In 2011, seven academics from five Australian universities and one international university received an ALTC (Australian Learning and Teaching Council) grant to explore role play in a virtual world for professional experience, hence the project was called VirtualPREX. These academics are now all based at four institutions: the University of New England, Curtin University, Charles Sturt University, and RMIT University. Through VirtualPREX, pre-service teachers can practise their teaching in a risk-free environment before engaging in real-life professional experience. VirtualPREX provides a learning environment for pre-service teachers, where the use of role play in a virtual classroom is a key factor within distance education (Gregory et al., 2011). The pre-service teachers synchronously practise their teaching skills with peers through role-play activities in Second Life. We chose this virtual world for the project as all team members had existing, extensive experience in using Second Life as a teaching and learning tool. In the first phase of the project, we conducted a pilot study to test the virtual classroom environment where pre-service teachers were role-playing as either a teacher or primary school student. The teacher presented a seven-minute teaching episode or provided an idea, and their peers acted as the primary school students in either an “on-task” or “off-task” role. This required synchronous role plays. Information for the on-task and off-task roles came from a focus group held with school teachers and principals. On-campus
pre-service teachers conducted the role plays in a computer laboratory in which all participated. Off-campus pre-service teachers undertook the role-play activity from their own homes. The results of these synchronous role-play activities are discussed in the chapter, “VirtualPREX: Providing Virtual Professional Experience for Pre-Service Teachers” (see also Gregory et al., 2011). Another component of the project focuses on developing bots (non-player characters [NPCs], alternatively known as “animated pedagogical agents, conversational agents, chat bots, conversational avatars and virtual characters”: Veletsianos, Heller, Overmyer, & Proctor, 2010, p. 124) to act as the primary school students to provide asynchronous role play for pre-service teachers. Heller and Proctor (2010) emphasize that the term “agent” in virtual worlds does not have a consistent definition across disciplines, and even though these agents might use different technologies (for example, Artificial Intelligence Markup Language [AIML], as well as ALICE [Artificial Linguistic Internet Computer Entity]; FreudBot uses AIML), they are all virtual representations embedded in learning environments that serve pedagogical purposes. In VirtualPREX the use of agents or interactive bots will enable pre-service teachers to visit Second Life on their own time, in their own place, and at their own pace, to practise teaching the interactive bots before they embark on their real-life professional experience. This will be of particular benefit to off-campus pre-service teachers.

Honest reflection on virtual worlds, namely large mainstream worlds such as Second Life, reveal that most places are empty, and city replicas, malls, bars, or educational places often look interesting but abandoned at the same time. Options designers use to attract visitors to locations in the virtual world are generally promotions, freebies, and some interactive designs (Friedman, Steed, & Slater, 2007). Less often, scenarios are enhanced by different kinds of avatars to entertain visitors. These interactions are either guided by user-controlled avatars (a personalized graphical representation of themselves; Gregory & Tynan, 2009), unanimated and unscripted avatars, or scripted avatars (bots: computer-controlled avatars, generally personalized by the owner of the bot).

There are excellent examples of innovative bot design, performance, and interactivity being used in virtual worlds within the past few years. Nowadays, bots representing people wander through virtual worlds to create the impression of the societies we live in. Some do not interact but are similar to everyday people we see on our way to work; sitting next to us in bars and filling theatres. Additionally, bots can do the work of real people by fulfilling different tasks such as demonstrating objects, explaining manuals, or guiding the way to new locations. These bots require simple scripting as the tasks they are following are
Virtual Bots

Virtual PREX

step-by-step procedures and need almost no interaction with the environment. Nevertheless, they enhance immersive feelings in a virtual world and provide answers to users that are seldom available through other means. Finally, the intelligence of the bots can be increased by advanced scripting and further sensory feedback to enable actual interaction with human avatars. Examples of these types of bots are social workers, tour guides who adapt to the situation, or victims in training scenarios such as hospitals. More sophisticated bots could add to the enrichment of virtual worlds. Continuous enhancement of autonomous behavioural skills could contradict prejudices many users have about the loneliness and boredom in many parts of a virtual world. Ullrich, Bruegmann, Prendinger, and Ishizuka support the notion that using bots in the virtual world provides a space with a sense of being alive, although they suggest that bots are “almost missing from Second Life” (2008, p. 282), the virtual world we predominantly discuss here. Bots have increased in number considerably since Ullrich et al.’s (2008) observations, with more people seeing the value of using them in their virtual space. As Veletsianos et al. (2010) suggest, bots need to be programmed to undertake a conversation with people inworld and respond to non-verbal cues (such as walking closer). They need to be created so that they are consistent with the environment they are placed in, and must be believable. Heller and Proctor point out that there are “challenges associated with programming to interact in such an unrestricted and often unpredictable environment” (2010, p. 312) like Second Life.

