efficacy theory. The explanations given by these five learning theories explain that, when students do $X^{VW}$, students get the opportunity to: apply physical world thinking processes; interact verbally as they would in the physical world; reflect on their performance; and vicariously observe their peers perform a certain task.

However, the explanations given by these five theories implausibly imply that, when students do $X^{VW}$, students gain the sensorimotor experience of doing $X^{PW}$. On their own, these explanations do not adequately explain
how students might undergo such a physical sensorimotor experience in virtual worlds. Other theories explain this and will be evaluated in the third part of this critical evaluation.

The third group of theories consists of theories that have been expressly developed to explain the correspondence between virtual and physical world experiences. These three theories are the projective identity model, flow theory, and presence theory.

Table 2 summarises how I divided the theories into three groups for this critical evaluation.

Table 2. Rationale for grouping theories

<table>
<thead>
<tr>
<th>Theories</th>
<th>Rationale for grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transactional distance, community of inquiry</td>
<td>These are theories that analyse particular learning activities, but do not explain underlying learning processes.</td>
</tr>
<tr>
<td>Experiential learning, situated learning, constructivism, social constructivism, self-efficacy</td>
<td>These are learning theories that attempt to explain learning processes and commonly imply that students gain the sensorimotor experience of doing $X_{PW}$ when they perform $X_{VW}$.</td>
</tr>
<tr>
<td>Projective identity, flow, presence</td>
<td>These are theories that explain the potential correspondence between virtual and physical world experiences.</td>
</tr>
</tbody>
</table>
I will now evaluate the first group of theories: transactional distance theory and the community of inquiry framework.

Transactional distance theory and community of inquiry

I will describe transactional distance theory and the community of inquiry framework before evaluating their applicability to this study.

Moore’s (1993) transactional distance theory aims mainly to analyse distance learning activities in order to compensate for the physical separation between teachers and students in distance education. Moore (1993) contends that this physical separation widens the psychological and communication space between teachers and students. He states that this space needs to be crossed in order for learning to happen because the widening of this space leads to more “potential misunderstanding between the [communicational] inputs of instructor and those of the learner” (p. 22).

Here is an example of how communication in distance education is more likely to result in misunderstandings compared to face-to-face classes: given that teachers and students do not share the same physical context in distance education, participants in distance education who are communicating via discussion boards are more likely to misunderstand commonly-used words such as “me”, “there”, and “tomorrow”. These are words whose meanings crucially depend on additional contextual information such as the place where and the time when the discussion post was made. This psychological and communications space constitutes the transactional distance that teachers need to reduce in order establish clearer communication with their students.
A key strategy to reduce transactional distance is to increase the level of dialogue between teachers and students (Moore & Kearsley, 2012). A distance learning course based solely on students watching recorded lectures has a high degree of transactional distance because students do not get any opportunity to clarify their understanding of the recorded lectures with each other. To lower the course’s transactional distance, the teacher can integrate online discussion boards where teachers and students engage in dialogic conversations around the topic of the lecture, where each party builds on the other party’s contribution to the discussion.

Thus the role of transactional distance theory lies in analysing a particular learning activity in order to determine its degree of transactional distance. Following the analysis, recommendations can be made to reduce this transactional distance and in turn to improve the clarity of communication between teachers and students.

Similarly to Moore’s (1993) transactional distance theory, Garrison, Anderson, and Archer's (1999) community of inquiry framework aims mainly to analyse distance learning activities in order to achieve effective higher educational experiences (e.g., critical thinking, higher-order thinking, social constructivist meaning making). This framework proposes that effective higher educational experiences contain three prerequisite elements: cognitive presence, social presence, and teaching presence. I will now describe the three prerequisite elements.

Cognitive presence refers to the degree to which students are able to construct meaning through dialogue and arrive at a shared understanding. Indicators of cognitive presence in a particular learning activity include information exchange between students and their connecting ideas together. Social presence refers to the degree to which students are able to identify with their classmates and to express their
individual personalities within the class. Indicators of social presence include students’ expressing their emotions safely in a trusting environment. Teaching presence refers to the design and direction of cognitive processes to achieve meaningful learning outcomes (e.g., critical thinking). Indicators of teaching presence include teachers initiating discussions and keeping discussions on topic.

According to the community of inquiry framework, the degree of each of these presences in a particular learning activity will determine the degree of effectiveness of the learning experience. If the learning activity features a high degree of all the three presences, then it is likely to be effective. However, if an online discussion features a low degree of social presence for example, then students will be less willing to express their personal views openly and the online discussion will less likely be effective. One way to raise the degree of social presence is to establish ground rules for the online discussion that respect a diversity of views, so that distance students feel safe in expressing themselves without fear of punishment (Palloff & Pratt, 2007).

Thus, as with transactional distance theory, the role of the community of inquiry framework lies in analysing a particular learning activity in order to determine to what degree cognitive presence, social presence, and teaching presence are present. Following the analysis, recommendations can be made to increase the presence and in turn to achieve a more effective higher educational experience.

Transactional distance theory and the community of inquiry framework are inapplicable to this study because they do not explain how students might learn to do X by doing Y, even though they do analyse particular learning experiences. I acknowledge that researchers might not have been explaining how learning takes place when they underpinned their work with theories. My evaluation of transactional distance theory
and the community of inquiry framework is an effort to identify all plausible mechanisms that explain learning in virtual worlds, not a critique of any particular theory.

In the next section, I will evaluate a second group of theories that do attempt to explain how students might learn to do \( X^{pw} \) by doing \( X^{vw} \): experiential learning theory; situated learning theory; constructivism; social constructivism; and self-efficacy theory.

**Experiential learning**

The majority of authors who underpinned their work with experiential learning theory cited Dewey (1938) and Kolb (1984). Kolb drew extensively from Dewey’s work and hence Deweyan experiential learning theory will be the focus here.

I will start by describing the learning practices that experiential learning theory critiqued. This is because most learning theories are more easily explained when contrasted with the learning theories and practices they are opposed to or different from.

In *Experience and Education*, Dewey (1938) critiqued the transmission model of teaching where teachers delivered a static set of information and skills to students and where the static set of information and skills was considered the ultimate goal of education (instead of the means to problem-solving and inquiry tasks). He judged that the transmission model would stunt students’ abilities to act creatively in new situations and that such a learning experience would hence be “mis-educative” (p. 13).

Dewey proposed instead that learning experiences should emphasise students’ personal lived experiences. When students make meaning of their personal lived experiences, it was believed that they can then make
meaning of future experiences and tackle new problems in new situations. Dewey (1916) highlighted the importance of this meaning-making phase, without which mere activity would not be meaningful:

> Mere activity does not constitute experience. (...) Experience as trying involves change, but change is meaningless transition unless it is consciously connected with the return wave of consequences which flow from it. When an activity is continued into the undergoing of consequences, when the change made by action is reflected back into a change made in us, the mere flux is loaded with significance. We learn something. (p. 139)

The connection between an activity and its consequences is made when students deliberately reflect on their personal lived experience. By linking activity and consequences, the reflection phase gives meaning to students’ “raw” experiences. According to Dewey (1938), reflecting on one’s personal lived experiences leads to a meaningful, educative experience that “arouses curiosity, strengthens initiative, and sets up desires and purposes” (p. 31). The process of learning thus consists of making meaning of personal lived experiences.

It is important to highlight that the personal lived experiences Dewey referred to are physical in nature. To explain this, I need first to explain Dewey’s (1938) principle of interaction. This principle holds that every lived experience is an interplay between internal/biological and objective/environmental factors: “An experience is always what it is because of a transaction taking place between an individual and what, at that time, constitutes his environment” (p. 41). This transaction is physical in nature: Dewey (1896) stressed the importance of bodily “sensori-motor coordination” (p. 358) in the transaction between the learner and her immediate environment. It is in this physical
sensorimotor sense that experiential learning is said to yield “concrete experiences” (Kolb, 1984, p. 30) that are valuable for learning.

When experiential learning theory is applied to explain learning in virtual worlds, the theoretical explanation given is that when students perform $X^{vw}$, they undergo a concrete sensorimotor coordination with the virtual environment. In turn, it is implied that gaining this sensorimotor experience in the virtual world is what helps students learn to do $X^{pw}$.

However, it is implausible that students undergo a concrete experience of the physical world action when they perform a virtual world action. As explained in Chapter 1, the concrete experience of a student performing a chest examination in the Otago Virtual Hospital is that of clicking on the Examine Chest button. This differs markedly from the physical world target performance of placing a stethoscope on a patient’s skin. The morphological disconnect between the two actions is considerable. On its own, the explanation given by experiential learning theory is inadequate in explaining how the virtual world experience might help students learn physical world knowledge and skills.

I accept that virtual world actions might be “bodily” in the sense of being undertaken by a digital body or the avatar. However, this differs from students themselves having bodily sensorimotor interactions with the virtual environment, which is what would be required for the explanation given by Deweyan experiential learning to be legitimate.

To be sure, learning theories only illuminate some and not all aspects of learning. For example, experiential learning theory as elaborated by Dewey (1938) only illuminated the connection between concrete sensorimotor experience and education. It was not intended to illuminate the specific aspect of how students’ virtual world experiences might bring about the learning of physical world knowledge and skills, especially because such virtual world experiences were impossible in Dewey’s time.
My evaluation of the explanations given by Deweyan experiential learning theory as well as other theories is an effort to identify all plausible mechanisms that explain learning in virtual worlds, not a critique of any particular theory.

Experiential learning theory also highlights the importance of reflection to make meaning of concrete experiences, and this reflection is a plausible explanation of some learning in virtual worlds. For example, after role-playing as doctors in the Otago Virtual Hospital, medical students hold a debriefing session with their tutor to reflect on and make meaning of their virtual performance (Loke et al., 2012b). While debriefing is not strictly part of the in-scenario virtual world experience, it is integral to experiential learning theory. It is plausible that students can make meaning of their virtual world performance by reflecting on it: the reflection phase can be similar whether students’ performance is undertaken in the virtual or physical world. In this case, the explanation given by experiential learning theory does partially explain how the virtual world experience brings about learning.

Situated learning

The majority of authors who underpinned their work with situated learning theory cited Lave and Wenger (1991), Wenger (1998), and Hutchins (1995). The theory critiques the idea that human cognition resides in the individual’s head, independent of environmental context. The theory proposes instead that the ways in which human beings think and act are inherently coupled with their context (Brown et al., 1989). Human cognition is hence thought to be social (not individual) and situated in specific contexts (not universal).

As evidence of this, in *Cognition in practice*, Lave (1988) conducted a study on how the same people solved similar arithmetic problems in two
different contexts: while grocery shopping, and in schools. From the study, she provided empirical evidence that these people solved similar arithmetic problems in different ways, and that the ways they solved the problems were tightly coupled with the context they were situated in.

Hutchins (1995) also provided similar evidence. In *Cognition in the wild*, he studied how the crew of a Navy ship jointly solved the problem of navigating the ship to dock. He reported that cognition on the Navy ship did not reside in the individual crew member’s head and neither was it the sum of the individuals’ mental operations. Instead, cognition was *distributed* across the context: that is, interconnectedly across the crew members, their socio-professional practices (e.g., the hierarchy among Navy officers), and the on-board instruments.

Because the ways in which human beings think and act are believed to be inherently coupled with their immediate context, situated learning theorists typically lament how formal education offers students learning experiences that are too abstract and out-of-context, especially when contrasted with informal education (e.g., apprenticeships) where learning is contextualised in everyday professional activities (Lave, 1996). Therein lies the relevance of virtual worlds for professional education: to provide a context for students to think and act in. When situated learning theory is applied to explain learning in virtual worlds, the theoretical explanation given is that the virtual world would provide a realistic enough context to lead students to think and act as they would in physical world situations.

To illustrate how situated learning theory can be applied to explain learning in virtual worlds, I will use the example of a virtual underground mine from which mining personnel are tasked to evacuate, using the correct evacuation procedures to locate the refuge chamber (Garrett, 2012). For the virtual mine to be effective, it is implied that the virtual
mine would provide a realistic enough context to lead the mining personnel to think and act as they would while evacuating from a physical world mine.

I will illustrate both thinking and acting in virtual worlds with the example of regulating walking speed. In Garrett’s (2012) virtual mine, mining personnel have to make their avatar walk more quickly or more slowly so that they can reach the refuge chamber in the shortest possible time, without depleting their oxygen supply prematurely. Pressing a button to adjust one’s walking speed in a virtual mine is not the same physical action as adjusting one’s physical exertion in a physical world mine. It is hence implausible that students undergo the same physical experience when they perform virtual world actions as when they perform the physical world equivalent. In particular, students do not undergo the same physical exhaustion when they increase their walking speed in the virtual mine as when they increase their walking speed in a physical world mine. The experience and management of physical exhaustion plays an important part in the learning of evacuation procedures. Therefore, for the physical aspect of physical world actions, the explanation given by situated learning theory is inadequate in explaining how the virtual world experience might bring about the learning of physical world knowledge and skills.

I will now address the thinking aspect of regulating walking speed. In the virtual mine, to regulate their walking speed successfully, mining personnel have to apply their knowledge that a higher speed increases physical exertion, which in turn uses more oxygen in their self-rescuer. If mining personnel do not apply this knowledge, they might choose too high a walking speed, expending excessive physical effort and in turn exhausting their limited oxygen supply. For the thinking aspect of virtual world actions, the explanation given by situated learning theory does explain how the virtual world experience brings about the learning of
physical world knowledge and skills. As evidence of this, Garrett (2012) evaluated the virtual world performances of a group of mining personnel and concluded that they did have to apply their physical world knowledge to accomplish emergency evacuation tasks successfully in the virtual mine. It is hence plausible that students role-playing in virtual worlds can be led to think as they would in physical world situations.

For the sake of simplicity, I will classify the application of knowledge as a “thinking process”, in line with Bloom’s revised taxonomy (Krathwohl, 2002). This will allow me to group learning mechanisms that are common across the five learning theories. The usefulness of this grouping will be more evident when I present my preliminary findings towards the end of this chapter (under “Preliminary findings”).

Constructivism

The majority of authors who underpinned their work with constructivism cited Dede (1995), Dickey (2005), and Papert (1980), whose work can all be traced back to the Piagetian theory of constructivism. Piaget (1970) critiqued the predominant transmission model of teaching based on which teachers transmitted information to students and students acquired these ready-made facts through the perception of external stimuli. He judged the transmission model as being incapable of generating creative individuals who are capable of acting in new situations because it only elicits “correct repetition of what has been correctly transmitted” (p. 77).

Instead, Piaget (1970) developed a theory that foregrounded the role of learners in constructing their own knowledge, instead of one that foregrounded the role of external stimuli in stimulating learners. The theory holds that “a truth is never truly assimilated as a truth except insofar as it has been first been reconstructed or rediscovered by means
of some activity adequate to that task” (p. 26). In other words, students need to actively construct their own knowledge via some activity, not passively acquire the ready-made knowledge via the mere perception of external stimuli.

This activity constitutes the theory’s mechanism. It involves interactions between learners and their environment, during which learners continually re-interpret their experience to match their conceptualisations (assimilation) and adjust their conceptualisations to match their experience (accommodation). This adjustment is active and deliberate, (not automatic or instinctive).

Here is an example of accommodation: a doctor notices her patient’s confusion and hence suspects that her patient might be suffering from a head injury. That is, the doctor’s initial conceptualisation of what might be wrong with the patient or her initial diagnosis was a head injury. After ordering a head CT scan for the patient and receiving scan results that conflict with her initial suspicions, the doctor adjusts her diagnosis, eliminating a head injury in favour of other potential causes of confusion (e.g., urinary tract infection). In an iterative manner, the doctor will then order more laboratory tests (e.g., urine dipstick test) to verify her hypotheses.

For constructivists, the learning process thus consists of iterative cycles of assimilation and accommodation in the pursuit of equilibrium between conceptualisation and experience. In the example above, equilibrium is reached when the doctor’s diagnosis (conceptualisation) matches the results from laboratory tests (experience). Piaget (1970) coined this process as an “active discovery of reality” (p. 26).

When constructivism is applied to explain learning in virtual worlds, the theoretical explanation is that these learner-environment interactions occur in students’ virtual world experience. Piaget (1970) was clear that
such interactions involve both physical sensorimotor activity and thinking processes. However, he did highlight the importance of physical bodily activity in learning:

(...) whenever it is believed that an idea has been derived from a perception, without any other process intervening (...) it becomes apparent later that the sensorimotor activity constitutes the common origin of the corresponding ideas and perceptions. This is a general and fundamental fact that education cannot ignore. (p. 35)

To illustrate both physical sensorimotor activity and thinking processes in learner-environment interactions, I will use the example of medical students performing a “physical” abdomen examination of their patient in a virtual hospital (Loke et al., 2012b). I will start with the sensorimotor aspect of the interaction: in the Otago Virtual Hospital, students click on the Examine Abdomen button to perform an abdomen examination and receive feedback in the form of textual notifications in the text chat (e.g., “Abdomen is normal”, “Hard mass felt”). Based on this textual feedback, students then adjust their conceptualisation of what might be wrong with their patient.

For the sensorimotor aspect of the interaction, when constructivism is applied to explain learning in virtual worlds, the theoretical explanation is that the virtual world experience brings about learning in the same way as a sensorimotor experience. However, it is implausible that students undergo a sensorimotor experience of the physical world action by performing a virtual world action: clicking on the Examine Abdomen button is not the same sensorimotor experience as physically examining a human patient’s abdomen. In the physical world, as part of examining the patient’s abdomen, doctors are expected to physically feel or palpate the patient’s abdomen and then adjust their diagnosis according to what they physically feel (e.g., soft or hard areas, abnormal masses). In terms of the
examination of the patient’s abdomen, there is considerable morphological disconnect between the virtual world action and the physical world action. For the sensorimotor aspect of physical world actions, the explanation given by constructivism is inadequate in explaining how the virtual world experience might bring about learning.

I will now give an example of the thinking aspect of the learner-environment interaction. In the virtual hospital described above, while examining the patient’s abdomen, medical students arrive at a diagnosis by applying the thinking process of differential diagnosis. As students examine their patient’s abdomen, they mentally eliminate improbable diseases based on the textual feedback they receive (e.g., “Abdomen is normal” or “Patient feels pain”), adjusting their conceptualisation of what might be wrong with their patient as they receive more feedback.

For the thinking aspect of the interaction, when constructivism is applied to explain learning in virtual worlds, the explanation is that the virtual world experience brings about learning in the same way as the application of thinking processes. This implication is plausible because the application of a student’s thinking processes (e.g., differential diagnosis) can be similar whether in the virtual or physical world. As evidence of this, Roy, Walker, Blyth, and Wilkinson (2014) examined the construct validity of role-playing in the Otago Virtual Hospital and reported that the clinical reasoning required in such a role-play resembles clinical reasoning in the physical world. This clinical reasoning included differential diagnosis. For the thinking aspect of learner-environment interactions, the explanation given by constructivism does explain how the virtual world experience brings about learning.
Social constructivism

The majority of authors who underpinned their work with social constructivism cited (Vygotsky, 1978). The Vygotskyan theory of social constructivism critiques the idea that learning results either solely from environmental stimulation or solely from biological maturation. The theory holds instead that learning results from a person’s internalisation of social practices:

Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first between people (interpsychological), and then inside the child (intrapsychological). (...) All the higher [mental] functions originate as actual relations between human individuals. (p. 57)

According to the theory, the higher levels of cognitive development originate on the social plane. The transformation of knowledge from the social to individual planes occurs through internalisation, which is the theory’s mechanism.

Internalisation arises from social interactions. These social interactions essentially involve people solving problems together as a shared endeavour. As they solve problems collectively, people negotiate the various meanings they make of the problem to arrive at a shared understanding or a consensus. It is in this way that people are thought to socially construct knowledge.

Here is one example of such social interactions from medical education: during their final year of medical education, trainee doctors are often paired with experienced clinicians in the hope that, by practising clinical reasoning with their mentors (involving meaning negotiation to arrive at a joint consensus), the trainees would eventually develop their individual clinical reasoning ability.
When social constructivism is applied to explain learning in virtual worlds, the theoretical explanation is that these social interactions occur in students’ virtual world experience. For Vygotsky (1978), these social interactions involve both verbal and bodily hands-on activity: “children solve practical tasks with the help of their speech, as well as their eyes and hands” (p. 26).

To illustrate both verbal and hands-on aspects in social interactions, I will use the example of trainees tasked to dismantle a tower crane collaboratively in a virtual construction plant (Guo et al., 2012).

I will start with the hands-on aspect of the social interaction. Using Nintendo Wii game controllers, one trainee operates another tower crane while the other two connect the crane elements to the hook. To succeed collectively, the three trainees need to coordinate their actions in a harmonious manner. For the hands-on aspect of the interaction, the theoretical explanation is that the virtual world experience brings about learning in the same way as a hands-on experience. However, it is implausible that students undergo a hands-on experience of the physical world action in virtual worlds: controlling a virtual tower crane on a computer screen is not the same hands-on experience as controlling a tower crane in the physical world. For the hands-on aspect of physical world actions, the explanation given by social constructivism is inadequate in explaining how the virtual world experience might bring about learning.

I will now give an example of the verbal aspect of the social interaction. In the virtual construction plant described above, the three trainees verbally communicate with one another to dismantle the tower crane collaboratively, negotiating verbally with one another to arrive at a consensus of how best to solve the problem. For the verbal aspect of the interaction, the theoretical explanation is that the virtual world
experience brings about learning in the same way that a verbal interaction in the physical world does. This implication is plausible because a verbal interaction can be similar whether in the virtual or physical world. In this case, social constructivism does explain how the virtual world experience brings about the learning of physical world knowledge and skills.

Virtual worlds enable students to interact verbally in many ways, and some ways are closer to physical world verbal interactions than others. I will illustrate the various ways people can interact verbally in virtual worlds with Second Life, the most popular virtual world in education (Wang & Burton, 2013). Verbal interactions in Second Life can be carried out via voice chat or text chat. Voice chat in Second Life is problematic because of two reasons: first, the way sound is propagated in Second Life often makes it difficult for students to hear each other in the virtual world. In one Second Life language learning class, for example, students too often did not hear each other because their avatars were too far away from each other (audio volume is proportional to distance) or their avatars were not directly in front of the speaking avatar (audio is directional) (Lan, Kan, Hsiao, Yang, & Chang, 2013).

Second, voice chat in Second Life is problematic because there is no indication to other users when a particular user is about to speak, and this typically results in users speaking over each other unintentionally. I personally witnessed a live demonstration of a Second Life virtual hospital featuring voice chat (Honey, Connor, Veltman, Bodily, & Diener, 2012) and, after observing the frequent interruptions and false starts, was convinced that text chat is currently more usable than voice chat, particularly when more than two users are involved in the role-play. This is a common problem: in another Second Life learning environment for foreign language learning, students also encountered numerous
interruptions and “simultaneous talk” (Zhang, 2013, p. 248) because the virtual world does not indicate when a particular user is about to speak.

However, verbal interactions via text chat are less realistic than voice chat. Instead of communicating using voice, users have to type their message in text chats and post it into a common text log that is viewable by all users. In the text log, messages are displayed in reverse chronological order, with the newest message displayed on top of older ones. From a case study (Loke et al., 2012b), one medical student who role-played in the Otago Virtual Hospital expressed how text chatting was more “stilted” (p. 569) compared with verbal interactions in the physical world. Because of the difference between virtual world text interactions and physical world verbal interactions, this student questioned the virtual hospital’s relevance in developing patient interaction skills that are useful in the physical world.

Similarly, in another virtual world where trainee teachers get to teach a group of pupils in a virtual classroom, the choice of text chat over voice chat was also criticised for hindering smooth communication flow that is necessary for an orderly lesson. For example, one trainee teacher regretted not being able to use her intonation to communicate with her pupil-avatars: “it was difficult to discipline the students as we only had a [text] chat room and we didn’t use our voices” (Gregory et al., 2013, p. 26).

Given the problems associated with text chats, I do have to qualify my earlier assertion that a verbal interaction can be similar whether in the virtual or physical world. Granted, text chats are slower and more discontinuous compared to verbal interactions in the physical world. In addition, text chats do not offer students the whole repertoire of ways to communicate their thoughts and feelings. For example, text chats exclude voice intonation and facial expressions (which, strictly speaking, are part
of non-verbal communication). Nonetheless, I believe that, in most cases, there is a high enough degree of correspondence between the virtual world and physical world verbal interactions. In virtual worlds, at the very least, students get to express what they mean to say successfully, and they also get the opportunity to easily read and interpret what others say. In addition, this verbal interaction takes place synchronously or in real time (as opposed to asynchronously as in emailing). Because these essential elements of verbal interactions are conserved in virtual worlds, I maintain that the explanation given by social constructivism does explain how the virtual world experience brings about the learning of verbal interactions.

Self-efficacy theory

The authors who used self-efficacy theory to underpin virtual worlds for learning cited Bandura’s (1997) work. In this theory, self-efficacy is defined as people’s personal beliefs about their capability to complete a particular task. These feelings of competency are thought to influence people’s choice of activities (e.g., low self-efficacy results in task avoidance) and persistence (e.g., high self-efficacy results in high persistence in a learning task). As such, self-efficacy theory is a theory about raising one’s self-efficacy in performing particular tasks, and not directly about learning to do particular tasks.

Self-efficacy is influenced by four factors:

1. personal performances or what people do firsthand (enactive experiences);
2. watching peers perform the task successfully (vicarious experiences);
3. verbal persuasion that lead people into believing that they can overcome challenges; and
4. physiological and affective states.

For example, enactive experiences influence self-efficacy in the following way: past successes in performing a particular task will raise one’s self-efficacy in performing the task in future; past failures will lower it. Bandura (1997) believes that, among the four factors, enactive experiences have the greatest influence on self-efficacy.

When self-efficacy theory is applied to explain learning in virtual worlds, the theoretical explanation is that enactive experiences and/or vicarious experiences form part of students’ virtual world experience. The following is an example of an enactive experience in a virtual world: in a virtual Chinese restaurant, language students are tasked to order food in Mandarin (Henderson et al., 2012).

This virtual experience is expected to raise students’ self-efficacy in ordering food in the physical world, as would a firsthand experience in an actual Chinese restaurant. However, while it is plausible that ordering food in an actual restaurant could serve as an enactive experience to ordering food in the physical world, it is less plausible that ordering food in a virtual restaurant could serve as an enactive experience to ordering food in the physical world. As elaborated in the earlier sections of this chapter, two aspects of the virtual world experience might correspond to the physical world experience: the application of thinking processes (e.g., understanding the Chinese characters in the menu) and verbal interactions (e.g., negotiating with others which dishes to order). However, in terms of the physical aspect of virtual world actions (e.g., walking to the appropriate table indicated by the waiter, sitting down at the table at the appropriate moment, catching the waiter’s attention), it is implausible that the virtual world experience corresponds to the physical world experience. For the physical aspect of physical world actions, the
explanation given by self-efficacy theory is inadequate in explaining how the virtual world experience might bring about learning.

The virtual world experience can alternatively be taken to be the student’s vicarious experience. For example, in the virtual restaurant described above, getting students to observe their classmates’ avatars order food in a virtual restaurant is expected to raise their self-efficacy in ordering food in the physical world, as would observing their classmates order food in an actual restaurant. If taking this perspective, the theoretical explanation is that the virtual world experience influences self-efficacy in the same way as a vicarious experience. This implication is plausible because a student’s vicarious experience can be similar whether in the virtual or physical world.

There is possibly a neurophysiological mechanism underlying the power of vicarious experiences for learning. Researchers at the University of Parma discovered a specific class of visuomotor neurons that would fire when a person observes an action done by others (Rizzolatti & Craighero, 2004). These mirror neurons will also fire when the person performs the same action herself, thus providing a basis for learning via imitation or via vicarious learning experiences. Extending this finding to virtual worlds for education, de Freitas (2008) contends that it is plausible that a student’s mirror neurons would also fire when the student observes another avatar perform an action. However, this claim has yet to be supported by empirical evidence.

As an aside, I did initially explore the theory of mirror neurons as a possible explanation of neurological mechanisms underlying learning using an avatar. I had a few conversations with Professor Elizabeth Franz (Psychology, University of Otago) regarding the possibility of the activation of mirror neurons as students manipulate and observe their avatar act. However, the precision of functional magnetic resonance
imaging (fMRI that is used to map neuronal activity) is unlikely to go down to the level of specific actions and hence unlikely to show that brain activation while examining a patient’s abdomen during a virtual world role-play reflects neuronal correlates of examining a human patient’s abdomen in the physical world, which is the ideal level of precision that is required for my research. One study in human brain mapping illustrates this limitation: using fMRI, Mathiak and Weber (2006) recorded the neuronal activity of 13 gamers while playing a violent first-person shooter game. They concluded conservatively that playing violent video games produces some effects in neuronal activity that appear to overlap with what might be expected when a person acts aggressively in the physical world. I hence did not continue to pursue this line of inquiry.

When self-efficacy theory is applied to explain learning in virtual worlds, in the case of vicarious experience, the explanation given does explain how the virtual world experience brings about some aspects of the learning. However, it is likely that students can equally gain this vicarious experience by watching video clips. Providing a vicarious learning experience is hence not a unique characteristic of learning in virtual worlds. Moreover, creating video clips is likely to be a less expensive alternative compared to building a whole multi-user virtual world. When educators have more than one way to help their students achieve the same learning objective (e.g., a low technology versus a high technology way), they should choose the less expensive and more efficient way (Clark, 1994).

Preliminary findings

I have evaluated the second group of explanations that explain how students might learn to do $X_{PW}$ by doing $X_{VW}$. In this section, I present my preliminary findings so as to highlight that the aspect for which this
second group lacks an explanation is the aspect which the third group aims expressly to explain.

I evaluated the second group of explanations in terms of their applicability to explain learning in virtual worlds. Table 3 summarises my preliminary findings.

**Table 3. Adequacy of learning theories in explaining learning in virtual worlds**

<table>
<thead>
<tr>
<th>Theory</th>
<th>Adequate</th>
<th>Inadequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiential learning theory</td>
<td>Explains how students make meaning of virtual world performance by reflecting on it</td>
<td>Does not explain how students undergo concrete experience of physical world action</td>
</tr>
<tr>
<td>Situated learning theory</td>
<td>Explains how students learn thinking processes by applying physical world knowledge</td>
<td>Does not explain how students undergo physical experience of physical world action</td>
</tr>
<tr>
<td>Constructivism</td>
<td>Explains how students learn thinking processes by applying physical world thinking processes</td>
<td>Does not explain how students undergo sensorimotor experience of physical world action</td>
</tr>
</tbody>
</table>
The theoretical explanations above adequately explain how four learning mechanisms are applicable to virtual worlds. Students learn:

1. verbal interactions by engaging in verbal interactions;
2. thinking processes by applying thinking processes;
3. through reflection; and
4. through vicarious experiences.

However, when applied to virtual worlds, the explanations commonly imply that students undergo a sensorimotor experience of the physical world action when they perform a virtual world action. In other words, they imply that performing virtual world actions counts or matters for learning partly because such performances give students a sensorimotor experience of the physical world action. This implication is implausible because students do not undergo a sensorimotor experience of the physical world action when they perform a virtual world action.
Performing the virtual world action and physical world action do not correspond in terms of physical movement. Some correspondence is needed for learning to happen. On their own, these explanations do not adequately explain this sensorimotor correspondence.

Without such an explanation, it is unclear how:

- clicking the Examine Chest or Examine Abdomen button in a virtual hospital might help students learn to physically examine a human patient’s chest or abdomen;
- pressing the up or down buttons to adjust walking speed in a virtual mine might count for learning to adjust one’s physical exertion in a physical world mine;
- using Nintendo Wii game controllers to dismantle a virtual tower crane might help students learn to physically control a tower crane in a physical world construction plant; and
- pressing arrow buttons to walk to the appropriate seat in a virtual restaurant might count for learning the corresponding physical action in the physical world.

It is unclear how students can learn or become competent in such physical world skills by pressing a button. Despite this lack of clarity, virtual worlds are celebrated as learning environments that distinctively offer students “concrete experiences” (Wehner, Gump, and Downey, 2011, p. 280) and “hands-on learning” (Farley, 2014, p. 326).

This lack of explanation pertains to virtual world actions that feature a considerable morphological disconnect. Providing such an explanation is essential because such actions are often important actions that students are expected to learn. I will illustrate this with Fardinpour and Reiners’ (2014) taxonomy of virtual world actions. Fardinpour and Reiners proposed a taxonomy of virtual world actions in order to assess their students more comprehensively and precisely based on the actions
performed during the course of a virtual world role-play. Their students are engineering students and the virtual role-play includes cutting metal bars correctly in a virtual machine shop.

Fardinpour and Reiners (2014) classify virtual world actions in the following way:

- **Gestural actions**: (movements in the avatar's body and/or face expressing different meanings such as contempt or affection);
- **Responsive actions**: (responses triggered by changes in the environment such as the avatar pushing a button when the green light comes on);
- **Decisional actions**: (the avatar making choices between different available options such as the different lengths of a metal bar);
- **Constructional actions**: (the avatar's actions allowing them to make changes to their environment such as cutting a metal bar); and
- **Locomotive actions**: (the avatar's movements to different parts of the virtual world such as different rooms).

They illustrated their taxonomy with an example scenario of a student learning (via her avatar) to cut a copper rebar into the desired dimensions using a virtual lathe machine. First, the student makes her avatar walk into the machine shop (Locomotive) to choose a copper rebar with diameter of 0.4 inch (Decisional). Then the student makes the avatar cut two pieces of rebar (Constructional) in sizes 1.5 and 0.5 inch (Decisional).

The student performs all these actions via a keyboard and mouse, resulting in considerable morphological disconnect in executing Gestural, Responsive, Constructional, and Locomotive actions. Examples of such morphological disconnect include how cutting the rebar in the virtual world (Constructional) and walking into the virtual machine shop.
(Locomotive) are performed with very different physical movements in the physical world.

In contrast, there is less morphological disconnect in executing Decisional actions because they do not involve physical movement. For example, choosing the correct dimension for the rebar is a very similar thinking process whether performed in the virtual world or the physical world.

At this point, I want to depart slightly from Fardinpour and Reiners’ (2014) terminology and simply call Decisional actions “decisions”. This allows me to distinguish decisions from actions, a distinction which is helpful in this thesis. I will henceforth define “decisions” as thinking processes (not as actions as in “Decisional actions”); and “actions” as things that are done with overt physical movements (I will elaborate on “actions” in the next paragraph). Because I take decisions to be thinking processes, I will consider decision-making to be equivalent to the application of thinking processes. In the previous section on situated learning and constructivism, I stated that students can learn thinking processes because they do apply physical world thinking processes in virtual world role-plays (e.g., they do apply differential diagnosis or mentally eliminate improbable diseases among a range of diseases based on ongoing feedback). I will take this application of a thinking process as being equivalent to decision making, which consists similarly of choosing an option among a range of options. Therefore, as with the application of thinking processes, students can learn decision making by role-playing in virtual worlds.

Contrasting “decisions” with “actions”: in the context of virtual worlds, I will henceforth narrow down the definition of “virtual world actions” to mean actions that are correspondingly performed by people in the physical world with overt physical movements. Types of virtual world actions include Gestural, Responsive, Constructional, and Locomotive
actions. Examples of virtual world actions include clicking the Examine Chest button in a virtual hospital and pressing the up buttons to increase walking speed in a virtual mine. This narrowing down is helpful in this thesis because virtual world actions typically feature considerable morphological disconnect and currently lack an explanation as to how performing them might bring about the learning of their physical world equivalent. Developing such an explanation is a main concern for the rest of this thesis, and calling these actions “virtual world actions” provides a succinct and helpful way to write about them (compared with the unwieldy “actions that are performed by people in the physical world with overt physical movements”).

The virtual world actions listed in Fardinpour and Reiners’ (2014) taxonomy are important for learning because: students need to learn them in the course (i.e., these actions form the course’s learning objectives); students need to demonstrate them in order to pass the course (i.e., these actions form part of the course’s assessment); and the performance of these virtual world actions is assumed to be a valid indication of students’ physical world abilities (i.e., clicking the Examine Chest button at an appropriate time in a virtual hospital is assumed to reflect a student’s ability to do the same in the physical world).

Despite the importance of virtual world actions for learning, there is currently a lack of explanation about how getting students to perform virtual world actions helps them learn to perform the physical world equivalent. The explanations given by the five learning theories I just evaluated implausibly imply that performing virtual world actions counts for learning because such performances give students a sensorimotor experience of the physical world action. As elaborated in Chapter 1, the explanations are implausible because students learning in virtual worlds do not execute the same physical movements needed to complete the physical world action. Another explanation of how the virtual and
physical world experiences correspond and in turn how virtual world actions count for learning is needed. This is where the third group of theories comes in. The third group consists of theories that have been expressly developed to explain the correspondence between virtual and physical world experiences. These three theories are the projective identity model, presence theory, and flow theory. They indicate that human experience can extend into virtual environments.

In a bid to identify all plausible mechanisms that explain learning in virtual worlds, I will now examine the ways these theories explain how the virtual world experience might correspond to the physical world experience. In the next section, I will examine Gee’s (2003) projective identity model, which is based on Clark's (1997) extended mind theory. After that, I will examine presence theory and flow theory together because these two theories are premised on a similar mechanism.

Projective identity model and extended mind theory

Gee (2003) developed the projective identity model in his work on video games for learning. In response to criticisms that video games are mindless forms of entertainment, he contended that playing role-playing video games (e.g., *Half-Life*, *Deus Ex*) is a powerful way to learn. Gee explained this power via the projective identity model.

The projective identity model explains how gamers learn to become certain kinds of people (e.g., scientists, footballers) through the interaction between their physical world and virtual identities. This interaction will be illustrated using the video game *Lara Croft: Tomb Raider*. In this role-playing video game, gamers play Lara Croft, an English archaeologist in search of lost relics.

To play Lara Croft successfully, gamers have to adopt their virtual character's goals and values. For example, in order to win the game, they
have to adopt Lara’s goal of stopping her enemies from obtaining relics. To stop her enemies, Lara often has to use physical force, whether gamers like it or not in their physical world identity. In identifying with their virtual character, video gamers “must act for it” (Turkle, 2005, p. 82).

While adopting their virtual character’s goals and values, gamers have to project their own goals and values into Lara Croft at the same time. For example, pacifist gamers may choose to minimise the number of mutants Lara kills, while more aggressive gamers may choose to maximise the killings. In this way, gamers exercise their personal agency. According to Gee (2003), it is through the interaction between gamers’ physical world and virtual identities that their “projective identity” (p. 55; emphasis in original) is formed and that gamers learn to become certain kinds of people.

I will now extrapolate the projective identity model from game worlds to educational virtual worlds. By role-playing as doctors in the Otago Virtual Hospital, medical students are believed to adopt their virtual character’s goals (e.g., to relieve the patient’s pain) as well as to project their own goals and values into the character (e.g., to take time to show compassion towards the patient or to be more time-efficient and task-focussed). Gee (2003) speculates that it is in this reciprocal learner-character relationship that students would develop their target identity (e.g., doctors) and learn a particular “way of being in the world” (p. 3).

Gee (2008) stressed the importance of the projection of one’s goals and values into the virtual character, claiming that the projection helps to extend the learner’s mind and body into the virtual world: “Virtual characters have virtual minds and virtual bodies. They become the player’s surrogate mind and body” (p. 258). I will examine the plausibility of a student extending her mind and body into the virtual world by referring to Clark’s (1997) extended mind theory which forms
the mechanism underpinning the projective identity model, according to Gee (2008).

It is important to first highlight that Clark does not directly study desktop virtual worlds. Educators should hence be cautious when using Clark’s theory to explain learning in desktop virtual worlds. The closest example Clark (2003) gives to desktop virtual worlds would be “electronic prostheses” (p. 114) that connect parts of the user’s physical body to other forms of virtual reality. For example, the user’s arm might be connected to a computer-based virtual environment via such prostheses, and moving one’s physical arm will then result in a corresponding virtual arm movement in the virtual environment. However, this is not the kind of experience that desktop virtual worlds can offer students.

Clark’s (1997) extended mind theory holds that human cognition is not limited to our heads, but extends into the local environment, “parasitizing environment resources” (p. 63). Here is an example of such an extension: while using a pocket calculator, a person might offload some cognitive load onto the machine (e.g., the recall of previously-stored numbers). In turn, the person might make use of the calculator’s displayed output to make subsequent calculations mentally. Clark (1997) claims that the user’s brain and the calculator might then become so tightly coordinated that the inner system (brain) and outer system (calculator) work together “as a single integrated computational unit” (p. 66).

In a way, Clark’s (1997) extended mind theory is similar to Hutchins’ (1995) notion of distributed cognition (elaborated under the section on situated learning in this chapter). Both theories critique the idea that human cognition resides within the individual’s head, and propose instead that cognition is distributed across the context, exploiting environment resources such as notebooks and computing devices.
When the extended mind theory is applied to explain learning in virtual worlds, the theoretical explanation is that the student’s cognition could extend into her avatar, and that the student and her avatar could form an integrated computational unit.

However, forming such a computational unit does not imply that the student’s avatar would necessarily become her surrogate mind and body, as Gee (2008) claimed. The extended mind theory indicates that the student can make use of her avatar as she would a calculator (e.g., offloading cognitive load onto the avatar). It does not indicate that the student can extend her whole body into the virtual world, establishing a sensorimotor coordination with the virtual world and undergoing a sensorimotor experience of the virtual world through her “surrogate body” (i.e., her avatar). Therefore, the explanation given by the extended mind theory does not explain how a student’s virtual world action might correspond to her physical world action in desktop virtual worlds.

Emerging technologies such as head-mounted displays (e.g., Oculus Rift) and gesture sensors (e.g., Microsoft Kinect) can offer users an experience that approximates extending their whole body into the virtual world. I will examine these emerging technologies after evaluating presence theory and flow theory in the next section.

Presence theory and flow theory

I mentioned earlier that presence theory and flow theory are premised on a similar mechanism explaining how the virtual world experience might correspond to the physical world experience. To be precise, presence theory forms an overarching theory of which flow theory explains but one step in the process. Hence, I will mainly evaluate presence theory in this section and embed flow theory only when describing the relevant step.
The majority of authors using presence theory to underpin their work cited Blascovich (2002), Heeter (1992), Slater (1999), Steuer (1993), Winn (1993), and Witmer and Singer (1998). Many definitions of “presence” exist in the field of virtual reality. The one provided by Witmer and Singer (1998) is one of the most commonly accepted: “Presence is defined as the subjective experience of being in one place or environment, even when one is physically situated in another” (p. 225). Examples of such experiences range from exploring fully immersive virtual environments, watching movies, speaking to someone on a mobile phone, to daydreaming. The first three examples are mediated by technologies; the fourth does not require any technology external to the human being.

One way to describe the sensation of presence is when people “forget” that they are still situated in the physical world because they feel sufficiently present in another (virtual) environment. This is where Csikszentmihalyi’s (1990) flow theory comes in. Csikszentmihalyi’s theory emerged from his study about the psychology of happiness. In brief, his theory puts forth that people are happiest when they are acting with total involvement. When such people are experiencing a high flow experience “in the zone”, they are thought to forget that they are still in the physical world.

Flow theory is useful in identifying the factors that are likely to increase flow experience. In educational virtual worlds, factors such as representational fidelity and immediacy of communication can influence students’ flow experience (e.g., a higher representational fidelity resulting in a higher flow experience) (Choi & Baek, 2011). In turn, students having a high flow experience in a virtual world are more likely to experience presence in the virtual world. This is how flow theory and presence theory are related.
This section is divided into two subsections. I will first describe the types of claims made based on presence theory. In the second subsection, I will describe the factors that influence the degree of presence that users can feel in virtual environments, based on which I will critically evaluate the explanations given by presence theory to determine how it might help explain learning in desktop virtual worlds.

**Claims made based on presence theory**

Broadly, two claims are made based on presence theory that are related to learning in virtual worlds. First, presence theory indicates that, if a user experiences a sufficiently high degree of presence in a virtual environment, the psychological processes activated by her interactions with the virtual environment are likely to be similar to those activated by her interactions with the physical world (Winn, 1993).

This is the mechanism that underpins Virtual Reality Exposure Therapy (VRET). One example of such therapy is the treatment of fear of flying: patients are exposed to a virtual airplane in the hope of activating the same emotional anxiety as when they are exposed to an actual airplane (Rothbaum, Hodges, Smith, Lee, & Price, 2000). Through this exposure, patients are thought to de-sensitise themselves of the anxiety and steadily reduce their fear of flying. In a similar way, VRET has been employed to treat post-traumatic stress disorder in war veterans (Gamito et al., 2010) and acrophobia (Krijn et al., 2004).

Extrapolating this idea to virtual worlds for education: *if* a student experiences a sufficiently high degree of presence when performing a virtual world action, it is implied that she will likely experience a similar emotional state as when she is performing the corresponding physical world action.
This first claim relates to emotions and feelings, not to behaviours. It appears that the relationship between presence and feelings is stronger than the relationship between presence and behaviours. Persky and Blascovich (2008) set up experiments to investigate whether playing a fully immersive violent video game would result in increased aggressive feelings and behaviour. They concluded that presence mediated the relationship between playing a violent video game and increased aggressive feelings, but not between playing a violent video game and increased aggressive behaviours.

The second claim made based on presence theory relates presence to behaviour. Presence theory indicates that, if a user experiences a sufficiently high degree of presence in a virtual environment, she is likely to transfer elements of her virtual world behaviour to the physical world. In other words, there is likely to be some “behavioral transfer” (Fox, Bailenson, & Binney, 2009, p. 295) from the virtual environment to the physical world. I will exemplify this claim with two empirical studies.

Fox et al. (2009) conducted a study in which participants watched a photorealistic virtual representation of themselves eating food in a fully immersive virtual environment. After a six-minute exposure to this virtual environment, participants were led to a computer and asked to complete a survey. A bowl of candy was placed next to the computer and participants were told that they could help themselves to the candy if they wished.

It was shown that participants’ degree of presence affected behavioural imitation, but with gender differences: men who experienced high presence were more likely to eat candy than low presence men; in contrast, women who experienced high presence were more likely to not eat candy than low presence women. Fox et al. (2009) concluded that some form of behavioural transfer occurred, but more in the form of a
heightened awareness of one’s body than in the specific imitation of the identical behaviour in the physical world (i.e., eating candy).

I emphasise the word “imitation” because Fox et al. (2009) explained that the mechanism underlying this behavioural transfer is Bandura’s (1977) social learning theory, which involves one’s imitation of a behaviour observed in others.

In another study, Rosenberg, Baughman, and Bailenson (2013) examined how playing a superhero-like virtual character might increase prosocial behaviour in the physical world. Participants experienced a fully immersive virtual environment where they either were given the “superpower” of flight (akin to Superman’s flying ability) or rode as a passenger in a helicopter. After their virtual experience, the participant removed their head-mounted display and the experimenter put away the virtual reality equipment. While doing that, the experimenter would “accidentally” knock over a cup of pens sitting on a table, giving the participant five seconds to help before attempting to pick up the pens herself.

It was found that participants who experienced the superpower of flight helped the experimenter pick up spilled pens significantly more frequently than participants who were virtual passengers in the helicopter. Therefore, experiencing the superpower of flight in the virtual environment led to greater prosocial behaviour in the physical world. Rosenberg et al. (2013) speculated that a possible mechanism underlying this behavioural transfer is that the experience of having a superpower primed concepts and prototypes associated with superheroes who use their superpowers to do good.

It is important to reiterate that the behavioural transfer mediated by presence is broad and not specific. In both studies (Fox et al., 2009; Rosenberg et al., 2013), the behaviours that transferred from the virtual
environment to the physical world were broadly similar (e.g., prosocial video games leading to prosocial behaviour), but not identical (e.g., participants who virtually experienced the superpower of flight did not learn how to fly like Superman in the physical world). In Fox et al. (2009), the women who experienced high presence even exhibited the opposite behaviour of not eating candy.

In most cases, the aim of such studies in the field of virtual reality is not to transfer a specific behaviour, but to examine if people who have experienced high presence might perform “coincident behaviors” (Yoon & Vargas, 2014, p. 1044) in the physical world. In contrast, when students role-play in virtual worlds, they are typically expected to learn and transfer identical behaviours (e.g., to learn how to perform chest examinations in the physical world by performing chest examinations in the virtual world). It is important to make these distinctions so as to gain more precision regarding what students can and cannot learn by role-playing in virtual worlds.

Summarising the two main claims made based on presence theory: if a student experiences a high degree of presence in a virtual world, presence theory indicates that (1) she will likely transfer coincident behaviours from the virtual world to the physical world, and (2) she will likely experience a similar emotional state as when she is performing a physical world action. These claims are made on the basis of experiments conducted in fully immersive virtual environments, not desktop virtual worlds.

Care must be taken in applying presence theory to understand learning in desktop virtual worlds. Researchers in the field of virtual reality have rarely studied presence in desktop virtual worlds (Schroeder, 2011). Instead, these researchers mostly investigate fully immersive virtual reality environments such as CAVEs where users’ whole physical bodies
are surrounded by the virtual environment. This differs markedly from the morphologically disconnected experience that desktop virtual worlds offer.

I have described the types of claims made based on presence theory. In the next subsection, I will describe the factors that influence the degree of presence that users can feel in virtual environments, based on which I will critically evaluate presence theory’s applicability to desktop virtual worlds.

Factors influencing presence

Researchers in virtual reality are divided as to whether users can experience presence in desktop virtual worlds. This depends on their conceptions of how presence is generated. One group believes that presence is more dependent on the virtual reality system’s technological features. For example, Steuer (1993) recommends realistic and vivid graphics to maximise the likelihood of generating presence in virtual environments.

This group of researchers would classify desktop virtual worlds as non-immersive because of the relatively low graphical and behavioural realism in desktop virtual worlds (Bailenson & Blascovich, 2004; Blascovich & Bailenson, 2011; Fox, Arena, & Bailenson, 2009; Schroeder, 2011; Winn, 1993). For this group, immersive environments include CAVEs where users control their avatars in naturalistic ways (e.g., user’s own arm movements leads to avatar’s corresponding arm movement), a feature which gives high behavioural realism. This differs markedly from desktop virtual worlds where users control their avatars in a morphologically disconnected way via keyboards and mice. If taking this perspective, presence theory states that desktop virtual worlds are ineffective in generating presence in virtual environments, and that a student’s virtual
world action does not correspond sufficiently to her physical world action in order to generate presence.

Blascovich and Winn are two virtual reality researchers who believe that desktop virtual worlds are ineffective in generating presence in virtual environments. Blascovich considers Second Life avatars as “avatars in the minimal sense of the word [because] behavioral and photographic realism is usually quite low” (Bailenson and Blascovich, 2004, p. 66). Winn (1993) also categorically classifies desktop virtual worlds as being non-immersive because desktop virtual worlds feature low behavioural realism.

However, some educational technology researchers continue to substantiate their claims that desktop virtual worlds can generate presence by citing Blascovich and Winn, even though these two researchers consider desktop virtual worlds to be non-immersive. For example, by citing Blascovich’s work, Singh and Lee (2009) assert that Second Life (SL) is capable of generating presence:

Users tend to immerse themselves in virtual environments due to the natural modes of interaction and control that users possess when they use this communication tool. Because virtual environments permit interaction with both the computing environment and the work of other users, it creates a psychological state in which the individual perceives himself or herself as existing within the virtual environment (Blascovich, 2002). One such virtual world is SL. (p. 318)

Similarly, Beaumont et al. (2014) cite Winn’s work to support their claim that desktop virtual worlds are immersive: “there is a strong similarity in the psychological processes that become active in immersive virtual realities and those that operate when people construct knowledge through interaction with [physical] objects” (p. 127).
By conflating fully immersive virtual environments and desktop virtual worlds, Singh and Lee (2009) and Beaumont et al. (2014) erroneously transpose the characteristics of the former on the latter (e.g., erroneously claiming the desktop virtual worlds feature “natural modes of interaction”) and consequently overstate the power of desktop virtual worlds in being capable of generating presence in users.

Therefore, for virtual reality researchers who consider presence to be predominantly generated by the system’s technological features (e.g., tracking of user’s physical movements), desktop virtual worlds currently do not have the necessary features to generate presence. This version of presence theory does not explain how a student’s virtual world action might correspond to her physical world action.

The other group of virtual reality researchers believes that presence is more dependent on people’s psychological/subjective responses and less on technological/objective features (e.g., Fox et al., 2009; Slater, 1999). This group believes that people can mentally evoke a sense of presence in desktop virtual worlds: if students role-playing in desktop virtual worlds are not physically immersed in the virtual environment, students are nonetheless able to undergo “psychological immersion” (Dalgarno & Lee, 2010, p. 14). For example, Regenbrecht and Schubert (2002) conducted an experiment involving a desktop video game and reported that both the gamers’ actual interactions and perceived interaction possibilities (what gamers thought they could do in the game) increased their sense of presence in the game.

It is noteworthy that this group of researchers believes that presence can also be experienced in many other contexts besides desktop virtual worlds. These contexts include technology-mediated ones (e.g., CAVEs, reading novels, talking to someone on the phone) as well as non-technological ones (e.g., mind-wandering while attending a lecture). In
this sense, for these researchers, there is nothing unique about desktop virtual worlds as a technology in its ability to evoke a sense of presence.

For researchers who consider presence to be more dependent on people’s psychological responses, desktop virtual worlds appear to have the potential to generate presence. However, Regenbrecht (personal communication, June 11, 2014) asserted that the depiction of many interactions in Second Life is so unrealistic and outlandish that they are likely to hinder people’s psychological efforts in evoking presence and to cause many breaks in presence (Slater and Steed, 2000). Second Life is the most popular virtual world in education (Wang & Burton, 2013) and, compared to commercial video games, most virtual world actions in Second Life are depicted by default in rudimentary ways.

For example, by default, the avatar’s arm tends to flail unrealistically and to be positioned in unnatural ways when performing most virtual world actions (see Figure 5 that shows an avatar performing the virtual world action of checking the patient’s blood pressure via a vital signs monitor). Such an outlandish depiction is likely to cause breaks in presence because students are likely to stop believing that they are in the virtual environment and “remember” that they are actually situated in the physical world.
Another example is how text chatting is depicted in an outlandish way in Second Life: the built-in animation depicting text chatting shows avatars typing in mid-air (watch a video clip of doctor-avatars typing in mid-air at http://bit.ly/au7jWH). From a case study of the Otago Virtual Hospital, some students did express that this built-in animation made the patient-doctor interaction less believable (Loke et al., 2012b).

Therefore, even if presence is considered to be dependent on people’s psychological responses, I contend that students can at best evoke a sense of presence intermittently in desktop virtual worlds. Given that most virtual world actions are likely to be depicted in an outlandish way and cause breaks in presence, I speculate that students are unlikely to feel a sense of presence when performing virtual world actions in desktop virtual worlds. Consequently, presence theory would indicate that a student’s virtual world action is unlikely to correspond to her physical world action.
This lack of correspondence is largely due to the differences between desktop virtual worlds where users control their avatars using keyboards and mice, and fully immersive virtual environments where users wear head-mounted displays and where their physical movements are tracked in real time. Some emerging virtual reality technologies that are compatible with desktop virtual worlds are capable of approximating the fully immersive experience and are becoming more readily available to educators and students. Before I conclude this chapter, I will describe these emerging technologies, examine their implications for learning physical world actions, and speculate on the likelihood of their being widely adopted by educational institutions in the near future.

Emerging technologies

The annual Horizon Report produced by the New Media Consortium is frequently used by educators, researchers, and policy-makers to identify technologies that have a large impact in education and that are likely to be widely adopted by educational institutions. In the 2016 Horizon Report (Johnson et al., 2016), virtual reality technologies were given a time-to-adoption horizon of two to three years. This means that the 58 educational technology experts surveyed in the report judged that virtual reality technologies are likely to be adopted by a large number of educational institutions by 2018-2019.

The 2016 Horizon Report defines virtual reality technologies as “computer-generated environments that simulate the physical presence of people and objects to generate realistic sensory experiences” (Johnson et al., 2016, p. 40). Typical examples of such technologies include: head-mounted displays; gesture sensors; and virtual reality rooms. I will describe and examine the implications for learning of each of these technologies separately in the next sections.
Head–mounted displays

Head-mounted displays are display devices worn on the head (over the eyes) that allow users to see the virtual environment via a small display optic in front of each eye. One such device that has recently received a lot of press coverage in the video gaming world is the Oculus Rift (see Figure 6). The Oculus Rift also includes embedded sensors that track the user's head motions and adjust the display accordingly. Wearing the Oculus Rift, gamers playing *EVE: Valkyrie* can pilot a spaceship, turning their heads physically to hunt down enemy ships and to avoid obstacles. As such, gamers physically imitate the same movements as those used to perform the physical world action and gain a more realistic sensory experience of the physical world action (e.g., turning their heads to hunt down enemy ships).

![User using the Oculus Rift](image)

**Figure 6. User using the Oculus Rift. From “Orlovsky and Oculus Rift,” by Sergey Galyonkin, 2013. CC BY-SA 2.0.**

It has become increasingly easy to use the Oculus Rift. The first consumer version of the Oculus Rift was made available to consumers in 2016 (at about $600 per piece). It comes with the Oculus software development kit.
which is compatible with popular game engines Unity 5, Unreal Engine 4, and Cryengine and which allows content developers (e.g., game developers) to create their own content that makes use of this head-mounted display. In 2014, Facebook acquired Oculus VR (the company making the Oculus Rift), raising the potential of the Oculus Rift becoming more widely adopted.

Head-mounted displays are useful for learning physical world tasks that require one to turn one’s head in order to search for items or information. For example, engineering students were tasked to assemble a virtual coffee machine from disparate pieces using the Oculus Rift and a game joystick (Bharathi & Tucker, 2015). With the Oculus Rift, students could see and search for the pieces of the virtual coffee machine in 360 degrees; using the game joystick, students “picked up” the various pieces to put the virtual coffee machine together.

In terms of implications for learning physical world skills, head-mounted displays offer students a more immersive experience because students can feel as if they are “inside” the virtual environment (their visual experience would give them such an impression). Using head-mounted displays, students can feel a sense of presence while performing virtual world actions.

However, students wearing head-mounted displays still have to perform most virtual world actions using input devices such as game controllers (e.g., game joysticks, game pads), keyboards, and mice. I reiterate that I am developing an explanation for the learning benefits of getting students to perform “virtual world actions” in the sense of actions that are performed in the physical world with overt physical movements (e.g., examining the patient’s abdomen, evacuating from a cave, cutting a metal bar). In the classroom example given above (Bharathi & Tucker, 2015), students wearing the Oculus Rift still have to use a game joystick to
perform the virtual world action of “picking up” and “assembling” the various pieces of the virtual coffee machine. In this case, the level of behavioural realism is as low as that in desktop virtual worlds.

Granted, there are also cases where virtual world actions involve mainly head and neck movements: for example, firefighters searching for people trapped in buildings in search and rescue missions; building inspectors inspecting newly built houses for non-compliance to the building code; and footballers scanning the pitch to locate their team mates during a match. These are cases where the level of behavioural realism is higher and where head-mounted displays are capable of approximating the fully immersive experience. However, I contend that virtual world actions that involve mainly head and neck movements are few in number compared to the whole range of physical actions students have to learn, and head-mounted displays hence may have limited use in education.

Also, I want to highlight that the technical obstacles in making head-mounted displays readily available to most educators and students are not trivial, even though there are presently fewer such obstacles. The Oculus software development kit requires advanced software development skills to use, as do its compatible game engines (namely Unity 5, Unreal Engine 4, and Cryengine). Just as a comparison, the skill level required to develop and maintain content for the Oculus Rift is much higher than that needed for Second Life. While some educators, including myself, can learn how to develop content in Second Life by themselves (e.g., by reading books and learning from online communities), it is more likely that educators will have to additionally employ professional software developers to develop and maintain any content for head-mounted displays. In short, the consumer version of the Oculus Rift is far from being a plug-and-play consumer device such as a printer or a digital camera. In terms of hardware, the Oculus Rift is an extra piece of hardware to be acquired at about $600 per piece; students using Second
Life just need a regular desktop computer or laptop (albeit with a free-to-download Second Life software installed).

At this point, I can be clearer about what I mean when I say that desktop virtual worlds are readily available to most educators and students. What I mean is that educators and students can use this technology:

1. with widely available hardware and software (and any extra hardware or software is either free or can be purchased at a low cost);
2. in widely available physical spaces such as existing school computer laboratories or at home (not requiring costly purpose-built rooms); and
3. at multiple times or at any time of their convenience (not a once-a-year learning experience). Iterative cycles of practice and reflection is key to developing professional knowledge and skills.

Second Life satisfies the three criteria (as do smartphone applications, GoPro cameras, and fitness trackers); the Oculus Rift and Microsoft Kinect (a gesture sensor examined in the next section) come close. In comparison, mannequin-based simulators for training clinical skills such as the Sim-Man (e.g., Burgess, 2007) are probably not readily available to most educators and students because: they require proprietary hardware and software costing about $66,000 per mannequin; their use is confined to dedicated purpose-built rooms; and they are available to students only a few times during their medical education.

Head-mounted displays allow students to see the virtual environment in 360 degrees, but users still cannot track their hand movements in the virtual environment. One way to solve this problem is through gesture sensors.
Gesture sensors

Gesture sensors are motion sensing devices that allow users to control computer programs using human gestures. One such device that has been widely adopted by gamers is the Microsoft Kinect. When they are positioned about two metres in front of this motion sensing device, gamers playing the first-person shooter *Blue Estate* can, for example, switch weapons by raising their arm over their shoulder. This is done without the use of a physical game controller, unlike other game consoles such as the Nintendo Wii and Sony Playstation which still require gamers to hold a physical game controller in their hands. As such, gamers using the Kinect physically imitate the same movements as those used to perform the physical world action and gain a more realistic sensory experience of the physical world action (e.g., switching weapons).

It has become increasingly easy to use the Microsoft Kinect. In 2011, Microsoft released a non-commercial Kinect software development kit which allows software developers outside Microsoft to develop their own non-commercial applications that make use of Kinect. This has increased the adoption of Kinect in other fields such as education.

Gesture sensors can be broadly divided into two categories: sensors that can provide haptic or force feedback to the user; and those that cannot. The Microsoft Kinect is an example of gesture sensors that cannot provide haptic feedback, mainly because the user does not hold a physical game controller. In a way, the user herself becomes the game controller. Such gesture sensors are suitable for learning physical movements that do not require adjustments based on haptic feedback and that do not require the use of tools (e.g., hand drills, syringes). For example, a Kinect-based system was developed to help students learn dance movements (Marquardt, Beira, Em, Paiva, & Kox, 2012). This system captures the live motion of students and shows the difference between students’ ballet
movements and prescriptive movements, thus providing students with instructional feedback in real-time. Because the Microsoft Kinect does not feature haptic feedback, it may have limited use in education. In fact, most video games that make use of the gestural functions of Kinect are either about dancing (e.g., *Dance Central, Just Dance*) or fitness/martial arts (e.g., *UFC Personal Trainer, Fitness Evolved*).

In comparison, the Virtual Technical Trainer (Crison et al., 2004) is an example of gesture sensors that can provide haptic feedback. This system was developed to help students learn how to use a milling machine to cut various workpieces. This system is composed of two parts. First, students look at a graphical display of a virtual milling environment (comprising a workbench, milling machine, cutting tool, and workpiece) on a computer screen. Second, students manipulate a physical haptic device to control the virtual milling machine. The Virtual Technical Trainer makes use of a haptic device called the PHANTOM Premium (see Figure 7). Manipulating this haptic device, students can feel its resistance when the virtual cutting tool “mills” the virtual workpiece, and consequently adjust the force they apply based on the haptic feedback provided by the PHANTOM Premium.
In terms of implications for learning physical world skills, gesture sensors offer students higher behavioural realism compared to desktop virtual worlds. Using gesture sensors (particularly those featuring haptic feedback), students can perform virtual world actions that correspond more with the physical world equivalent in terms of physical movements. For example, if medical students in a virtual hospital could manipulate the PHANTOM Premium to examine the abdomen of their virtual patient and consequently adjust their diagnosis according to what they physically feel (e.g., soft or hard areas, abnormal masses), there will be less morphological disconnect between students’ virtual world and physical world actions. Gesture sensors are thus capable of approximating the fully immersive experience and letting students feel a sense of presence while performing virtual world actions in desktop virtual worlds.
However, I question the predictions that gesture sensors are likely to be adopted by a large number of educational institutions by 2018-2019 (Johnson et al., 2016) because of the considerable logistical and technical obstacles in making gesture sensors readily available to most educators and students. The Kinect is relatively easier to implement in classes than the PHANTOM Premium, but yet still poses challenges in terms of:

- the need for a large classroom space (users need to stand at least two metres in front of the sensor for it to detect users accurately);
- the lack of an intuitive development kit to allow the Kinect to communicate with the virtual world software (the Kinect software development kit requires advanced software development skills to use); and
- a long calibration time to allow the sensor to track a user’s body correctly (Hsu, 2011).

Beyond these technical requirements, both the Kinect and the PHANTOM Premium require proprietary adapters and special ports to be able to communicate with the computer. To make these gesture sensors readily available to most educators and students would most likely require a purpose-built or a reconfigured computer laboratory.

While the prices of these gesture sensors are dropping, they are still costly. As of January 2017, a Kinect sensor costs about $150 and its adapter $65. The price of the PHANTOM Premium is not available without a request for a quote, but is likely to be six to seven times that of the Kinect.

In terms of the likelihood of gesture sensors being widely adopted by educational institutions: I contend that the Microsoft Kinect has the possibility of being widely adopted, but it also has limited use in education. Given the considerable logistical and technical obstacles, I
contend that gesture sensors with haptic feedback are unlikely to be readily available to most educators and students in the near future.

Gesture sensors with haptic feedback allow students to perform hand movements that correspond more with the physical world equivalent, but users still cannot move their whole body around in the virtual environment. This is why gesture sensors and head-mounted displays are known as seated or stationary virtual reality technology. In contrast, virtual reality rooms are a form of virtual reality technology that allows users to move around with some degree of freedom.

**Virtual reality rooms**

Virtual reality rooms are physical rooms that immerse users’ entire body in a computer-generated environment, inside which users can physically move around. Virtual reality rooms can be broadly divided into two categories: rooms that can track users’ movement around the room (e.g., using multiple cameras); and those that cannot.

The Augmentarium is an example of virtual reality rooms that cannot track users’ movement (see Figure 8). It features a large 24-foot by 8-foot, high-resolution stereoscopic rear projection screen that surrounds users and that allows users to view the display along 180 degrees.
The Augmentarium has been used to train medical students in providing patient care in a range of settings. The large screen can simulate different computer-generated settings (e.g., mass casualty scenarios, night clubs, roadside crash). Surrounded by the screen, medical students then get to practise providing patient care in a greater variety of settings.

I am providing a description of the Augmentarium even though I had stated earlier in this chapter that I exclude fully immersive virtual environments in this thesis because such sophisticated technologies are currently not readily available to most educators and students. However, I describe the Augmentarium here because the 2016 Horizon Report (Johnson et al., 2016) used the Augmentarium to support their claim that such virtual reality technologies will achieve “widespread adoption” (p. 34) by educational institutions in 2018-2019.

I maintain that fully immersive virtual reality rooms such as the Augmentarium will not be readily available to most educators and students in the near future. The Augmentarium is a purpose-built room filled with specialised equipment that required a one million dollar
funding by the National Science Foundation to build. It resembles an exclusive research laboratory rather than a teaching and learning space for “mainstream use” as claimed by the Horizon Report (Johnson et al., 2016). Given the considerable logistical and technical obstacles in building virtual reality rooms, I contend that virtual reality rooms are unlikely to be readily available to most educators and students in the near future.

Other virtual reality rooms that capture users’ movement are even more exclusive and less likely to be readily available to educators and students. For example, Virginia Tech built The Cube, a virtual reality room that is lined with 24 cameras to capture users’ movement within a physical space the size of a large theatre. Currently, The Cube is mainly used for art projects and research in the field of Virtual Reality, although it has the potential to allow students to perform virtual world actions with a high behavioural correspondence to the physical world equivalent in terms of moving around a physical space (e.g., adjusting one’s walking speed to evacuate from a virtual mine). However, I contend that virtual reality rooms such as The Cube are highly unlikely to be readily available to most educators and students in the near future.

I have described and examined three typical virtual reality technologies: head-mounted displays, gesture sensors, and virtual reality rooms. Overall, these technologies are “technologies of imitation” (de Castell, Jenson, and Thumlert, 2014, p. 333) that allow students to imitate the physical movements of particular actions: head-mounted displays for head and neck movements; gesture sensors for arm and hand movements; virtual reality rooms for walking around. Using these virtual reality technologies, the performance of virtual world actions corresponds more with that of the physical world equivalent in terms of physical movement, compared to desktop virtual worlds.
However, most of these virtual reality technologies are unlikely to be readily available to most educators and students in the near future. While the Oculus Rift and Microsoft Kinect have the potential to be widely adopted by educational institutions, they may have limited use for learning virtual world actions relevant for professional education. Lastly, after researching fully immersive virtual environments, Blascovich and Beall (2010) were also cautious in stating that such virtual environments are not sufficiently realistic to give users the sensual realism of physical world experiences and in turn cannot generate comparable learning effects as physical world sensorimotor experiences.

Conclusion

In this chapter (Chapter 3), I critically evaluated the explanations given by ten theories found in my systematic literature review (Chapter 2) in terms of how applicable they are to virtual worlds. If educators knew which explanations are applicable to virtual worlds, they would have a better understanding of what their students can and cannot learn via desktop virtual world role-plays.

Following this evaluation, an adequate theoretical explanation can now be provided of how students can learn the following via virtual world role-plays:

1. getting students to engage in verbal interactions in virtual worlds helps them to learn physical world verbal interactions (e.g., verbally coordinating with other classmates how to dismantle a tower crane in a virtual construction plant);
2. getting students to engage in thinking processes in virtual worlds helps them to learn physical world thinking processes (e.g., practising the thinking process of differential diagnosis while examining the patient’s abdomen in a virtual hospital).
However, it is still unclear how getting students to perform virtual world actions (e.g., clicking the Examine Chest button) might help them to learn the physical world equivalent (e.g., physically examine a human patient’s chest). This is because there is considerable morphological disconnect between the two types of actions. Performing the virtual world action and physical world action do not correspond in terms of physical movement. Some correspondence is needed for the transfer of learning to happen.

The projective identity model, flow theory, and presence theory explain how human experience can extend into fully immersive virtual environments, but do not explain how the desktop virtual world experience might correspond with the physical world experience.

The theoretical explanations that imply that students undergo a sensorimotor experience of the physical world action when they perform a virtual world action, or that students can feel a sense of presence when role-playing in desktop virtual worlds, are implausible. An alternative explanation is needed to explain how performing virtual world actions might bring about the learning of physical world knowledge and skills. To bring about this learning, virtual world actions must correspond with the physical world equivalent in some way. To be more plausible, this alternative explanation should explain this correspondence without implying a similar sensorimotor experience or a sense of presence.

I will develop this alternative explanation in Chapters 4, 5, and 6.
Part 2: A more plausible explanation of learning in virtual worlds
Chapter 4: Correspondence in meaning

Introduction

To provide a more comprehensive description of how educators currently explain learning in virtual worlds, a systematic literature review of theories used to underpin empirical studies about virtual worlds for education was reported in Chapter 2. Following an evaluation of the explanations given by these theories (Chapter 3), it is still unclear how getting students to perform virtual world actions (e.g., clicking the Examine Chest button) might help them to learn the physical world equivalent (e.g., physically examine a human patient’s chest). This is because there is considerable morphological disconnect between the two types of actions. Performing the virtual world action and physical world action do not correspond in terms of physical movement. Some correspondence is needed to explain the transfer of learning.

An alternative explanation is needed to explain how performing virtual world actions might correspond with the physical world equivalent. In this chapter, I develop such an explanation by relating John Austin’s (1962) speech act theory to the performance of virtual world actions. This chapter culminates with the integration of this new explanation into Deweyan experiential learning theory to illustrate how experiential learning theory, when extended in line with Austin’s speech act theory, can explain learning in virtual worlds. In the next section, I will further describe how the explanations given by Deweyan experiential learning theory inadequately explain learning in virtual worlds.
Embodied experiential learning is implausible in virtual worlds

Deweyan experiential learning theory is the most common learning theory used to underpin virtual world learning in the literature (Loke, 2015). I have given a detailed description of Deweyan experiential learning theory in Chapter 2. In brief, Dewey’s (1916) theory was that people learn when they (1) perform an action, (2) experience the action’s consequences, and (3) establish a link between the action and consequences through reflection.

The explanations given by Deweyan experiential learning theory are implausible when applied to virtual worlds mainly because the nature of actions described in the theory differs from the nature of virtual world actions. I reiterate that Dewey (1896) stressed the importance of embodied “sensori-motor coordination” (p. 358) between the learner and her immediate environment in order for learning to happen. To illustrate this, Dewey used the example of the concrete embodied experience of touching a flame to learn that touching a flame can cause physical pain. Dewey’s example also highlights how the consequences that he referred to, and that learners undergo in order to learn, are often physical in nature (e.g., physical pain).

In contrast, when students role-play in desktop virtual worlds, they undergo the bodily sensorimotor experience of clicking buttons in order to make their avatar act within the virtual environment. As such, they neither perform virtual world actions with the same physical movement as the physical world equivalent, nor experience any physical consequences of their virtual world actions.

The difference between the natures of virtual world actions and physical actions result in two key problems in using Deweyan experiential
learning theory to explain learning in virtual worlds. First, if the two actions are not performed with the same physical movements and do not produce the same physical consequences, how might they count as the same action?

Fundamentally, to bring about the learning of physical world skills, virtual world actions and physical world actions need to be the same action. In other words, these actions need to correspond with each other in terms of their being the same action and their “doing the same thing”. Taking again the example of learning how to perform an abdomen examination: given that clicking the Examine Abdomen button is very different from performing an actual abdomen examination, how then might students be considered to be doing the same thing? If clicking the Examine Abdomen button is not the same action and does not do the same thing as performing an abdomen examination in the physical world, then the degree of correspondence between the two actions is very low and the transfer of learning into physical world contexts will be unlikely. Without sufficient correspondence, the explanations given by Deweyan experiential learning theory inadequately explain the learning of physical world actions via virtual world role-plays.

The second problem caused by the differences between the nature of virtual world actions and physical actions relates to their consequences. If virtual world actions do not produce any physical consequences (e.g., students playing the patient do not feel any physical pressure on their abdomen when the doctor-avatar performs an abdomen examination on their patient-avatar), how can virtual world actions be said to “do” anything at all? And if they do not do anything or have any impact at all, how might virtual world actions even count as actions at all? Because virtual world actions appear to do nothing, many gamers have trivialised the violent actions they take in violent video games (e.g., killing people) as being “just pixels” (Whitty, Young, & Goodings, 2011, p. 271).
To bring about learning, experiential learning theory requires actions that are capable of “doing something”, specifically of producing “the return wave of consequences” (Dewey, 1916, p. 139). It is only by undergoing these consequences that learners learn something.

Beyond producing the return wave of consequences, virtual world actions need to produce consequences that count as the same consequences as that produced by the physical world equivalent. If virtual world actions do not have the same consequences for the student, then the explanations given by Deweyan experiential learning theory are inadequate in explaining the learning of physical world actions via virtual world role-plays.

If experiential learning theory is to be a plausible learning theory for virtual worlds, the theory needs to include an explanation of how performing virtual world actions corresponds in some way with performing physical world actions. The two types of action clearly do not correspond in terms of physical movement and physical consequences. In this chapter, I will apply speech act theory to show that virtual world actions and physical world actions correspond in another way that can be fruitful for learning.

First, I describe speech act theory and the function of performative utterances in this theory. Then I show how virtual world actions can function as performatives and can hence count as the same action in the context of a virtual world role-play. After that, I will discuss how functioning like performatives would make virtual world actions correspond in specific ways to their physical world equivalent and performing virtual world actions can hence contribute to the learning of physical world actions. I conclude this chapter by arguing that this correspondence can make experiential learning theory—when extended in line with speech act theory—a more plausible explanation of how students can learn physical world actions in virtual worlds.
How to do things with words

In *How to do things with words*, Austin (1962) developed the theory of speech acts. This theory challenged the then-predominant view that language serves only to state that something is either true or false: for example, to state that the Germany football team won the FIFA World Cup in 2014. Instead, Austin proposed that, in some cases (and more often than most people think), the uttering of a sentence constitutes the performing of an action. In other words, speech act theory recognises the ability of language to describe reality as well as to perform actions.

For example, at the FIFA World Cup opening ceremony, when the FIFA president says “I declare the 2014 FIFA World Cup open”, he is performing the act of opening the tournament through that statement. By uttering the sentence, the FIFA president is performing the speech act of OPENING a football tournament and not stating that the football tournament being open is true (speech acts will henceforth be written in all uppercase letters). In this case, “to utter the sentence... is to do it” (Austin, 1962). In other words, some actions can be legitimately performed by words and not by physical movements.

There are many other such examples in everyday life: a priest baptising a baby by saying “I baptise you in the name of the Father”; a police officer taking an oath by saying “I swear that I will perform all the duties of the office of constable according to law”; and a person saying “Sorry” to perform the speech act of APOLOGISING. Austin (1962) named this type of sentence a “performative utterance” (p. 6) because the uttering of the sentence performs the action.

Speech act theory acknowledges that there are usually a few ways to perform the same action. In some cases, the uttering of the speech act is a mandatory component of the action (e.g., the taking of an oath). In other
cases, the uttering of the speech act is not absolutely necessary. For example, to make a promise, one might utter the performative sentence “I promise you that...” and/or entwine one’s little finger with another's in a “pinky promise”. Although pinky promises are performed with different physical movements from the uttering of “I promise you that...”, both hold the same intention or the same “illocutionary force” (Austin, 1962, p. 100) of a promise; both perform the same act of promising.

When a few options to perform the same act are available, situational constraints might make one kind of performative preferable over another. When talking over the phone, given that the two interlocutors do not share the same physical space, it is impossible to perform the act of promising via a pinky promise. Instead, the uttering of “I promise you that...” is preferred over the phone. When sending text messages on mobile phones, given that the interlocutors do not share an audio channel, the typing and sending of the written words “I promise you that...” is preferred over the physical speaking of the performative sentence. Thus, with text messaging, a performative utterance can be performed via typing and sending written words, not necessarily via one’s literal utterance or speaking a sentence aloud.

How to do things with mouse clicks

Web conferencing applications provide an example of how a mouse click can function as a performative. For the web conferencing application Adobe Connect, when a participant clicks on the Raise Hand button, a raised hand icon will appear next to her name under the list of participants. This icon is visible to all web conference participants. During a web conference, given that the speakers and participants are not in the same physical space, participants typically click on the Raise Hand button to perform the action of “raising their hand” in cyberspace.
For Adobe Connect, other such status buttons that can function as performatives include the Agree button (indicated via a thumbs up icon), the Applause button (indicated via a hand clapping icon), and the Laughter button (indicated via a smiley face) (see graphical representations of all status buttons at http://adobe.ly/1k7SbpW). These status buttons are all activated by mouse clicks.

The example of the Raise Hand button highlights how the clicking of the mouse can count as an action in an online environment. More specifically, clicking on the Raise Hand button can count as the same action of raising one’s hand in a web conference, even though the act of clicking the mouse is not realised by the same physical movement as raising one’s hand in the physical world.

For the clicking on the Raise Hand button to count as the same action of raising one’s hand in a web conference, it needs first to meet the following conditions for the effective execution of performatives, as adapted from Austin (1962) and Searle (1969).

- There is an “accepted conventional procedure” (Austin, 1962, p. 14) that the person who clicks the Raise Hand button should be allowed to speak during a web meeting. This convention is partly established in the history of face-to-face meetings where raising one’s hand normally signals a request to speak. Because new technologies often require new conventions, this new convention is also explicitly spelled out in user manuals, for instance, which state that the Raise Hand button is used to “request the microphone” (University of Pennsylvania, n.d.).

- The persons involved hold the appropriate roles and responsibilities to execute the performative. In this case, the person making the request to speak must be a participant in the meeting (e.g., not an absentee) and the person granting the permission to speak must be
a meeting host (e.g., not a mere participant). In Adobe Connect, these roles are defined and the respective powers given clearly. The meeting host has the sole authority of enabling or disabling participants’ microphones and so the sole authority to allow or disallow participants to speak when the latter “raise their hand”.

- The person completes the act of clicking the Raise Hand button. In other words, the person does not miss the Raise Hand button and click an adjacent button, or put the mouse cursor over the Raise Hand button without clicking it, for example.

- The person who clicks the Raise Hand button has the sole intention of requesting the microphone. In other words, she does not have other intentions (e.g., testing out the software, disrupting the meeting) and did not click the Raise Hand button accidentally.

- The meeting host recognises and understands what the participant who clicks the Raise Hand button intends or means. That is, the meeting host understands that the participant is requesting the microphone. This is in line with Searle’s (1969) position that “the ‘effect’ on the hearer is not a belief or response, it consists simply in the hearer understanding the utterance of the speaker” (p. 47; emphasis added). Hence, if a participant clicks the Raise Hand button and the meeting host understands the raised hand icon according to the accepted social convention, then the action will have been performed successfully. The action will have been successfully performed regardless of whether the meeting host grants or denies the participant who “raised her hand” the permission to speak.

These five conditions make the clicking of a button count as a kind of action. I use the expression “a kind of action” to differentiate the online action from the physical world equivalent (the “original” or “real” action). The online action has certain characteristics of the physical
world action (to be elaborated below), but is not identical to the physical world action.

This online action is not just any action, but an action that counts as the same action as the physical world action. When all these conditions are satisfied, the clicking of the Raise Hand button counts as the same action as raising one's hand in a web conference.

If any of these conditions is not satisfied, the clicking of the Raise Hand button might no longer count as the action of raising one's hand in a web conference. For example, if the user manual of a web conferencing application does not explicitly spell out what the raised hand icon means, users can reasonably interpret the raised hand icon in other ways (e.g., as a hand gesture to signal to others to stop talking).

Although clicking on the raised hand icon does not involve the same physical movement as a person physically raising her hand, clicking on the button fills the same performative function as physically raising the hand. The correspondence of the virtual world and physical world actions hinges on the similarity of their performative function. The similarity of their performative function is the condition for the two types of actions to count as the same action.

As with other speech acts, there are usually a few ways to perform an action besides clicking a button. To ask to speak during a web conference, participants can also type “I have a question” in the text chat or raise their hand physically if they have a web camera. What I am highlighting here is that, in some online environments, clicking on buttons has become a legitimate way to perform some actions that are normally performed via physical movements (e.g., raising one’s hand, applauding, laughing). Just as uttering words can count as actions in Austin’s speech act theory, clicking on buttons can count as physical actions under certain circumstances.
In addition, actions performed via mouse clicks can produce consequences and effects in the physical world because they play the same performative role as the physical action. Being able to produce consequences and to “do something” is a key characteristic of any action. Here is an example of how online actions can “do something”. For example, web conference participants are likely to get a chance to speak if they click on the Raise Hand button; participants are likely to disapprove if a meeting host repeatedly ignores a raised hand icon.

Clicking on buttons to perform actions that have physical world consequences is not new. Other common examples include web users who click on the Vote button to vote in online polls, and on the Bid button to bid in online auctions. Although not involving the same physical movement, clicking on the Bid button in online auctions is definitely an action with consequences in the physical world because the conditions for a successful performative have been satisfied.

Also drawing on speech act theory, Powers (2003) gave a more sinister example of how online actions can have effects in the physical world. In the example, an alleged cyber-rape took place in a computer-based and text-based virtual community called LambdaMOO. All LambdaMOO users have a character that they control by typing textual commands (e.g., to move the character into different rooms, to build objects, to interact with other characters). What each character says or does is displayed to other users whose characters are in the same room. The alleged cyber-rape involved the character Bungle raping the characters legba and Starsinger, an act that was witnessed by other users whose characters were in the same room. To carry out the text-based rape, Bungle’s controller used a subprogram called a “voodoo doll” to attribute actions to legba and Starsinger, actions for which their controllers did not actually type the commands. Powers (2003) argued that the cyber-rape victims can suffer non-physical effects such as shame (as evidenced in the victims’ eventual
public statement), even though no physical contact took place. The cyber-rape can cause non-physical effects in the physical world because the text-based rape satisfied all the conditions for the effective execution of performatives, notably that Bungle's controller had the intention to rape and that both the victims and witnesses understood Bungle's controller's intention. A key point in Austin's (1962) speech act theory is how actions do not need to be performed by "physical movements" (p. 19) to count as actions and have effects on others.

As an aside, the perception that only the physical elements matter (i.e., that only physical movements can “do something”) is perpetuated in criminal laws concerning virtual worlds in the U.S.A. (Kerr, 2008). Whether a person has committed a crime depends on whether a series of elements have been satisfied, and these elements tend to be physical in nature (e.g., involving physical acts, physical impact). For example, the crime of trespass requires the physical entrance of a person into a prohibited space. Currently, making a prohibited entrance into a virtual property is a non-criminal offence.

Virtual world actions can function as performatives

Like clicking the Raise Hand button, clicking the Examine Chest button in Otago Virtual Hospital can also function as a performative. Although the two actions are realised with different physical movements, clicking the Examine Chest button corresponds with a physical chest examination because it fills the same performative function. Let us examine the necessary conditions for the successful execution of a chest examination in Otago Virtual Hospital:

- There is an accepted conventional procedure that the doctor has to click on the Examine Chest button to examine the patient’s chest. In fact, this virtual hospital is designed such that clicking on the
Examine Chest button is the only way a doctor can perform a chest examination. Currently, students find out that they have the option of performing a chest examination in the following way: when the doctor moves close enough to the patient on the bed, the Examine Chest button appears on the doctor’s interface. After the doctor clicks on the button, the patient receives a text notification in the text chat that the doctor is performing a chest examination on her. The effectiveness of this virtual world action hinges on students knowing this convention, so I recommend that the tutor spell out this conventional procedure clearly to students (at a pre-scenario briefing or in the user manual, for example).

- The student role-playing the doctor holds the appropriate responsibility to perform a chest examination on the patient-avatar, and the student role-playing the patient expects the doctor-avatar to examine the patient-avatar’s chest at some point in the consultation. These social expectations are shaped by the students’ medical training as well as current norms in actual hospitals. The tutor assigns the roles of doctor and patient prior to the role-play.
- The student role-playing the doctor completes the act of clicking the Examine Chest button. In other words, the student does not miss the Examine Chest button and click an adjacent button, or put the mouse cursor over the Examine Chest button without clicking it, for example.
- The student who clicks the Examine Chest button does so deliberately and has the sole intention of examining the patient’s chest to establish a diagnosis. In other words, the student has no other intentions (e.g., experimenting with different procedures just to see how the patient reacts, molesting the patient). Nonetheless, it is useful to briefly explore a counter example just to highlight the importance of the intention or illocutionary force behind the mouse click in establishing the meaning of the action. In the event that the
student clicks the Examine Chest button with other intentions, the virtual world action will take on a different meaning. For example, if a particular student clicks the same button with the alternative intention of experimenting with different procedures (e.g., accompanying her mouse click with a text message “Sorry, just trying out all the buttons to see what they do, please ignore”), then the action will have a different meaning and the intended effect on the patient will also be different (i.e., that of ignoring the action). This counter example however constitutes a violation of the accepted convention and also involves the student being out-of-character in the role-play (i.e., the student is no longer playing the doctor when she experiments with different procedures).

- The student playing the patient reads the text notification that the doctor is performing a chest examination on her and understands or interprets the doctor’s intentions as wanting to perform a chest examination on her, according to the accepted social convention.

I emphasise “understands or interprets” above to highlight that the basis of virtual world actions is derived mainly from social convention and mutual agreement. A student who ignores or does not accept the social convention can reject the clicking of the Examine Chest button as signifying the doctor’s intention to examine the patient’s chest and interpret it as something else. This interpretation is possible because virtual world actions are “portions of the real world, objective facts in the world, that are only facts by human agreement” (Searle, 1995, p. 1). Other such examples of objects whose meaning is derived from social convention include footballs, wedding rings, and money. Just as one could interpret a two-dollar coin as merely a circular piece of copper, one could very well interpret the clicking of the Examine Chest button as being totally devoid of meaning (“just pixels”), or meaning something other than a chest examination. However, most people do follow the accepted
social conventions and interpret the circular piece of copper as money, a medium of exchange and a valuable asset. Similarly, when students see the text notification that the doctor is performing a chest examination, they are expected to “take it as” (Austin, 1962, p. 33) a chest examination even though no physical contact was made. Cyberpunk author Gibson (1984) foregrounded the necessity for this mutual human agreement in virtual worlds when he famously defined cyberspace as a “consensual hallucination” (p. 69).

In contrast, physical actions in the physical world rely less on mutual agreement to count as actions. For example, when a footballer elbows her opponent in the face during a football match, it is harder for the opponent to deny that an action actually took place because of the physical effects of the action (e.g., a swollen face). This is unlike virtual world actions that do not produce any physical consequences and that rely more on social convention and human agreement to count as actions.

When the above conditions are satisfied, the clicking of a button can then count as a kind of action, as “doing something” in the virtual world. More specifically, the clicking of a button counts as the same action: clicking the Examine Chest button counts as examining the patient’s chest in Otago Virtual Hospital. Thus, performing a chest examination in Otago Virtual Hospital can fill the same performative function as a chest examination in the physical world. It is the performative function that helps explain how virtual world actions can correspond with their physical world equivalent, and in turn how performing virtual world actions can bring about the learning of physical world actions.

To further illustrate how virtual world actions can function as performatives, I present below an overview of the virtual classroom VirtualPREX (Dalgarno et al., 2016; Gregory et al., 2011) which provides an interesting example of how a particular Locomotive action
(Fardinpour & Reiners, 2014) gains its meaning from the virtual world context.

**VirtualPREX**

VirtualPREX is a virtual classroom developed in Second Life in which pre-service teachers role-playing as teachers get to try out different teaching strategies with a class of primary school pupils (see Figure 9).

![Figure 9. Teacher-avatar giving a lesson in VirtualPREX. From “VirtualPREX – Virtual Professional Experience,” by VirtualPREX Project Team, n.d. CC BY 3.0.](image)

There are two versions of this virtual classroom: one version involves pupil-avatars that are played by other pre-service teachers; the other involves pupil-avatars that are “bots”. Bots are non-player characters that are controlled by the computer (instead of by pre-service teachers) and that are pre-programmed to respond to the teacher-avatar’s actions in pre-determined ways. Using bots has the advantages of ensuring every pre-service teacher has a consistent learning experience and of allowing pre-service teachers to undertake role-plays at any time of their
convenience. Pre-service teachers can interact with bots on their own, without having to gather other pre-service teachers to play the pupil-avatars.

In VirtualPREX, pre-service teachers are expected to learn how to manage disruptive pupils. One way to manage a disruptive pupil in VirtualPREX is to walk closer to the pupil to indicate to the pupil that the teacher is aware of the disruptive behaviour. In the bot version of VirtualPREX, when the teacher-avatar walks closer to the disruptive pupil (e.g., who is standing on her desk or disturbing other pupils), the pupil-avatar (a bot) is pre-programmed to have a 90% chance of stopping her disruptive behaviour and then resuming her learning.

As an aside, the pre-programming of bots will typically render the virtual world more artificial. Disruptive pupils in physical world classrooms may have a lower probability than 90% of stopping their disruptive behaviour when the teacher walks near them.

Walking closer to the disruptive pupil is a Locomotive action. In general, Locomotive actions pose a particular challenge in the design of virtual worlds because their meanings are harder to establish compared to other actions. It is easy to establish that clicking the Examine Chest button means a chest examination, but harder to establish what the teacher-avatar means by walking around the classroom or if the teacher-avatar means anything specific at all. The design of the bot version of VirtualPREX had to differentiate between intentional walking around to manage disruptive pupils and “meaningless” walking around with no intention of managing disruptive pupils. This is where Austin’s (1962) speech act theory is again useful to establish a particular meaning to a particular type of walking around the classroom.
When the necessary conditions for the successful execution of performatives are satisfied, the Locomotive action of walking closer to a disruptive pupil can count as the act of managing the disruptive pupil.

- There is an accepted conventional procedure in physical world classrooms that walking closer to a disruptive pupil means that the teacher is aware of the behaviour and expects the pupil to stop her disruptive behaviour. This social convention is designed into VirtualPREX: the disruptive bots are designed to stop their disruptive behaviour when the teacher-avatar walks closer to them.

- The pre-service teachers playing the teacher holds the appropriate responsibility to manage disruptive behaviours in the class, and the bots are pre-programmed to accept the teacher’s authority.

- Establishing the pre-service teacher’s intention for walking closer to a particular pupil is trickier than for other virtual world actions. VirtualPREX is designed such that if the teacher-avatar walks sufficiently close to a disruptive pupil and stays there for a sufficiently long time, then it is assumed that the pre-service teacher playing the teacher has the intention of managing the disruptive pupil.

- Establishing that a bot an “understand” the pre-service teacher’s intention is also trickier than for other virtual worlds without bots. VirtualPREX is designed such that if the teacher-avatar walks sufficiently close to a disruptive pupil and stays there for a sufficiently long time, then it is assumed that the bot “understands” the teacher’s intention for her to stop the disruptive behaviour.

Without satisfying these conditions, walking closer to a pupil has no meaning, or at least does not mean that the teacher intends to manage the disruptive pupil. It is because this Locomotive action fills the same
performative function as walking closer to a disruptive pupil to manage the pupil’s behaviour that pre-service teachers can learn Locomotive $X^{PW}$ by doing Locomotive $X^{VW}$. In an evaluation of VirtualPREX, 46% of participating students expressed that the virtual world role-play helped to develop their skills in moving around the classroom (Dalgarno et al., 2016). At the same time, it is acknowledged that 54% of the participants expressed otherwise.

In the final section, I will integrate this new explanation into Deweyan experiential learning theory to illustrate how experiential learning theory, when extended in line with Austin’s speech act theory, can explain learning in virtual worlds.

Experiential learning in virtual worlds

I stated earlier that Deweyan experiential learning theory involving sensorimotor experience provided an implausible explanation of learning physical world actions because doing $X^{VW}$ does not correspond with doing $X^{PW}$ in terms of physical movement. To provide a more plausible explanation, I replaced sensorimotor experience with the performative function. By extending Deweyan experiential learning theory in line with Austin’s (1962) speech act theory, I resolved the two initial problems caused by difference between the natures of virtual world actions and physical actions. First, when virtual world actions function as performatives, they count as a kind of action (i.e., they “do something”) even though they do not produce physical consequences. Second, when virtual world actions fill the same performative function as the physical world action, the two actions count as the same action despite the morphological disconnect between them.

First, virtual world actions count as a kind of action even though they do not produce any physical consequences. As elaborated above, when all the
conditions for the effective execution of performatives are satisfied, virtual world actions count as legitimate actions that can produce non-physical effects; they are socially accepted actions that “do something”. For example, if a student playing the doctor clicks the Close Curtain button in order to draw the curtain before examining the patient-avatar’s chest, the student playing the patient is likely to feel respected (i.e., a non-physical effect) because the doctor made an effort to protect her avatar’s privacy. This particular virtual world action produces even more pronounced consequences when they are not performed at the appropriate time: if the doctor-avatar fails to draw the curtain before examining the patient-avatar’s chest, the student playing the patient might feel disrespected and reprimand the doctor-avatar, as was the case during a trial of the Otago Virtual Hospital (Loke et al., 2012b). When virtual world actions function as performatives, their effects are less than physical effects, but they do produce some effects (see Figure 10).

**Figure 10. Continuum of effects produced by actions**

To reiterate, Deweyan experiential learning theory requires actions that are capable of producing “the return wave of consequences” (Dewey, 1916, p. 139), consequences that learners need to undergo in order to learn something. When virtual world actions function as performatives, they count as a kind of action and can produce the necessary (albeit non-physical) consequences to bring about the intended learning. I will further elaborate on how non-physical consequences are sufficient to bring about learning in Chapter 5.
Second, when all the conditions for the effective execution of performatives are satisfied, two actions that are performed with different physical movements can count as the same action in terms of their meaning the same action. Taking again the example of drawing the curtain: clicking the Close Curtain button involves a different physical movement than drawing an actual curtain, but the two actions mean or signify the same action in the context of the virtual role-play. When virtual world actions function as performatives, they are socially-accepted actions that are more than just pixels (i.e., not real at all), but less than physical actions (see Figure 11).

**Figure 11. Continuum of reality of actions**

To reiterate, Deweyan experiential learning theory requires actions that correspond with each other in terms of being the same action. In this chapter, I developed an alternative explanation of how virtual world actions and physical world actions correspond with each other: when virtual world actions fill the same performative function as the physical world equivalent, although they are not executed with the same physical movements, they nonetheless mean the same action in the virtual world role-play. As with performative utterances, virtual world actions count as the same action by virtue of social convention or “human agreement” (Searle, 1995, p. 1) and not by virtue of similar physical movements or physical effects. It is in meaning the same action that virtual world actions correspond with the physical world equivalent.
I will now integrate the alternative explanation into Deweyan experiential learning. By extending Deweyan experiential learning theory in line with Austin’s (1962) speech act theory, experiential learning in virtual world now consists of students:

1. performing virtual world actions that fill the same performative function as the physical world equivalent (i.e., virtual world actions that mean the same action as the physical world action);
2. undergoing the virtual world actions’ non-physical effects (which correspond with the non-physical effects normally produced by the physical world equivalent); and
3. establishing a link between the action and effects through reflection.

Therefore, performing virtual world actions helps students learn the physical world equivalent because students get to do the action semantically (not because they get to do the action physically). In other words, students get to act with meaning. To “act with meaning” is not a commonly-used expression and it may be difficult to visualise what it involves. I will hence provide an empirical illustration of acting with meaning in Chapter 6.

One important characteristic of performing virtual world actions is that students get to act with meaning publicly, just as people utter sentences publicly to perform speech acts. It is probably in this sense that students role-playing in virtual worlds are said to be undertaking a “performative” (Warburton, 2009, p. 421) and “enactive” (Henderson et al., 2012, p. 412) learning experience. In other words, the performance of virtual world actions involves some form of public instantiation that is observable by others.

More fundamentally, it is probably in the sense that students get to act with meaning in virtual worlds that virtual worlds are said to offer
students a “hands-on” (Farley, 2014, p. 326) learning experience. By acting with meaning, students get to “do something” and perform legitimate actions. In this sense, hands-on learning contrasts with learning by reading books or listening to lectures. However, hands-on learning in virtual worlds is not the same as physical hands-on learning, as in “lots of hands-on cooking” (Otago Polytechnic, 2017, para. 1) in the New Zealand Diploma in Cookery. Students learning in virtual worlds get to perform legitimate actions, but not in a physical way.

By relating Austin’s (1962) speech act theory to the performance of virtual world actions, I have developed an alternative explanation about how students can learn physical world skills in desktop virtual worlds without implying a similar sensorimotor experience or a sense of presence. Based on this alternative explanation, the basis of learning by doing something in desktop virtual worlds is better explained as deriving from social conventions, rather than from physical experience.

One potential objection to integrating speech act theory to explain virtual world learning is that virtual world actions are not exactly speech acts. A chest examination is not a speech act in that it does not mean or signify anything other than a chest examination. Contrasting with the speech act of PROMISING: a chest examination is unlike a pinky promise that signifies a promise. This is why I have stressed that virtual world actions can function as performatives, but are not speech acts per se.

**Conclusion**

I started this chapter by stating that an alternative explanation is needed to explain how performing virtual world actions might correspond with the physical world equivalent. The two types of actions do not correspond in terms of physical movement. When the conditions for successfully executing performatives are met, virtual world actions correspond with
physical world actions in terms of filling the same performative function. They thus count as the same action.

Therefore, when students do $X^{VW}$, they get to do $X^{PW}$ semantically in the sense that they get to act with meaning. Getting this opportunity to perform $X^{PW}$ with meaning helps students learn $X^{PW}$. Based on this alternative explanation, the basis of learning by doing something in desktop virtual worlds is better explained as deriving from social conventions, rather than from physical experience. It is the social conventions that lend weight to virtual world actions, giving these actions their illocutionary force and making them more than just pixels.

Experiential learning theory can provide a plausible explanation of how students can learn physical world actions in virtual worlds if the theory is extended in line with Austin’s (1962) speech act theory. This is a useful example of how the “the boundaries of traditional theories” can be stretched in order to provide a plausible explanation of human experience in virtual worlds (Powers, 2003).

In Chapter 5, I will describe and reply to Austin’s (1962) potential objection to my claim that virtual world actions performed in the context of make-believe role-plays can function as performatives.
Chapter 5: Make-believe yet effective

Introduction

In the previous chapter, I showed how performing virtual world actions can bring about the learning of physical world actions (e.g., a chest examination). To explain transfer of learning from the virtual learning context to the target physical world context, there needs to be a high degree of correspondence between the learning performance and target performance. When virtual world actions function as performatives, they correspond to physical world actions in terms of meaning the same action. This correspondence is sufficient to explain how students can learn how to perform physical world actions by role-playing in virtual worlds.

In this chapter, I will reply to Austin’s (1962) potential objection to my claim that virtual world actions performed in the context of make-believe role-plays are able to function as performatives. One example of a make-believe virtual world is the Otago Virtual Hospital (Blyth & Loke, 2014; Loke, Blyth, & Swan, 2012a). In brief, this virtual world is make-believe in the sense that medical students are pretending to be doctors and their virtual world actions have no material effect on the physical world.

Here is an outline of Austin’s objection and how it affects my argument. Austin stated that, if performed in the context of theatre, all performatives are ineffective. They are ineffective because they are hollow and void (these terms will be explained in the next section). If virtual world role-plays are like theatrical performances, and if all theatrical performatives are ineffective, then all virtual world actions are also ineffective and cannot function as performatives. In turn, if virtual world actions cannot function as performatives, then there is insufficient
correspondence between the learning performance and target performance.

In the next section, the basis of Austin’s objection will be examined in depth. After that, I will show that, despite Austin’s objection, virtual world actions can still function as performatives because of two reasons. First, virtual world actions are not as hollow and void as theatrical actions. Second, some forms of workplace learning where students do learn physical world actions involve actions that are just as hollow and void as virtual world actions. Therefore, students can also learn physical world actions by role-playing in virtual worlds even if there is some degree of hollow-ness or void-ness.

Theatrical performatives are ineffective

The basis of Austin’s (1962) objection will be examined in this section. While exploring all the possible ways performative utterances can go wrong, Austin (1962) stated that:

[A] performative utterance will, for example, be in a peculiar way hollow or void if said by an actor on the stage, or if introduced in a poem, or spoken in soliloquy... Language in such circumstances is in special ways—intelligibly—used not seriously, but in ways parasitic upon its normal use. (p. 22)

I will illustrate how theatrical utterances might be hollow and void with a line from Shakespeare’s Romeo and Juliet. The context of this line was that Juliet was going against her father Lord Capulet’s wish for her to marry Paris because she wanted instead to marry Romeo. In a theatrical performance, when the actor playing Lord Capulet utters “get thee to church o’ Thursday, Or never after look me in the face” to the actor playing Juliet, he could be conceived as performing the speech act of THREATENING to disown Juliet. However, Austin would classify this on-
stage utterance as void and hollow. It is void because the actor playing Lord Capulet is not the “real” father of Juliet and is hence not in a position to disown Juliet (notably not in the physical world). The utterance is hollow because the action is not performed with the actor’s sincere intentions: the actor utters the threat knowing full well that the threat will not be effective in the physical world.

Austin’s classification of theatrical utterances as hollow and void can be further clarified if an actor uttering “Or never after look me in the face” to threaten Juliet was compared with a priest uttering “I baptise you in the name of the Father” to baptise a baby. The latter utterance is not void because the priest is a real priest in the physical world and hence in a position to baptise the baby. Correspondingly, the beneficiary of the utterance (the baby) is a real baby who needs baptising. The priest’s utterance is not hollow because the priest is sincere and knows that the utterance will effectively christen the baby in the physical world (e.g., other Christians will effectively recognise and accept that the baby has been christened).

I accept Austin’s characterising theatrical performatives as being hollow and void. However, I will show that virtual world actions are not hollow and void to the same degree as Austin’s description of theatrical performatives, even though they are to some extent make-believe like a theatrical performance. To do that, I will examine the degrees of “hollow-ness” and “void-ness” in four different contexts:

1. theatre;
2. virtual world role-plays (i.e., learning experience where students role-play as doctors in a virtual hospital);
3. clinical placements (i.e., learning experience where medical students undertake some clinical activities in hospitals/general practices under the supervision of actual doctors); and
4. actual professional practice undertaken by qualified doctors.

Actions taken in these four contexts exhibit a range of hollow-ness and void-ness, from (1) being totally hollow and void in theatre to (4) being totally real in actual professional practice (e.g., the actions undertaken by qualified doctors have a material effect in the physical world). Examining hollow-ness and void-ness in these four contexts will allow me to determine the degrees of hollow-ness and void-ness within which students can plausibly learn physical world actions. Determining this range is important because my argument is that, while virtual world actions are hollow and void to some degree, they are not so hollow and void that physical world learning cannot take place. In other words, virtual world actions are partially hollow and void (just as clinical placements are, as I will argue below), but sufficiently real to function as performatives because they correspond sufficiently with physical world actions. Adequacy conditions for what amounts to being “sufficiently real” will be spelled out in the section on degrees of hollow-ness.

The degrees of void-ness in the four contexts listed above will be examined in the next section. I will illustrate my examination with examples from the Otago Virtual Hospital, where medical students role-play as doctors to provide medical care for a patient in a virtual hospital.

**Degrees of void-ness**

In the context of theatre, actors’ actions are totally void because actors are not and do not aspire to be the characters they play on stage. As stated earlier, the actor playing Lord Capulet is not the “real” father of Juliet and is hence not in a position to disown Juliet. Also, the actor most likely does not aspire to be the “real” Lord Capulet. So, the actor’s action is totally void because the actor is adopting a totally make-believe identity.
In virtual world role-plays, students’ virtual world actions are void—to some degree—because students are not fully the character they play and they know this. For example, in the Otago Virtual Hospital, the students are medical students and not fully the doctors they play.

However, unlike theatrical actions, students’ virtual world actions are not totally void because the students aspire to be the characters they play in the virtual world. In the Otago Virtual Hospital, the medical students role-playing as doctors are very close to being in the position of an actual doctor who can perform all the clinical procedures legitimately. At the very least, these students have the sincere intention of becoming doctors and have also shown some capability of becoming doctors. Medical students are “doctors-to-be”. As such, their virtual world actions are partially but not totally void.

In clinical placements, medical students are also doctors-to-be. As such, their actions during clinical placements are also partially but not totally void.

In actual professional practice, the qualified doctors are in a fully legitimate position to provide medical care for patients. As such, their actions are totally real (i.e., not void at all).

Therefore, the degree of void-ness of an action is dependent on the types of relationship students have with their virtual world identity (see Figure 12).
At this point, I will build my argument that partially void virtual world actions are sufficiently real for students to learn physical world actions. In other words, virtual world actions are not so void that physical world learning cannot take place.

There are two parts to my argument. First, I argue that virtual world actions and actions taken during clinical placements are equally void and hence both should have similar learning results. They are equally void because, in terms of identity, medical students in virtual world role-plays are similar to medical students on clinical placements: they are both doctors-to-be in the sense that they aspire to become doctors, although they are not yet fully qualified doctors. Hence, students’ actions in both cases are partially void, to the same degree.

Here is an example of how actions taken during clinical placements are partially void. Medical students, being only doctors-to-be, are not given full responsibility of their patients so as to preserve patient safety. Often, the only “real” actions that medical students get to carry out during clinical attachments are “benign” tasks such as calling a patient into a consulting room or completing a request form (Dornan et al., 2007). When medical students are asked to perform more important tasks (for
which they are not yet in a position to perform), their actions are partially void because their supervisors (qualified doctors) typically repeat their actions and make final decisions to ensure patient safety. For example, a medical student might take the patient’s medical history, report her assessment to her supervisor, only to have the supervisor take the patient’s medical history again as a safety measure and then make the final decision about the assessment. From a case study on the Otago Virtual Hospital (Loke et al., 2012b), one medical student shared the following example of medical students performing physical examinations of patients during clinical placements:

It depends on the (supervisor). In a nice cooperative environment, if they were OK with it, then you could write out the admission notes and examination findings, even though they will want to repeat the examinations anyway. (p. 569)

In such cases, clinical placements are make-believe in the sense that medical students are pretending to be doctors and performing actions over which they do not have the official authority. Virtual world role-plays are make-believe in a similar way.

The second part of my argument is that, even though actions taken during clinical placements are partially void, they are sufficiently real such that medical students do learn some clinical skills during clinical placements (Dornan et al., 2006). Featuring the same degree of void-ness, virtual world role-plays should also involve similar learning.

During clinical placements, while pretending to be doctors, students get to practise physical world actions in the form of a “rehearsal” (Dornan et al., 2007, p. 86) in the sense that students engage in a mock practice that prepares them for the “real thing” in the near future. Although it is not the “real thing”, this trial performance allows students to physically engage in the target actions in a safe environment.
Therefore, if virtual world actions are just as void as actions taken during clinical placements, and if students do learn some physical world skills during clinical placements, it is plausible that virtual world actions are also sufficiently real such that medical students can learn some physical world actions via virtual world role-plays. Even though medical students are pretending to be doctors in virtual world role-plays, they get to rehearse clinical actions (e.g., examining the patient’s chest, ordering a CT scan) in a safe environment.

In particular, in virtual worlds, students get to rehearse the detection of an appropriate opportunity to commit to an action (e.g., is this a good time to order a CT scan?). Students have reported that they get to “make the call” in the Otago Virtual Hospital, and that they rarely get to do so during clinical placements to ensure patient safety (Loke et al., 2012b). This detection of the appropriate opportunity relies on one’s dispositions. I will relate the performance of virtual world actions to the dispositional theory of thinking in Chapter 6 to show how students can learn the dispositional components of physical world actions by performing virtual world actions.

I have argued that, even though virtual world actions are partially void, they are sufficiently real for some physical world learning to take place. I will now extend my argument to the degree of hollow-ness.

**Degrees of hollow-ness**

In the context of theatre, actors’ actions are totally hollow because actors carry out the action knowing full well that the action will *not* have an effect in the physical world. So, actors’ actions are totally hollow because the actions have a totally make-believe effect in the physical world.

In virtual world role-plays, students’ virtual world actions are hollow—to some degree—because virtual world actions have no physical effect in the
physical world. Drawing on Schechner’s performance theory, virtual world actions, like all theatrical actions, are characterised by their “non-productivity” (Schechner, 2003, p. 19) in the physical world. For example, in the Otago Virtual Hospital, medical students carry out virtual world actions knowing full well that the student playing the patient will not suffer any physical effects of their virtual world actions. For example, the doctor-avatar might administer an injection on the patient-avatar, but the student playing the patient will not receive an injection physically. This is how one student described the non-productivity of the virtual hospital: “It’s less scary too, it’s not a real patient. If something goes wrong, it’s not going to kill them” (Loke et al., 2012b. p. 570).

However, virtual world actions are not totally non-productive because they can produce non-physical effects. Even though virtual world actions cannot generate physical effects, I have argued in the Chapter 4 that it is plausible that virtual world actions can cause non-physical effects such as humiliation or anger. At this point, let me qualify my argument: virtual world actions can cause non-physical effects only when the avatar targetted by the action is controlled by a human being. Some virtual worlds feature non-player characters (NPCs) or bots controlled by the computer. NPCs are incapable of feeling any effects (physical or non-physical). An example of a virtual world that features NPC patients is the virtual hospital developed by Imperial College London (Toro-Troconis, Meeran, Higham, Mellström, & Partridge, 2010). When medical students take their patient’s medical history in this virtual hospital, they know full well that they are “talking” to a machine and that they cannot cause any effects such as humiliation or anger on the NPC. In other virtual worlds where avatars are controlled by human beings, virtual world actions can produce non-physical effects.

Moreover, unlike theatrical actions which are totally hollow, students’ virtual world actions are not totally hollow because students carry out
virtual world actions with sincere intentions. In other words, students really mean what they do in virtual worlds. For example, in the Otago Virtual Hospital, when medical students take their patient’s history, they honestly do not know what might be wrong with their patient and are sincere about finding out what might be wrong by asking the patients some questions. In the context of theatre, theatre actors asking a question of their patient already know their patient’s pre-scripted response and hence are not sincere about finding out what might be wrong with the patient.

That virtual world actions are performed with sincere intentions is not a new idea. Many educators already assume that students perform virtual world actions with sincere intentions, although few have made the assumption explicit. The best example is how many educators assess their students’ physical world abilities based on their students’ virtual world performance. At least three assessment frameworks have been developed that assess students based on their virtual world performances (Chodos et al., 2014; Fardinpour & Heinz, 2012; Loke et al., 2012a). Virtual world performances can be considered a valid reflection of students’ physical world capability only if it is assumed that students genuinely mean what they do in the virtual world. In other words, the virtual world performance would not be a valid reflection of students’ physical world capability if, for example, students were role-playing in the sense of playfully acting as an “evil doctor”. In contrast to virtual world role-plays for professional education, because theatre actors’ on-stage actions do not stem from their physical world intentions, it would be unreasonable to judge theatre actors’ physical world capability or character based on their on-stage actions (e.g., violent tendencies while playing an evil doctor on stage).
Therefore, in virtual world role-plays, students’ actions are partially but not totally hollow because their actions can produce non-physical effects and are performed with sincere intentions.

In clinical placements, the degree of hollow-ness of students’ actions depends on how “real” the actions are. The “real” actions are not hollow at all; the make-believe actions are partially hollow. As mentioned earlier, to ensure patient safety, the only “real” actions that medical students get to carry out during clinical attachments are often unimportant tasks such as calling a patient into a consulting room or completing a request form (Dornan et al., 2007). It is also acknowledged that, at certain times, medical students do perform other actual tasks such as taking the patient’s blood pressure, but under the supervision of their supervisor. In such cases, the students’ actions are not hollow because medical students perform the actions with sincere intentions (e.g., they truly mean to call the patient into the consulting room) and their actions produce material effects (e.g., the patient who hears their call will likely follow them into the consulting room as a result of their call).

However, to ensure patient safety, the majority of actions that medical students take during clinical placements are partially make-believe (Sinclair, 1997) and hence partially hollow. From his ethnographic study of a clinical placement, Sinclair (1997) coined the term “cold patients” (p. 32) to describe patients who used to but no longer have clinical problems. Most of the time, medical students in clinical placements are tasked to take actions directed at such cold patients. For example, medical students write up treatment plans for cold patients for whom treatment plans have already been written by senior doctors. In such cases, the students’ actions are partially hollow because their plans have no material effect (given that their plans will not be executed), even though the students are sincere about recommending a particular treatment plan. Providing
another perspective, Sinclair (1997) described such partially hollow actions as “hypothetical actions” (p. 32).

One medical student who role-played in the Otago Virtual Hospital described medical students’ hypothetical actions during clinical placements in this way:

And sometimes it’s a difficult mental shift because you’re just thinking, I’m just a student, it doesn’t matter, my decisions don’t really count for much. So you’ve got to physically make that mental shift so that you can prepare yourself for later on. (Loke et al., 2012b, p. 570)

This medical student judged that role-playing in the Otago Virtual Hospital potentially helped her make this mental shift. I contend that, while virtual world role-plays are partially hollow, they are not “hypothetical” in the same way clinical placements are. This is because virtual world role-plays are concerned with what students actually did in the virtual world and not what they would do if an imaginary situation presents itself.

In actual professional practice, the qualified doctors’ actions are totally real (not hollow at all) because their actions are performed with sincere intentions and produce material effects. For example, when the qualified doctor administers an injection on the patient, the patient receives the injection physically.

At this point, I will build my argument that partially hollow virtual world actions are sufficiently real for students to learn physical world actions. In other words, virtual world actions are not so hollow that physical world learning cannot take place.

Again, there are two parts to my argument. First, I argue that virtual world actions and actions taken during clinical placements are equally
hollow. Like virtual world actions, actions taken during clinical placements typically have no material effect in the physical world. In such cases, clinical placements are make-believe in the sense that students’ actions are non-productive. At the same time, both virtual world actions and actions taken during clinical placements are not totally hollow: they are both performed with sincere intentions.

The second part of my argument is that, even though actions taken during clinical placements are partially hollow, they are sufficiently real such that medical students do learn some clinical skills (Dornan et al., 2006). Even though their clinical placement actions are non-productive, students get to physically engage in the target actions in the form of a rehearsal. Rehearsing these actions will prepare them for the “real thing” in the near future.

Therefore, if virtual world actions are just as hollow as actions taken during clinical placements, and if students do learn some physical world skills during clinical placements, it is plausible that virtual world actions are also sufficiently real such that medical students can learn some physical world actions via virtual world role-plays.

The adequacy conditions for what amounts to being “sufficiently real” will now be spelled out:

1. The student adopts an identity that is at least aspirational to the physical world identity;
2. The action is at least able to produce the same non-physical effects as the physical world action does.

In contrast, a theatre actor’s actions are not considered to be sufficiently real because the actor does not aspire to become the physical world equivalent of their character and their on-stage actions are totally non-productive, as explained above.
Table 4 summarises the degrees of void-ness and hollow-ness in the different contexts.

**Table 4. Degrees of void-ness and hollow-ness in different contexts**

<table>
<thead>
<tr>
<th>Void-ness and hollow-ness</th>
<th>Context</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totally void and totally hollow</td>
<td>Theatre</td>
<td>Actor is not the character and does not aspire to be the character</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action is totally non-productive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medical student aspires to be a doctor but is not fully a doctor</td>
</tr>
<tr>
<td></td>
<td>Virtual world role-play</td>
<td>Action is partially non-productive (can have non-physical effects)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action is performed with sincere intentions</td>
</tr>
<tr>
<td>Void-ness and hollow-ness</td>
<td>Context</td>
<td>Reason</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>Partially void and hollow</td>
<td>Clinical placement</td>
<td>Medical student aspires to be a doctor but is not fully a doctor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action is typically non-productive (typically directed at cold patients)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action is performed with sincere intentions</td>
</tr>
<tr>
<td>Totally real</td>
<td>Actual professional practice</td>
<td>Person is a qualified doctor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action has real, material effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action is performed with sincere intentions</td>
</tr>
</tbody>
</table>

Therefore, as with actions undertaken during clinical placements, virtual world actions are sufficiently real for some physical world learning to take place, even though they are partially void and hollow.

**Necessity of some void-ness and hollow-ness**

Some educators may want to find ways of making virtual world actions totally real (i.e., not at all void nor hollow) in the hope of improving their
students’ learning experience. However, if we removed hollow-ness and void-ness completely, we would also remove the learning advantages of virtual worlds. In a sense, some degree of void-ness and hollow-ness is necessary for learning in virtual worlds to happen.

One learning advantage of virtual world role-plays (or any role-play for professional education) is to allow students to take on their aspirational identity. It is by virtue of their taking on this new identity that students are allowed to take virtual world actions that they are not normally allowed to take in the physical world. Taking on another identity necessarily makes students’ actions partially void.

Another learning advantage of virtual worlds is to allow medical students to make mistakes as medical students. This is made possible by virtual world actions being non-productive in the physical world, which in turn makes students’ actions partially hollow. If virtual world actions had a material impact on the physical world (e.g., if ordering a CT scan in the virtual world resulted in ordering a CT scan in an actual hospital), then virtual worlds would be unsafe for students to use and they could not make the errors necessary for deeper learning.

To be sure, there are instances during some virtual world role-plays when students weave back into their physical world identity and are hence no longer void. However, these are instances when the intended learning is not happening. Jauregi, Canto, de Graaff, Koenraad, and Moonen (2011) provide one such example: in Second Life, two foreign language students and two language teachers find a suitable place for a conversation and one teacher suggests that they all sit down. The first teacher (T1) cannot sit down.

T1: I can’t sit down.

T2: Why not?
T1: Because I have forgotten my mouse. I am at my mum’s house and I have forgotten my mouse and I don’t know how to [make my avatar sit down] with my keyboard.

During this brief period, both T1 and T2 weave back into their real identities (by accident), but are no longer participating in the intended learning activity.

Therefore, virtual world actions have to be void and hollow to some degree for the intended learning to happen. The necessity of some degree of void-ness and hollow-ness aligns with the conception of learning in virtual worlds as make-believe rehearsals. In the next section, I will build on this alignment and explain why it is useful to conceive learning in virtual worlds as being like a particular kind of theatrical performance: shadow puppetry.

Virtual world role-plays as shadow puppetry

Virtual world actions are void and hollow to some degree because they involve make-believe identities and make-believe effects. This aligns well with the notion of rehearsals, which are make-believe practices that prepare students for the “real thing”. During rehearsals, people also adopt make-believe identities and take actions that have make-believe effects. It is hence possible to conceive virtual world role-plays as rehearsals. Using such a lens, a lecturer in Theatre Studies told me that role-playing in the Otago Virtual Hospital then becomes a question of “rehearsing hospital rituals” (Little, personal communication, August 26, 2014) with the aim of learning to become doctors.

Conceiving virtual world role-plays as make-believe rehearsals, as a kind of theatrical performance, does not compromise their effectiveness in helping students learn to become the professionals they aspire to be. In *The presentation of self in everyday life*, Goffman (1959) showed that the
theatrical use of language is very much part of everyday and “real” life. Everyday examples of how people use language to continually “stage” themselves include: soldiers swearing frequently to give the impression of aggression; nurses speaking curtly to patients to show “who is boss” in the wards; and lecturers using informal language in class to give the impression that they are not the traditional pedantic academics. Goffman’s main point is that, beyond preparing people for the “real thing”, rehearsals and theatrical elements are integral parts of living and sustaining the “real thing”. Simply put, real life is itself very much a theatrical performance in Goffman’s view. Even fully qualified doctors keep up their “doctorly” appearances everyday by putting up a performance and staging themselves in a certain way. Many parts of ordinary and “real” life in the physical world are effectively performed with theatrical elements.

I contend that it is useful to conceive virtual world role-plays as a kind of theatrical performance, and in particular like shadow puppetry. Before I explain why this is useful, let me first describe what shadow puppetry is. Shadow puppetry is a form of theatrical performance that tells stories using cut-out figures between a source of light and a translucent screen. The audience sees the shadows cast on the screen (see Figure 13) and a puppeteer animates the cut-out figures behind the screen (see Figure 14).
Figure 13. Shadows on a screen. From “Ramayana play,” by Rebecca Marshall, 2005. CC BY-SA 2.0.

Figure 14. Puppeteer animating figures behind the screen. From “Dalang wayang kulit,” by Nuralinda Maharfar, 2015. CC BY-SA 4.0
The shadows moving on the translucent screen are similar to avatars moving on the computer screen. Both do not have any substance or materiality. This is how Gross (2011) describes shadow puppets:

The thinnest of puppets, the poorest, the least substantial, is the puppet of shadow theater—the true puppet here being the moving shadow itself, a thing bound to the screen, whose life is independent of the opaque or translucent silhouette of paper, leather, or plastic that casts it. This is a puppet all of surface, with no back to it, no depth, or only such hints of depth as are caused by the silhouette’s being held closer or farther away from the screen, or with one shadow overlaying or passing through another. (Loc 1829)

Similarly, avatars are made of a very different substance/matter compared to the physical world. Built solely of electrons and photons, the virtual world is “free of the earthly constraints of weight and inertia” (Jonscher, 1999, p. 65), as are shadows.

Conceiving virtual world role-plays as shadow puppetry is useful for dispelling four misleading but common conceptions about learning in educational virtual worlds. First, it is useful to foreground how avatars are inanimate so as to reduce the likelihood of researchers implying that avatars are in any way sentient. For example, Gee (2008) suggested that avatars are somehow sentient in that they “have virtual minds and virtual bodies” (p. 258) and I have argued in Chapter 3 that this is unlikely and so a misleading way to describe avatars. Conceiving virtual world role-plays as shadow puppetry will highlight that, just as a puppet is an “inanimate object moved in a dramatic manner by human agency” (Currell, 1974, p. 1), avatars in desktop virtual worlds are inanimate objects that are controlled by their human users. Emphasising the avatar's lack of agency, the developers of Second Life have designed
avatars to resemble an inanimate puppet hanging from puppet strings when the avatars’ users are away from keyboard (see Figure 15).

**Figure 15. Second Life avatar hanging like a puppet when its user is away from keyboard**

Foregrounding that avatars are inanimate will reduce the likelihood of people inferring that avatars can somehow have “a life of their own”.

Second, it is useful to emphasise the physical separation between student and avatar (akin to that between puppeteer and puppet) so as to reduce the likelihood of researchers considering desktop virtual worlds as fully immersive virtual environments (as explained in Chapter 3). Conceiving virtual world role-plays as shadow puppetry will highlight that, just as puppeteers control their puppets using strings and rods, students control their avatars “at a distance” using keyboards and mice. Emphasising this physical separation will make it clear that students are not physically immersed in desktop virtual worlds.
Third, it is useful to foreground the morphological disconnect between what students physically do and what their avatars do, akin to that between what puppeteers do and what their puppets do. This is useful so as to reduce the likelihood of researchers implying that students can gain a sensorimotor experience of the physical world action in desktop virtual worlds (as explained in Chapter 2). Conceiving virtual world role-plays as shadow puppetry will highlight that students control their avatars in an unnaturalistic way (Blascovich & Bailenson, 2011), just as puppeteers animate their puppets in an unnaturalistic way. For example, a shadow puppeteer might wave a rod connected to the puppet’s chest to make the puppet “run” back and forth; the puppeteer does not run to make the puppet “run”.

Lastly, it is useful to conceive virtual world role-plays as shadow puppetry to emphasise how the basis of virtual world role-plays, as with shadow puppetry, is derived from social conventions, rather than from physical experience (as elaborated in Chapter 4). As with virtual world role-plays, the interpretation of shadow puppetry also relies heavily on social conventions. For example, this is how a fight is depicted in shadow puppetry:

Let me describe the representation of the physical blow of one puppet to another... The puppet “stands”—it is placed more or less vertically on the screen... Then, in preparation for the blow, the whole puppet is moved backward quite like one would move a hammer or an axe before one strikes... At the farthest point of this movement, the puppet is about horizontal, or even the puppet’s head can be somewhat below the level of its feet... Then, to represent the blow, the puppet is thrust from that position at the other puppet—again, very much as if the puppeteer were hitting with a hammer or similar instrument... the particular part of the puppet that is hitting (such as the puppet’s hand) is aimed at the particular part of the
puppet that is to be hit (such as the chest or the head). Thus, the hitting movement representing the blow is both forceful and controlled. (Mrázek, 2005, p. 263-264)

I acknowledge that the analogy between virtual world role-plays and shadow puppetry is imperfect because one puppeteer typically manipulates all the different puppets, while a student only controls one avatar in a role-play. Also, shadow puppetry is almost entirely pre-scripted, whereas virtual world role-plays are more like improvisational theatre. In addition, the puppeteer’s goal is not to learn to become like the puppet, while the student’s goal is to learn to become like the virtual character. Nonetheless, the analogy provides a useful metaphor to talk about learning in virtual worlds.

McKay, van Schie, and Headley (2008) predicted that, with practice, new participants in Second Life would progress from feeling like the avatar was a puppet to feeling like it was an extension of the self. I disagree. Given the physical separation between student and avatar as well as the unnaturalistic way avatars are controlled, I contend that experiencing the avatar as a shadow puppet is the most realistic experience desktop virtual worlds can offer.

As an aside, following my conversation with Dr Suzanne Little (Theatre Studies, University of Otago), I also explored how applied theatre might help explain learning in virtual worlds. The main aim of applied theatre is to provoke or shape social changes (e.g., reduce domestic violence, racism). One form of applied theatre involves non-actors participating as actors in theatrical performances in order for them to develop empathy towards social issues such as poverty and racism (e.g., by playing a character from a marginalised ethnic group). However, this is different from virtual world role plays for professional education where students play a character that they aspire to become, and students are arguably
learning to conserve (not change) a social practice. I hence did not continue to pursue this line of inquiry about applied theatre.

**Conclusion**

In conclusion, I have replied to Austin’s (1962) potential objection that virtual world actions are void and hollow by showing that:

- virtual world actions are only partially void and hollow (and they will necessarily be so to preserve the learning advantages of virtual worlds); and
- virtual world actions are sufficiently real for some physical world learning to take place.

Therefore, virtual world actions can function effectively as performatives, even though they are make-believe to a certain degree.

Austin’s argument positioned being void and hollow in a binary way, holding that utterances are either totally void/hollow or not at all void/hollow. I argue that there are degrees of void-ness and hollow-ness, and that conceiving void-ness and hollow-ness in terms of degrees is useful in explaining how virtual world role-plays can bring about some physical world learning.

Learning in virtual worlds can usefully be conceived as make-believe rehearsals. In particular, conceiving virtual world role-plays as being like shadow puppetry can help to dispel some misleading conceptions about learning in virtual worlds.

In Chapter 4, I stated that virtual world role-plays can bring about some physical world learning because when students do $X_{VW}$, they get to do $X_{PW}$ semantically in the sense that they get to act with meaning. In Chapter 6, drawing on Perkins, Jay, and Tishman’s (1993b) dispositional theory of thinking, I will provide an empirical illustration of “acting with meaning”
and in turn show how acting with meaning in virtual worlds is relevant for professional education.
Chapter 6: Empirical illustration of acting with meaning

Introduction

In Chapter 4, I showed that Dewey’s (1938) experiential learning theory can provide a plausible explanation of how students can learn physical world actions in virtual worlds if the theory is extended in line with Austin’s (1962) speech act theory. When extended with speech act theory, experiential learning theory would consist of students performing virtual world actions that fill the same performatively function as the physical world equivalent. As such, when students do $X^{VW}$, they get to do $X^{PW}$ semantically in the sense that they get to act with meaning.

However, “acting with meaning” is not a commonly-used expression and it may be difficult to visualise what acting with meaning involves. In this chapter, I will hence provide an empirical illustration of acting with meaning and in turn show how it is relevant for professional education. I will do this in the context of Perkins et al.’s (1993) dispositional theory of thinking.

First, I describe the dispositional theory of thinking and show how dispositions are necessary for professional practices. I then show how meaning or intending an action constitutes performing the “dispositional components of [intelligent] behavior,” namely the dispositional components of sensitivity and inclination (Perkins, Tishman, Ritchhart, Donis, and Andrade, 2000, p. 289). After this, I show how virtual worlds offer students opportunities to demonstrate these dispositional components that correspond sufficiently with those opportunities in the physical world. When virtual world opportunities to demonstrate sensitivity and inclination correspond sufficiently with those in the
physical world, students can learn these dispositional components in virtual worlds. I conclude this chapter by showing how certain unique features of virtual worlds make them suitable for supporting the learning of sensitivity and inclination.

Dispositional theory of thinking

The dispositional theory of thinking was first developed in Perkins et al. (1993). This theory emerged from studying intelligent behaviour in everyday situations—“intelligent behavior in the wild” (Perkins et al., 2000, p. 269)—instead of intelligence under contrived laboratory conditions. As with Hutchins (1995) who studied the intellectual effort in solving the real world task of navigating a ship to dock in *Cognition in the wild* (elaborated in Chapter 3), Perkins and his colleagues also believed that studies of intellectual aptitude under laboratory conditions do not fully capture the intelligent behaviour that is required in everyday situations, and that research on such intelligent behaviour should be situated in real world contexts.

One reason why the dispositional theory of thinking is a suitable lens to examine virtual worlds for professional education is that such virtual worlds are also concerned with *intelligent* behaviour performed in everyday situations. I emphasise “intelligent” because, when I mentioned above that experiential learning theory now consists of students performing virtual world actions in the sense that they get to do $X^{PW}$ with meaning, I meant students perform virtual world actions intelligently in the context of a role-play. In earlier chapters, I did not explicitly state the expectation for students to behave intelligently because it was reasonable to assume that all educators wanted to develop intelligent behaviour in their students. In other words, I assumed that no educator would deliberately develop their students’ ability to perform unintelligent actions through virtual world role-plays. However, I now state it
explicitly that virtual worlds seek to develop intelligent behaviour because “intelligent behaviour” takes on a specific meaning and plays a crucial role in the dispositional theory of thinking (which I will explain later in this chapter).

While studying intelligent behaviour in real world contexts, Perkins and his colleagues observed that many people who have the ability to behave intelligently do not end up behaving intelligently. I will illustrate their observation with the trait of open-mindedness. Doctors are expected to be open-minded in the sense of being open to alternative perspectives or diagnoses. Conti (2005) pointed out how good doctors should “search for secondary medical problems even if there is an obvious cause of the patient’s illness” (p. 496). All qualified doctors will have been trained in searching for secondary medical problems. They hence have the ability to be open-minded. However, for one reason or another (e.g., impatience, overconfidence), many doctors end up exploring only a limited range of possible diagnoses and coming to a rushed decision in practice, thus failing to behave “intelligently”. According to the dispositional theory of thinking, what these doctors lack is not the ability or capacity to be open-minded, but the disposition or tendency to be open-minded.

“Dispositions” can be defined as “people’s tendencies to put their capabilities into action” (Perkins, Jay, and Tishman, 1993b, p. 75). Besides open-mindedness, other dispositions expected of doctors include reflectiveness on one’s own practice and compassion for patients (Medical Council of New Zealand, 2013).

Therefore, abilities alone do not suffice for intelligent behaviour; both abilities and dispositions are necessary for intelligent behaviour (Perkins et al., 1993a). An explanation of what dispositions mean will now be given by listing and defining the components of intelligent behaviour. To be clear, dispositions are not behaviours per se, but are tendencies that are exemplified through particular behaviours.
Perkins et al.'s (1993) dispositional theory of thinking holds that intelligent behaviour is underpinned by three components: sensitivity; inclination; and ability. Among the three components, *sensitivity* and *inclination* form the two dispositional components of intelligent behaviour. The example of open-mindedness will once again be used to illustrate each component:

1. *sensitivity* refers to a doctor’s alertness to notice the appropriate circumstances to start searching for secondary medical problems;
2. *inclination* refers to a doctor’s motivation to follow through on the search for secondary medical problems; and
3. *ability* refers to a doctor’s capacity to search for secondary medical problems.

All three components are necessary for intelligent professional behaviour. In professional practice, the doctor who searches for secondary medical problems even if there is an obvious cause of the patient’s illness will have behaved intelligently by demonstrating sensitivity, inclination, and ability. In contrast, the qualified doctor who explores only a limited range of possible diagnoses fails to behave intelligently because the doctor neither demonstrates the sensitivity nor the inclination to be open-minded, despite having the ability to search for secondary medical problems. As such, any single missing component will hinder intelligent behaviour: “the trio of inclination, sensitivity, and ability constitute individually necessary and jointly sufficient conditions for [intelligent] behavior” (Perkins et al., 1993, p. 4).

The examples above highlight cases where a person has the ability to behave intelligently, but lacks the dispositions. However, there are also cases where a person has the dispositions, but lacks the ability. For example, a first year medical student might have the sensitivity and inclination (disposition) to search for secondary medical problems of a
patient, but not the medical knowledge (ability) to make sense of all the possible diagnoses. Nevertheless, the lack of dispositions (rather than the lack of ability) is more often the “principal bottleneck” (Perkins et al., 2000, p. 276) hindering intelligent behavior, and so will remain my focus.

**Dispositional components are necessary for professional practice**

The two dispositional components for intelligent behaviour are necessary in everyday professional situations, but only under appropriate circumstances. Dispositions are propensities or tendencies that are likely to manifest themselves when the appropriate opportunity arises. It is not expected of an open-minded doctor to behave in an open-minded manner all the time. There are times when it is inappropriate for a doctor to demonstrate the disposition of open-mindedness. For example, it would be inappropriate to search for secondary medical problems when breaking the news of a patient’s death to relatives. So a good doctor is pre-disposed to be open-minded or has the tendency to behave in an open-minded manner when the appropriate opportunity arises (e.g., when taking the patient’s medical history).

I emphasise “when the appropriate opportunity arises” because the appropriateness of the circumstances determines whether an action is performed intelligently or not. In other words, the mere performance of an action does not make it intelligent or unintelligent. In the dispositional theory of thinking, “intelligent behaviour” takes on a specific meaning. Intelligent behaviour in everyday situations involves the performance of a particular action under the appropriate circumstances (Perkins et al., 2000):

> Everyday contexts present a wilderness of vaguely marked and ill-defined occasions for thoughtful engagement. Opportunities for investing one’s intelligence must be detected. (p. 270)
The detection of appropriate opportunities is key to intelligent behaviours in many everyday situations. Good doctors must detect appropriate opportunities to examine the patient’s chest before the chest examination is judged to be intelligent (e.g., examining the patient’s chest after the patient complains of coughing frequently). Similarly, good teachers must detect appropriate opportunities to check their students’ understandings (e.g., when they notice the “blank look” on many students’ faces), and good footballers must detect appropriate opportunities to make an overhead kick (e.g., when their back is towards the opposition’s goal).

A key challenge to detecting appropriate opportunities is that everyday situations usually do not give obvious cues as to when the appropriate opportunity is present. Hence, students have to learn to detect these opportunities under “relatively uncued conditions” (Tishman, Jay, & Perkins, 1993, p. 149).

The detection of appropriate opportunities relies on a person’s sensitivity, which is one of the two dispositional components. The necessity of sensitivity will be explained using an example from medical practice. In *Alarm bells in medicine*, Ali (2005) sought to help novice doctors become more sensitive to “certain symptoms [that] should make your ears prick up, your neck hairs bristle and your heart pound” (p. xiii). A doctor who is more sensitive or alert to these “alarm bells” is more likely to detect appropriate opportunities to perform certain examinations or order certain laboratory tests. For example, a good doctor, upon hearing that her patient is confused, would detect this “alarm bell” and use it as an appropriate opportunity to order a CT scan of the patient’s head to ascertain whether the patient had suffered a head injury. In contrast, a novice doctor might miss such an opportunity to order a CT scan and risk not treating the head injury if such an injury did occur. Sensitivity is thus a necessary dispositional component of intelligent behaviour.
The necessity of sensitivity also applies in virtual world role-plays for professional education (Loke et al., 2012a). For example, in a virtual underground mine, trainees practise the correct procedures to evacuate from the mine (Garrett, 2012). In the course of the scenario, among other tasks, trainees are required to regulate their “physical” exertion so as not to deplete the limited supply of oxygen that is available to them. To be successful in this task, trainees need to detect the appropriate opportunities to increase “physical” exertion (e.g., when there are signs that the mine is going to collapse soon) or to decrease exertion (e.g., when the supply of oxygen is almost depleted).

In another example of how students need to demonstrate sensitivity in a virtual world role-play, students studying social work are tasked to conduct home visits in a virtual world (Wilson et al., 2013). In the course of interviewing the client during a virtual home visit, among other tasks, students are required to ensure that the interview is conducted in a suitable environment. To be successful in this task, students need to detect the appropriate opportunity, for example, to ask politely that the client turns off the television so that both parties can concentrate on the interview. If students fail to detect these appropriate opportunities, they will be judged to have performed poorly in the role-play.

However, sensitivity alone does not suffice for intelligent behaviour; the inclination to follow through is also necessary. Even if a doctor is sensitive to the need to check if the patient’s confusion was caused by a head injury, the doctor might not be inclined to follow through with the ordering of a CT scan. A particular doctor for example might be pre-disposed to saving money for the hospital and not order what the doctor deems to be an unnecessary and costly medical test. In this instance, the presence of sensitivity coupled with the lack of inclination will equally result in an unintelligent behaviour from a medical treatment perspective.
I highlight at this point that, while the demonstration of sensitivity does not necessarily involve the demonstration of inclination (as illustrated above), the demonstration of inclination always includes the demonstration of sensitivity. Using the example above, to follow through with the ordering of a CT scan (inclination) necessarily assumes that the doctor was alert to the potential need of a CT scan (sensitivity).

The necessity of inclination also applies in virtual world role-plays and will be illustrated with an example from a case study of the Otago Virtual Hospital (Loke et al., 2012b). In an interview after a role-play in the virtual hospital, one medical student regretted that, even though he had noticed the patient’s thirst and was alert to the need to check if the patient’s thirst was a symptom of urinary tract infection (presence of sensitivity), he did not eventually pursue the possible link between the patient’s dehydration and urinary tract infection (lack of inclination). In contrast, other students followed through on their intention to check if the patient had a urinary tract infection by ordering a urine dipstick test.

I emphasise “follow through” because it will help me explain what “acting with meaning” involves in the context of the dispositional theory of thinking.

**Acting with meaning as performing dispositional components**

By “acting with meaning”, I mean that students follow through on their intentions to act, in the sense given by Perkins et al. (2000):

> In everyday life, people’s sensitivity to subtle occasions for thinking and their inclination to follow through would appear to be substantial influences on intellectual performances alongside their capabilities. (p. 270; emphasis added)
So, when students carry out a virtual world action, they act with meaning in the sense that they follow through on their intentions to act. Extending my argument in Chapter 4, when some researchers state that students role-playing in virtual worlds are engaging in “performative” (Warburton, 2009, p. 421) and “enactive” (Henderson et al., 2012, p. 412) learning experiences, they most likely mean that students get to “follow through” on their intentions publicly, in a way that is observable by others.

To be sure, I am solely concerned with students acting with meaning under the appropriate circumstances because intelligent behaviour in everyday situations involves the performance of a particular action under the appropriate circumstances (as elaborated in the previous section). If acting with meaning under the appropriate circumstances is the same as demonstrating one’s sensitivity and inclination, and if sensitivity and inclination are the dispositional components of intelligent behaviour, then acting with meaning under the appropriate circumstances is performing the dispositional components of intelligent behaviour.

Given that acting with meaning constitutes performing the dispositional components of behaviour, I could conclude prematurely that students can learn sensitivity and inclination relevant for professional practice by performing virtual world actions. However, this conclusion would be premature because I have yet to show that the virtual world performance of dispositional components corresponds sufficiently with the physical world performance of dispositional components.

The degree of correspondence between the two performances hinges on the nature of the “opportunities for investing one’s intelligence” (Perkins et al., 2000, p. 270). The opportunities in both cases must have a similar “degree of cueing”. Intelligent behaviour requires the demonstration of sensitivity and inclination under “relatively uncued conditions” (Tishman
et al., 1993, p. 149). In other words, it requires that people seize these relatively uncued opportunities to perform the appropriate actions. Hence, the opportunities to demonstrate sensitivity and inclination in the virtual and physical worlds must have a similarly low degree of cueing. I will now provide an empirical illustration of how these opportunities do correspond in terms of degree of cueing.

**Opportunities to demonstrate dispositional components**

My empirical illustration will be based on selected excerpts that took place between doctor-avatars and patient-avatars from a case study of the Otago Virtual Hospital (Loke et al., 2012b). In this section, I extend the excerpts from this case study to show that sensitivity and inclination in the virtual and physical worlds have a similarly low degree of cueing. Eleven medical students in the advanced stages of their medical training participated in this case study. These students role-played as doctors in an emergency department. They were tasked to provide medical care to a female patient (Gertrude) who was played by a faculty member.

In brief, Gertrude was a patient in her mid-70s, whose neighbour had taken to the hospital because she was found to be increasingly forgetful (e.g., not feeding her cat) and generally unwell (e.g., feverish).

Upon meeting Gertrude, the doctor-avatar was expected to carry out the following steps: take the patient’s medical history; “physically” examine the patient; order laboratory tests (e.g., CT scan); develop and negotiate a treatment plan with the patient; prescribe medicines; and write handover notes for the medical team that is taking over. In my empirical illustration below, I describe four selected excerpts that took place during the steps of physical examination (Excerpts 1A and 1B) and medical history taking (Excerpts 2A and 2B).
To give a common focus, I will concentrate on the students’ demonstration of the disposition of compassion in all four excerpts. This is an important disposition for doctors: doctors are widely expected to demonstrate compassion and empathy towards their patients (Medical Council of New Zealand, 2013) and, as such, medical students should develop such compassion during their medical training (Leget & Olthuis, 2007).

Compassion is dispositional in the sense that it is a propensity or tendency that is likely to manifest itself when the appropriate opportunity arises. Using Perkins et al.'s (1993) dispositional theory of thinking to analyse compassion as a dispositional behaviour:

1. sensitivity refers to a doctor’s alertness to notice the possible situations of a patient’s distress or discomfort;
2. inclination refers to a doctor’s motivation to follow through on showing concern and empathy during such situations; and
3. ability refers to a doctor’s capacity to show concern and empathy to a patient.

The demonstration of compassion will now be examined in the context of four excerpts. These excerpts have been slightly modified to improve readability.

**Table 5. Demonstration of Compassion during “physical” Examination**

<table>
<thead>
<tr>
<th>Excerpt 1A</th>
<th>Excerpt 1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr A: Sorry to interrupt, but we would like to do an examination, Gertrude.</td>
<td>Dr B: Mrs Macfarlane, I’d like to take a look at your chest and your tummy. Is that OK?</td>
</tr>
<tr>
<td>Gertrude: That’s fine, Dr A.</td>
<td>Gertrude: That’s fine.</td>
</tr>
</tbody>
</table>
Dr A: Would you like your daughter to stay in here with you?
Gertrude: I don’t mind.
Dr A: OK, I will shut the curtain.
(Dr A proceeds to draw the curtain.)
Gertrude: Thank you for doing that.

(Dr B proceeds to examine patient, without washing her hands with warm water and without drawing the curtain.)
Gertrude: As long as your hands are warm! And you close the curtain.
Dr B: Sure.
(Dr B draws the curtain and washes her hands.)
Gertrude: Thank you.

In the excerpts shown in Table 5, Dr A demonstrated compassion more readily than Dr B, given similar opportunities that were available to both doctors. In other words, Dr A seized the opportunity to demonstrate compassion while Dr B missed the opportunity.

It is possible that Dr A said what she said without any sincerity and hence did not actually demonstrate compassion. However, Austin’s (1965) theory of speech act excludes this possibility. As elaborated in Chapter 4, one of the conditions for the effective execution of performatives is that the person who, for example, offers the patient a chaperone has the sole intention of offering the patient a chaperone and has no other intentions. Having other intentions would render the performative ineffective.

Dr A detected—by herself—the physical examination as a likely situation where the patient might feel uncomfortable (sensitivity), and followed
through on her intentions (inclination) to ask the patient’s daughter to stay as well as to draw the curtain so as to protect the patient’s privacy.

In contrast, while Dr B sought the patient’s permission (“Is that OK?”), she did not detect the physical examination as an opportune time to demonstrate compassion towards her patient. Instead, her patient Gertrude was the one who noticed the opportunity and reminded Dr B to draw the curtain.

The virtual world opportunity corresponds with the physical world opportunity in terms of degrees of cueing. The cues for the doctors to draw the curtain include the seeking of consent to perform a physical examination (i.e., “we would like to do an examination, Gertrude” and “Mrs Macfarlane, I’d like to take a look at your chest and your tummy”) and the availability of an undrawn curtain around the hospital bed. Cues during a physical examination in the physical world are similar in nature. The doctor will seek the patient’s consent to perform a physical examination, and a curtain will be available. In this instance, for the virtual world action of drawing the curtain before a “physical” examination, the degree of cueing corresponds sufficiently with that in the physical world.

To clarify what other degrees of cueing there might be, I will give an example of a virtual world action that features a higher degree of cueing than that in the physical world. A virtual hospital developed by Imperial College London (Toro-Troconis et al., 2010) features a status bar that gives a cue to students regarding the next step to take. The status bar displays the four main steps of medical care, sequenced from left to right on the computer screen:

1. patient history;
2. differential diagnosis;
3. investigations; and
4. final diagnosis.

After students complete one of the steps (e.g., differential diagnosis), the status bar will indicate that the step is complete by shading the particular segment of the status bar, and thus cue students to engage in the next step (e.g., investigations). In this particular instance, the degree of cueing is higher than and does not correspond with that in the physical world. Doctors in the physical world do not receive automatic notifications indicating that they have completed a particular step and which step to take next. Therefore, in this case, having a higher degree of cueing than that in the physical world does not allow students to practise and learn the sensitivity of detecting when is the appropriate time to proceed to the next step. The students did not have to detect this opportunity by themselves because the virtual world was designed to detect the opportunity for them. It is possible that the Imperial College London virtual hospital was designed in this way to help students focus their attention on practising the skills involved in each step instead of detecting the appropriate opportunities to proceed to the next step. This would be a legitimate design choice if their students did not need to learn the sensitivity of proceeding to the next step at this point of their medical training.

I can now qualify my earlier statement that students can learn the dispositional components of intelligent behaviour in (all) virtual worlds. In virtual worlds that feature similar uncued conditions as the physical world, students can practise and learn sensitivity (other features are described in the next section). In some other virtual worlds, the higher degree of cueing may hinder the learning of sensitivity. Therefore, how virtual worlds are designed can support or hinder the learning of sensitivity.
It may be argued that the status bar in the virtual hospital developed by Imperial College London (Toro-Troconis et al., 2010) provides a scaffold for students to learn how to proceed through the steps in providing medical care, but this is a case where too much guidance or structure hindered the learning of sensitivity. Having a status bar can be viewed as a scaffold in the sense that it reduces the complexity and “messiness” of the scenario, helping students to move from step to step in an orderly way. Without such a status bar, many students in the Otago Virtual Hospital completed the steps in a non-linear (albeit more realistic) way. One example of such non-linearity was how some students went back to ask the patient about drug allergies after having taken the patient’s medical history. In order for students to practise and learn sensitivity, some messiness and imperfection should be allowed in the simulation. Similarly, Bacon, Windall, and MacKinnon (2011) recommend the simulation of information overload and time pressure for realistic virtual training, especially when the training is for crisis management (e.g., emergency departments).

To be sure, students learning in the Imperial College London virtual hospital (Toro-Troconis et al., 2010) still get to practise and learn the inclination of proceeding to the next step. After noticing the cue from the status bar, students still have to follow through on their intentions to move on to the next step. Students who lack the inclination to do so might notice the cue from the status bar, but not undertake the next step (for whatever reasons).

However, it is important at some stage in their training for medical students to learn the sensitivity of detecting when is the appropriate time to proceed to the next step. In a case study of the Otago Virtual Hospital (Loke et al., 2012b), students were asked to identify what about the virtual role-play was relevant to their medical education. A key finding was that the virtual role-play was relevant because students had to adapt
the generic steps of medical care (e.g., differential diagnosis, investigations) to the situation at hand. In particular, students had to work out what the next step was by themselves, instead of being cued by a status bar. As one student said in the case study (Loke et al., 2012b): “When you’re in the hot seat, knowing what to do next doesn’t come naturally” (p. 570). Students in the Otago Virtual Hospital got to learn the sensitivity of detecting when is the appropriate time to proceed to the next step because this virtual world was designed to be sufficiently open-ended. If students were instead guided and cued to a higher degree by a status bar, they would not get the chance to detect when the appropriate time to proceed to the next step is.

For transfer of learning to happen, it is important that the degrees of cueing correspond between the virtual world and physical world opportunities. It is not important that the degree of cueing in the virtual world is high or low in absolute terms. In the example above, I may have implied that a lower degree of cueing is always better. This is not the case. There are times when a high degree of cueing is relevant because a similarly high degree of cueing occurs in the physical world. For example, upon entering the Otago Virtual Hospital, the doctor-avatars receive a triage record of their patient that shows the patient’s vital signs such as pulse rate and blood pressure. These vital signs provide a relatively high degree of cueing towards the patient’s illness. In the case of the triage record, the degree of cueing in the virtual world is identical to that in an actual hospital.

So far, I have simplistically implied that the seizing of opportunities always results in better performances, and the missing of opportunities in poorer performances. Let me now qualify my implication with two other ideas. First, I do not mean that a student is not compassionate if the student misses a single opportunity to demonstrate compassion. However, if a student misses significant opportunities repeatedly, it
seems reasonable to judge that the student lacks the sensitivity and inclination to be compassionate. Dispositions are propensities or tendencies, the presence or absence of which can only be judged across multiple opportunities and across different situations.

Second, it is possible that the missing of some opportunities might result in a better performance. For example, a doctor who spends hours making small talk with her patient may well be considered “too compassionate” because being compassionate has resulted in excessively low efficiency. According to Blyth (personal communication, May 29, 2012) who is a colleague and emergency room doctor, one of the key challenges of emergency room doctors is managing the trade-off between proficiency and efficiency. I reiterate that the appropriateness of the circumstances determines whether an action is performed intelligently or not. Under time-critical circumstances, it may be more intelligent to ignore some opportunities to demonstrate dispositional behaviours that are non-life-threatening.

Excerpts 1A and 1B are located in the more “planned” step of a physical examination. Physical examinations are planned in the sense that they are one of the formal steps in providing medical care and are largely anticipatable by both patients and doctors. It is by virtue of being planned that the cue of curtains was deliberately designed into the Otago Virtual Hospital.

The next two excerpts (2A and 2B) are less planned and more incidental. The opportunities to demonstrate compassion arose out of an ongoing dialogue while the doctor was taking the patient’s medical history, during which the patient spontaneously mentioned her husband’s death. In this sense, Excerpts 2A and 2B illustrate opportunities that arose under conditions that are even less cued than Excerpts 1A and 1B, but that
nonetheless are similar to physical world opportunities in terms of degree of cueing.

**Table 6. Demonstration of Compassion During Medical History Taking**

<table>
<thead>
<tr>
<th>Excerpt 2A</th>
<th>Excerpt 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dr A: Do you smoke, Mrs Macfarlane?</strong></td>
<td><strong>Dr B: You mentioned you knew all about chest pain. What medical problems have you had in the past?</strong></td>
</tr>
<tr>
<td>Gertrude: No never!</td>
<td>Gertrude: Oh, I know about chest pain because my husband... well my late husband had chest pain before he died.</td>
</tr>
<tr>
<td>Gertrude: My husband smoked, and they killed him.</td>
<td>Gertrude: I’ve been pretty good.</td>
</tr>
<tr>
<td>Dr A: I’m sorry to hear that.</td>
<td>Dr B: Do you have any other medical conditions?</td>
</tr>
</tbody>
</table>

In the excerpts shown in Table Y, Dr A demonstrated compassion more readily than Dr B, given similar opportunities that were available to both doctors. In other words, Dr A seized the opportunity to demonstrate compassion while Dr B missed the opportunity.

Dr A detected the mention of the patient’s husband’s death as an appropriate occasion to show empathy (sensitivity), and followed through on her intentions (inclination) to show empathy (“I’m sorry to hear that”).
In contrast, Dr B did not detect the mention of the patient’s husband’s death as an opportune time to demonstrate compassion towards her patient in the form of acknowledging the death of her patient’s husband.

The virtual world opportunity in Excerpts 2A and 2B corresponds with the physical world opportunity. In these excerpts, the sole cue for the doctors to acknowledge the death of the patient’s husband is the patient’s spontaneous mentioning of her husband’s death during the course of an ongoing dialogue (i.e., “My husband smoked and they killed him” and “my late husband had chest pain before he died”). This cue is similar in nature during a patient-doctor dialogue in the physical world. In this instance, the degree of cueing corresponds sufficiently with that in the physical world.

When the degrees of cueing do correspond, the opportunities to demonstrate sensitivity and inclination in virtual worlds will correspond sufficiently with opportunities in the physical world. When these opportunities correspond, students can learn the “dispositional components of [intelligent] behavior” (Perkins et al., 2000, p. 289) in virtual worlds.

To show that students can also learn the dispositional components of intelligent behaviour in other virtual worlds besides the Otago Virtual Hospital, I will provide another empirical illustration from another virtual world: VirtualPREX (Dalgarno et al., 2016). As described in Chapter 4, VirtualPREX is a virtual classroom developed in Second Life in which trainee teachers role-playing as teachers get to try out different teaching strategies with a class of primary school pupils. A key teaching strategy that trainee teachers practise in VirtualPREX is how to manage off-task student behaviour. The following scenario takes place in a class on creative writing (a five-minute video of this scenario is available at
https://youtu.be/rZAyNpgFxmo). It involves the teacher-avatar managing Jeff, an off-task student played by another trainee teacher.

[Jeff stands up and walks towards his classmate Liz’s desk.]

Teacher: Jeff can you please sit down? [The teacher continues to question the class on what creative writing is.] “Good Mike. Now once Jeff is back in his seat we will do an activity.”

[Jeff remains standing.]

“Yes Jeff? Why are you standing?” [no response] “Jeff, you can go to the reading mat for a few minutes.”

[Jeff walks over to the reading mat, and the teacher continues her lesson.]

In the example above, the sole cue for the teacher to manage the student’s off-task behaviour is the student standing up. To be successful in VirtualPREX, the student teacher had to detect this cue by herself, and follow through on her intention to intervene and manage Jeff. This cue is similar in nature to that in classrooms in the physical world. In this instance, the degree of cueing corresponds sufficiently with that in the physical world, and students can practise and learn the dispositional components of managing an off-task student.

In an evaluation of VirtualPREX, student teachers expressed that the virtual world role-play was most helpful in providing opportunities to learn how to respond appropriately to unexpected occurrences in the classroom, including unexpected disruptive behaviours (Dalgarno et al., 2016). This suggests that students thought that VirtualPREX was suitable for learning the dispositional components of managing off-task student behaviour (e.g., is this an appropriate time to intervene?).
Several features of virtual worlds make them suitable in supporting the learning of dispositional behaviours. Four of these features will be described in the next section.

Features that support the learning of dispositional components

The first feature that supports the learning of the dispositional components is having an open-ended environment. In an open-ended environment, students are free to take multiple actions at every moment. In the Otago Virtual Hospital, as in physical world hospitals, students can chat with the patient, order laboratory tests, or prescribe medicines at every moment of the role-play. This contrasts with stations-based activities such as the objective structured clinical examination (OSCE) where students are limited to specific tasks at each station (e.g., history-taking station) and which has been criticised for letting students participate only in “isolated aspects of the clinical encounter” (Smee, 2003, p. 705).

Also in an open-ended environment, the cues as to which action to take at which moment are not obvious. There are no obvious signs to notify medical students to perform a chest examination, to show compassion, or to discharge the patient in the Otago Virtual Hospital. It is in this sense that the virtual world environment is open-ended and relatively uncued.

The learning of sensitivity requires an open-ended environment that lets students detect appropriate opportunities to perform a particular dispositional behaviour by themselves. It is only by acting under relatively uncued conditions that students can develop their alertness to the appropriate circumstances to act, and this alertness will in turn “influence what [they] notice within the total range of the presented data” (Ferré, 1996, p. 14) or what they become sensitive to.
The second feature that supports the learning of sensitivity and inclination is having windows of opportunity to perform particular dispositional behaviours. The learning of the dispositional components requires opportunities for performing intelligent behaviours that are of a limited duration such that it is possible for students to seize or miss the window of opportunity to act appropriately. In the example above regarding Gertrude mentioning her husband’s death, it would be appropriate to show empathy immediately after she mentioned it, but quite inappropriate to acknowledge the death of her husband five minutes after she mentioned it. This window of opportunity ensures that not only do students have to be alert to the appropriate circumstances to perform a particular dispositional behaviour (sensitivity), they also have to follow through on their intentions (inclination) within the appropriate time frame.

Virtual world role-plays feature these windows of opportunity because they take place over a certain time frame. Within this time frame, opportunities to perform particular dispositional behaviours will emerge during the course of the role-play that students can either seize or miss.

It is easier to understand the importance of these windows of opportunity if virtual worlds were contrasted against a similar learning activity that does not offer students such opportunities. In medical education, the “paper” case study is a typical learning activity that targets the same learning outcome of clinical reasoning as a virtual world role-play. To address these paper case studies, students typically read the textual descriptions of the patient (often including laboratory test results, past medical history, etc.) and then answer questions pertaining to the patient (e.g., suggest a diagnosis, suggest a treatment plan). As long as students answer these questions by the time the class finishes, they will be judged successful. There is no appropriate window of opportunity within which a particular behaviour should be performed, or that students can be said to
miss. In fact, I will argue in the next paragraphs that students do not perform any actions at all when they answer these paper case study questions.

The third feature that supports the learning of the dispositional components is letting students actually do the actions, to follow through on their intentions. The learning of sensitivity and inclination requires the explicit performance of actions. Virtual world role-plays feature the explicit and public performance of actions. In one study (Loke et al., 2012b), a medical student compared the Otago Virtual Hospital to a face-to-face role-play in the following way:

Well, you actually do the things here. Whereas in [a face-to-face role-play], you write down or you think about what you’re going to do, but you don’t have to practically go and do them. So there’s a bit more here. (p. 569)

A key finding from this study is that students reported that actually being able to “do the things” (e.g., examine the patient, order laboratory tests) was a unique learning benefit that virtual worlds offered. In particular, students had to do the things in the midst of competing demands and incomplete information in this virtual world role-play.

To further clarify what “actually do the things” mean in virtual world role-plays, I will once again turn to the counter example of paper case studies that do not allow students to actually perform actions. To address these paper case studies, students typically answer questions pertaining to the patient’s condition (e.g., suggest a diagnosis, suggest a treatment plan). Even if students were to suggest a course of antibiotics as their answer, they still cannot be said to have “actually” prescribed a course of antibiotics for the patient. This is because the students’ suggestions are purely hypothetical, suggesting what they would do if the situation in the case study were to present itself one day. Students’ answers in paper case
studies are very similar to the “hypothetical actions” (Sinclair, 1997, p. 32) they typically take on clinical placements, as elaborated in Chapter 5. In contrast, virtual worlds support the learning of the dispositional components of intelligent behaviour because virtual world role-plays are concerned with what students actually did in the virtual world, and not what they suggest they would hypothetically do. Compared with hypothetical actions in paper cases, virtual world actions count as legitimate actions that can produce non-physical effects. They are socially accepted actions that “do something”.

The fourth feature that supports the learning of the dispositional components is letting students participate in the role-play multiple times. Tishman et al. (1993) believe that dispositions are most effectively learnt through enculturation rather than transmission. Enculturation requires regular practice in a particular culture or environment. So, to foster the desired dispositions in professional education, students need to participate regularly in a particular professional practice.

Virtual world role-plays feature iterative cycles of participation and reflection that can support the learning of dispositional behaviours. The Otago Virtual Hospital, for example, allows students to participate in a role-play any time they want and as many times as they want, as long as there are two available students (one playing the patient, one playing the doctor). The recent incorporation of the Holodeck feature has further enhanced the scalability of the virtual hospital. The Holodeck is able to instantiate an infinite number of hospitals and the Otago Virtual Hospital can now (theoretically) scale up to an infinite number of role-plays (Blyth & Loke, 2014). As such, students can participate regularly in simulated clinical practice and, through reflection, develop the desired dispositions.

The provision of iterative cycles is where virtual world role-plays differ from face-to-face role-plays. I will once again use the example of
mannequin-based simulators for clinical skills training such as the Sim-Man. Such face-to-face role-plays have the following features that support the learning of sensitivity and inclination: an open-ended environment; windows of opportunity; and letting students actually do the action. However, because the use of these simulators is confined to dedicated purpose-built rooms and available to students only a few times during their medical education, such face-to-face role-plays do not allow students to participate regularly in clinical practice and in turn to effectively learn the dispositional components of intelligent behaviour.

Therefore, compared to other learning activities (e.g., face-to-face role-plays, paper case studies), virtual worlds are almost unique in supporting the learning of dispositional components for professional education. I emphasise “almost” because some other role-playing computer simulations can also support this learning. One such simulation is SimPharm, a more rudimentary text-based computer simulation that was developed by my colleagues and me and that also has the same four features that support the learning of dispositional components.

**SimPharm**

SimPharm is a text-based computer simulation where pharmacy students play the role of clinical pharmacists providing pharmaceutical care to their patients in a hospital (Loke et al., 2011). Each episode in the simulation is based on a clinical case involving a patient presenting some problems and that the pharmacist needs to solve (e.g., a patient with a broken neck of femur and requiring pain relief). Reflecting the professional practices of clinical pharmacists working in hospitals, SimPharm allows pharmacy students to:

- receive textual requests from the medical team (e.g., “The medical team wish for you to recommend a dose of morphine for pain relief”);
• ask questions of their patients from a pre-determined list (e.g., “Can you walk up stairs?”) and consult the patient notes;
• order laboratory tests and view test results;
• recommend new medicines (e.g., 7mg of morphine every 6 hours) or prescribe different doses (see Figure 16); and
• receive textual feedback from the medical team (e.g., “The patient reports good pain relief”).

Figure 16. SimPharm’s text-based interface

A key feature of SimPharm is time-sensitivity. The virtual patient “responds” to the drug and the pharmacist receives textual feedback from the patient and medical team in real time. For example, the patient might have been given 7mg of morphine at 10:30am (in the physical world). The medical team might then give the pharmacist the following feedback at 12:30pm: “the patient reports good pain relief”. However, the medical team might follow up with this feedback at 4:30pm: “The patient seems heavily sedated and unable to be woken on mild stimulus”, which is the cue for students to lower the morphine dose (a 2-minute video clip of this episode is available at http://bit.ly/aKxFnW).
Being time-sensitive, SimPharm features windows of opportunity within which students must act. In the above example, if the student does not lower the dose by 6:30pm, she would have missed the window of opportunity to adjust the morphine dose. Having missed the window, she would then be unable to prevent the patient from being totally unresponsive, at which point another medicine is needed to treat the morphine overdose.

The open-ended environment in SimPharm also lets students detect appropriate opportunities to perform a particular dispositional behaviour by themselves. In the above example, the student could have seized or missed the opportunity to adjust the morphine dose after receiving the feedback “The patient seems heavily sedated and unable to be woken on mild stimulus”.

SimPharm also allows students to actually do the actions and to follow through on their intentions. Despite being text-based, the actions within this simulation satisfy the conditions for the effective execution of performatives (as elaborated in Chapter 4) and hence count as actions.

In addition, SimPharm allows pharmacy students to partake in professional practice in iterative cycles. It is a web-based simulation that students can always access. Beyond access, the ways patients respond to medication are assigned a degree of probability (e.g., the patient might have a 90% chance of becoming heavily sedated from a 7mg morphine dose) and each encounter with the same patient might be different from the previous encounter. This degree of probability reflects the stochastic nature of human biological systems that do not always respond in perfectly predictable ways.

Virtual worlds are therefore not the only learning environments capable of supporting the learning of dispositional components for professional
education. Nonetheless, such learning environments are currently far from being mainstream.

Conclusion

In this chapter, using the dispositional theory of thinking, I clarified the meaning of “acting with meaning” as performing the dispositional components of intelligent behavior. Then I showed that virtual worlds offer students opportunities to demonstrate these dispositional components that correspond sufficiently with opportunities in the physical world, and concluded that students can hence learn these dispositional components via virtual world role-plays.

The four features I described in the previous section (open-endedness, window of opportunity, ability to actually perform an action, iterative cycles of participation) make virtual worlds almost unique in supporting the learning of sensitivity and inclination in professional education. Other common learning activities in professional education such as paper case studies, clinical placements, and face-to-face role-plays do not fully satisfy these four conditions. Similarly, Grotzer et al. (2015) compare virtual worlds and other common assessment activities, and describe the unique promise of virtual worlds in the following way:

Formal assessments enable us to see what ability students can reveal in cued situations but don’t illuminate whether students would reason about distal factors and extended time frames in authentic contexts without this cueing. Knowing to enact such knowledge in relevant contexts is essential to using it the everyday world. Actionable knowledge that transcends time and spatial scales is not easily assessed in classrooms. Virtual worlds... offer promise here. Virtual worlds—as parameterized versions of the real world—reveal what students actually do in a simulated context and provide an
approximation of what students might be sensitive to and carry forward into real world contexts. (p. 44; emphasis added)

To reiterate, being able to act in relatively uncued situations is essential to learning these dispositional components. Virtual worlds can simulate these uncued situations. These dispositional components are especially important in professional education because dispositions underpin professional identities, and professional education is concerned with the fostering of professional identities: “Our doings and undergoings (...dispositions, habits, inclinations, and tendencies to action and inaction) are, after all, what characteristically constitutes us as individuals” (Rescher, 1996, p. 107).

Virtual worlds then have a unique role in fostering these professional dispositions and identities. From their study, Perkins et al. (2000) reported that dispositions are “stable traits” (p. 269) that can help explain intellectual performance in everyday circumstances, a stability which holds promise for the transfer of learning from university to workplace settings.

In Chapter 7, the overall conclusions and recommendations from this thesis will be presented.
Chapter 7: Conclusions and recommendations

Introduction

I began this thesis with the following comment from a student who just participated in a virtual world role-play around an accident investigation (Falconer, 2013):

I am usually a “hands on” learner so I think that this helped in my understanding of real life scenarios even though it was fake. (p. 296; emphasis added)

Initially, this quote did not make sense to me because it was unclear how undertaking “fake” movements could bring about the learning of physical world skills, and how pressing buttons might be “hands on”. In this final chapter, I unpack this quote and show how the new explanation of learning in virtual worlds developed in this thesis helps make sense of the quote. Based on this new explanation, what students can and cannot learn by role-playing in virtual worlds will also be specified. Correspondingly, recommendations will be made about how to design virtual worlds to support what students can learn. Lastly, I elaborate on how the pessimistic stance was enacted in this thesis before outlining future research work.

Learning something real by doing socially-accepted actions

In this thesis, I developed an explanation of learning in virtual worlds by relating Austin’s (1962) speech act theory to the performance of virtual world actions. This new explanation holds that performing virtual world actions helps students learn the physical world equivalent because students get to do the action semantically. Applying this explanation to
the student comment above: the student was able to learn something about real life scenarios despite performing “fake” actions because these actions were legitimate socially-accepted actions.

In this alternative explanation, the basis of learning in virtual worlds is better explained as deriving from social conventions, rather than from physical experience. Social conventions lend weight and meaning to virtual world actions, giving these actions their illocutionary force and making them more than just pixels. In other words, social conventions make virtual world actions “real” and legitimate.

Getting to perform legitimate actions also makes the virtual world learning experience a “hands-on” experience. In the student comment above, the student suggested that the virtual world learning experience suited her because she was a “hands on” learner. Based on the alternative explanation of learning in virtual worlds, virtual worlds offer a “hands-on” experience in the sense that students get to “do something” and perform legitimate actions. In this sense, hands-on learning simply contrasts with learning by reading books or listening to lectures, but it does not mean that students learn by performing the same physical movements as physical world actions, as in “hands-on cooking” (Otago Polytechnic, 2017, para. 1).

Because students do not perform the same physical movements as the physical world actions, they cannot learn these physical movements via virtual world role-plays. What students can and cannot learn in virtual worlds will be specified in the next section.

What students can and cannot learn

Students can learn the thinking processes underpinning particular actions (as elaborated in Chapter 3), even though they cannot learn the physical movements of these actions. For example, while medical students in
virtual worlds cannot learn how to palpate the patient’s abdomen in a physical examination, they can learn how to interpret the text notification “Hard mass felt” given by the virtual world and mentally eliminate improbable diagnoses based on the textual feedback (i.e., differential diagnosis). Medical students can practise and in turn learn the thinking process of differential diagnosis in the Otago Virtual Hospital because their thinking processes are similar whether in the virtual or physical world. As evidence of this, Roy et al. (2014) reported that the clinical reasoning (including differential diagnosis) required in such a virtual world role-play resembles clinical reasoning in the physical world. Therefore, educators can use virtual worlds to help their students learn the thinking processes underpinning various actions that are relevant for professional education. It is in the learning of these thinking processes that virtual worlds can serve as a bridge between the classroom and the workplace.

There are ways to explicitly design virtual worlds so as to foreground the thinking processes underpinning actions. One recommendation is for educators to design virtual worlds that require students to make important decisions (i.e., the same decisions they would make in the physical world situation) in order to succeed in the role-play. Examples of such decisions include choosing the appropriate walking speed so that students can evacuate from a virtual underground mine without depleting their oxygen supply (Garrett, 2012), selecting appropriate questions to ask the virtual client while undertaking a home visit in social work (Wilson et al., 2013), and prescribing the correct medicines from a wide range of medicines in a virtual hospital (Blyth & Loke, 2014).

Students can also learn the dispositional components of physical world actions, as elaborated in Chapter 6. Using an example from the Otago Virtual Hospital: while medical students cannot learn the physical
movements of performing an abdomen examination, they can learn when it is appropriate to perform an abdomen examination.

I will also use a hypothetical example to illustrate the learning of dispositional components as well as to qualify a claim made above. I mentioned that hands-on learning in virtual worlds is different from “hands-on cooking” (Otago Polytechnic, 2017, para. 1) in face-to-face classes. If a virtual world on cooking were available for cookery students, while they cannot learn the mechanical movements of stirring vegetables in a wok in the virtual world, they can learn to notice the need to adjust the cooking temperature as appropriate (sensitivity) and to follow through on their intention to adjust the temperature (inclination).

Students in virtual worlds can learn sensitivity and inclination relevant for professional practice because the performance of these dispositional components is similar whether in the virtual or physical world. Therefore, virtual worlds are capable in developing students’ “understanding of when, how, and why it is appropriate to employ particular knowledge and skills and in what circumstances” (Dall’Alba & Barnacle, 2005, p. 720) and educators can use virtual worlds to help their students learn the dispositional components of actions. It is in the learning of sensitivity and inclination that virtual worlds can serve as a bridge between the classroom and the workplace. In Chapter 6, recommendations have been made regarding how to design virtual worlds to support the learning of sensitivity and inclination (namely open-endedness, window of opportunity, ability to actually perform an action, iterative cycles of participation).

What students cannot learn will now be described. After evaluating current theories used to underpin empirical work on virtual worlds, a common learning mechanism that is implausible for occurring in virtual world role-plays was identified: that performing a virtual world action
gives students a physical sensorimotor experience of the physical world action (see Chapter 3 for details). This is implausible because students are not physically immersed in desktop virtual worlds. Coupled with the observation that students perform the virtual world action and the physical world equivalent with very different physical movements (morphological disconnect), I contend that students cannot learn the physical movements of the physical world action via virtual world role-plays. Therefore, educators should not use virtual worlds to help their students learn such physical movements (e.g., perform welding tasks in mechanical engineering, provide appropriate grooming for pets in veterinary nursing, palpating the patient’s abdomen in medicine).

As such, educators should be cautious in suggesting that virtual world learning experiences could replace internships in the physical world, as suggested by Drake-Bridges, Strelzoff, and Sulbaran (2011) and Vergara, Caudell, Goldsmith, and Alverson (2008). The physical experience is still very much needed if educators intend for their students to learn the desired physical movements or to experience the physical environment. This physical experience is not something that desktop virtual worlds can offer to students.

Overall, being more specific about what students can and cannot learn via virtual world role-plays allows educators to use virtual worlds to achieve specific and appropriate learning outcomes, instead of believing that virtual worlds somehow offer “nearly limitless possibilities for both educators and students” (Morgan, 2013, p. 549) or “infinite imaginative educational possibilities” (Salmon, 2009, p. 526). Specifying what students can and cannot learn in virtual worlds is one way in which I enact the pessimistic stance (elaborated in Chapter 1) in this thesis:

(... ) pessimism still allows room for an acceptance that specific things are getting better (... ) the pessimistic educational technologist
is simply one who adopts a mindset that is willing to recognise—and work within—the current and historical \textit{limitations} of educational technology rather than its imagined limitless potential. (Selwyn, 2011, pp. 714-715; emphasis added)

I concur with Selwyn (2011) that adopting a pessimistic stance is a sensible and productive way to advance educational technology scholarship because it neither oversells nor undersells technology. A pessimistic stance simply accepts technology as it is, and this is my final recommendation.

\textbf{Accepting technology as it is}

Accepting technology as it is starts with not expecting learning to be inherently enhanced by technology and being open to all possibilities about what can and cannot be learned using a particular technology. In this thesis, I accepted virtual worlds as they are in two ways:

1. I evaluated all theories explaining learning in virtual worlds using the same principle of correspondence and accepted all outcomes from this evaluation (Chapters 2 and 3);
2. I accepted and worked within the limitations of desktop virtual worlds while developing a new explanation of learning in virtual worlds (Chapters 4, 5, and 6).

First, after comprehensively scanning the research literature to identify all current theories used to explain learning in virtual worlds, I evaluated all the theories using the same principle of correspondence. This principle holds that: to maximise the likelihood of transfer of learning from the virtual learning context to the target physical world context, there needs to be a high degree of correspondence between performing $X_{VW}$ and performing $X_{PW}$. I was open to all outcomes from this evaluation. For example, I was open to presence theory being able or not being able to
explain behavioural transfer from the desktop virtual world to the physical world.

As I developed my understanding of presence theory, I discovered that presence theory relied on behavioural correspondence that desktop virtual worlds do not offer. Many virtual reality researchers actually classify desktop virtual worlds as non-immersive because of the morphological disconnect between virtual world and physical world actions (Bailenson and Blascovich, 2004; Blascovich and Bailenson, 2011; Fox, Arena, et al., 2009; Schroeder, 2011; Winn, 1993). Therefore, presence theory does not satisfy the principle of correspondence and is inapplicable to explain how students might learn physical world actions by performing virtual world actions. I accepted this “negative” outcome as well as other “positive” outcomes from the evaluation (e.g., that situated learning theory partially satisfies the principle of correspondence in that students role-playing in virtual worlds can be led to think as they would in physical world situations).

The way all plausible theories were identified exemplifies how a pessimistic stance does not imply “a dogmatic blanket negativity towards education and technology” (Selwyn, 2011, p. 714). The stance or posture that I adopted was not negative in the sense that I did not aim to identify all implausible theories about learning in virtual worlds. My aim was instead to identify all plausible theories. Given that there is some evidence from empirical studies that students can develop their professional knowledge and skills by participating in virtual world role-plays (see Chapter 1), I sought to locate all plausible explanations of how this learning happens. It was in the process of identifying all plausible theories that I isolated the implausible explanation that students undergo a sensorimotor experience of the physical world action when they perform a virtual world action.
The second way I accepted virtual worlds as they are is: I accepted the limitation that desktop virtual worlds are non-immersive (as many virtual reality researchers already do) and worked within this limitation while developing a new explanation of learning in such non-immersive virtual worlds. The majority of educational technology researchers still conceive desktop virtual worlds as immersive (see Chapter 1 for examples). These researchers should specify which meaning of “immersed” they mean: that the student’s physical body is surrounded by the virtual environment; or that the student is psychologically engrossed in role-play (as they could be similarly engrossed in a novel, movie, or phone conversation). Or they could follow Dalgarno et al.’s (2016) example by describing desktop virtual worlds as “potentially immersive” (p. 130).

Accepting that students are not physically immersed in desktop virtual worlds implied that my new explanation should not hold the implausible assumption that students gain a physical sensorimotor experience of the physical world action in virtual worlds. It is by virtue of accepting this limitation that I looked beyond physical experience as a basis of learning in virtual worlds. Looking beyond physical experience led me to discover social conventions as a new basis of learning in virtual worlds. This is how adopting a pessimistic stance was a productive way to advance educational technology scholarship in this thesis.

Future work

My future work consists of exploring the implications on gamers of performing violent video game actions that function as performatives. A key contribution of this thesis was to shift the basis of learning by doing something in desktop virtual worlds from physical experience to social conventions and meaning. This shift is likely to also apply to desktop role-playing video games: when gamers perform video game actions, they
get to do physical world actions with meaning. In violent video games, what does it imply for gamers to be able to slash their enemies with meaning (e.g., *Assassins Creed*), shoot other soldiers with meaning (e.g., *Medal of Honour*), and knock people down with their cars with meaning (e.g., *Grand Theft Auto*)?

Existing research on the effects of violent video games tend to focus on psychological and physiological measures (Anderson & Bushman, 2001; Carnagey, Anderson, & Bushman, 2007; Lin, 2013). Future work in this area can focus on providing an account of the effects of violent video games that is based instead on social conventions and meaning. Such an account can complement and enrich existing accounts that are based on psychological and physiological measures.

**Shadows**

Overall, this thesis has much to do with shadows. As elaborated in Chapter 5, shadow puppetry is a useful metaphor for virtual world role-plays and virtual world actions are—like shadows—insubstantial. The underlying problem of this thesis is how something as insubstantial as a virtual world action might matter for learning something useful in the material world.

In addition, the main aim of this thesis is to develop an explanation of learning in virtual worlds so that educators are clearer about which learning outcomes virtual worlds can be best used for. If educators were clearer about what students can and cannot learn in virtual worlds, they would no longer use virtual worlds for learning outcomes involving physical experience. In a way, they would no longer be chasing shadows.
References


Appendices

Appendix A: List of journals in systematic literature review

1 Accident Analysis and Prevention
2 American Journal of Distance Education
3 American Journal of Physics
4 Australasian Journal of Educational Technology
5 Australian Journal of Basic and Applied Sciences
6 British Journal of Educational Technology
7 Business Communication Quarterly
8 Canadian Journal of Science, Mathematics and Technology Education
9 Communication Teacher
10 Computer Assisted Language Learning
11 Computers and Education
12 Computers in Human Behavior
13 Cultural Studies of Science Education
14 Education for Information
15 Educational Media International
16 Educational Research
17 Educational Researcher
18 Educational Technology and Society
19 Educational Technology Research and Development
20 Electronic Journal of e-Learning
21 Geology Today
22 Gerontology and Geriatrics Education
23 Innovate: Journal of Online Education
24 Interactive Learning Environments
25 Interactive Technology and Smart Education
26 Intercultural Education
27 International Journal of Art and Design Education
28 International Journal of Distance Education Technologies
29 International Journal of Human-Computer Interaction
30 International Journal of Teaching and Learning in Higher Education
31 International Journal of Technology, Knowledge and Society
32 Internet and Higher Education
33 Journal of Agricultural Education
34 Journal of Computer Assisted Learning
35 Journal of Computing in Civil Engineering
36 Journal of Educational Computing Research
37 Journal of Educational Multimedia and Hypermedia
38 Journal of Educational Technology and Society
39 Journal of Educational Technology Systems
40 Journal of European Industrial Training
41 Journal of Information Systems Education
42 Journal of Interactive Learning Research
43 Journal of Interactive Media in Education
44 Journal of Marketing Education
45 Journal of Research on Technology in Education
46 Journal of Science, Education and Technology
47 Journal of Teaching in Social Work
48 Journal of Teaching in Travel and Tourism
49 Journal of the American Academy of Nurse Practitioners
50 Language and Intercultural Communication
51 Language Awareness
52 Language Learning and Technology
53 Learning and Instruction
54 Learning, Media and Technology
55 Medical Education
56 Medical Teacher
57 Nursing Education Perspectives
58 On the Horizon
59  ReCALL
60  Rural Special Education Quarterly
61  Slavic and East European Journal
62  Systemics, Cybernetics and Informatics
63  Teaching and Teacher Education
64  Technical Communication
65  The Canadian Modern Language Review
66  The History Teacher
67  The Modern Language Journal
68  Western Journal of Nursing Research
## Appendix B: Classification of journal papers in systematic literature review

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Appendix C: Glossary of terms

**Avatar**
A person’s virtual character or graphic representation in a virtual world

**Behavioural transfer**
The transfer of elements of a person’s virtual world behaviour to the physical world

**Dispositions**
A person’s tendencies to put his or her capabilities into action

**Fully immersive virtual environments**
Virtual environments where users’ bodies are physically immersed in or fully surrounded by the virtual environment

**Learning theories**
A set of principles offered to explain how learning takes place in particular contexts

**Morphological disconnect**
The difference between what virtual world users do and what their avatars do

**Presence**
A person’s feeling of being in one place even though he or she is physically situated in another place

**Virtual world**
A computer-based, multi-user virtual environment that simulate events in the physical world and where users control their avatar using keyboards and mice

**Virtual world actions**
Actions performed in virtual worlds that are correspondingly performed by people in the physical world with overt physical movements
Appendix D: Peer-reviewed journal papers and conference paper drawn from this thesis