In this chapter we first present a short literature review examining distinct achievements for realizing intelligent bots in the context of learning in virtual worlds. We approach bots from the theoretical perspective of hard and soft technologies, and describe the effects that they can have on the degree of freedom, flexibility, and creativity in virtual worlds. That is, we present the hardening of a soft technology and then demonstrate how this restricts users in their interactions while increasing their immersion at the same time. Before we describe the development of bots in our project, Virtual PREX, we provide a brief overview of examples and technologies that utilize bots in Second Life—frameworks, programming environments, languages—and how these can be developed in the future by providing vibrant interactivity.

In Virtual PREX, pre-service teachers are given the opportunity to practise their skills and develop confidence in dealing with the different behaviours of schoolchildren. One element of Virtual PREX is to have these behaviours simulated with bot primary school students. In this chapter, we focus on the development of the bots; that is, on their anticipated behaviour, control mechanism,
and implementation. As VirtualPREX is about learning and interaction with a human-controlled avatar, the requirements for the capabilities of the bots are far different and more advanced than for the scenarios we described previously, such as demonstrating processes or products. We briefly look at the underlying concept of the bot recognizing teacher movements and/or instructions that would trigger a reaction. It should be pointed out that the project is still ongoing, and the described framework outlines our path for implementation based on the preliminary results of the pilot. Our research is geared toward educators with a strong understanding of pedagogical models but not necessarily technical specifics like state diagrams or pseudo code.

From Peers to Bots in Authentic Learning

Activities such as role play, simulations, and case studies need to occur in authentic learning environments to preserve a link with reality, as this supports information recall. Virtual worlds are well suited to providing simulated learning by modelling a process or interaction that closely resembles real-world situations in terms of fidelity and outcomes. Authentic learning environments can be created in both digital and physical settings (Ingram & Jackson, 2004; Lombardi, 2007). Realistic digital environments that use simulations to closely replicate the world and workplace have become popular over the past decade (Ferry, Kervin, Cambourne, Turbill, & Puglisi, 2004), however, these have primarily been 2D applications employing video playback or streaming and text-based simulations, with limited use of graphics and social networking tools. There are fewer instances of the use of 3D virtual world environments. A comprehensive research project (Hew & Cheung, 2010) conducted across the media arts, health, and environmental disciplines in 2008 on using 3D virtual worlds in K–12 and higher education settings found that they were primarily used for communication, simulation, and experiments.

Digital environments have many advantages for addressing current problems in professional experience, including wider access, the potential to present a broader range of situational learning experiences, increased communication and interaction opportunities, greater safety than real-life learning environments for exploring the consequences of decisions, and more facility for reflection (Ferry et al., 2006). Dalgarno and Lee (2010) show that the representational fidelity and aspects of learner–computer interactivity in 3D environments provide extra advantages over 2D alternatives. The affordances they isolate include facilitation of tasks that lead to enhanced spatial abilities, greater opportunities
for experiential learning, increased motivation/engagement due to higher levels of interaction and a sense of “presence” born of the immersive nature of the interaction, and improved contextualization of learning and richer/more effective collaborative learning. Among the few studies on simulated classroom environments, Foley and McAllister (2005), Ferry et al. (2005), Girod and Girod (2006), and Mahon, Bryant, Brown, and Kima (2010) have explored the possibilities of linking simulations and workplace experiences. This blended approach is proving helpful to cognitively prepare pre-service teachers for real classroom experiences, supporting the transfer of knowledge and skills learned in virtual environments to real classrooms. Recent research confirms that using Second Life to practise teaching with peers creates a significant difference in personal teaching efficacy after inworld practice sessions, and that collaborative practice teaching is an effective way of practising teaching (Cheong, 2010). Cheong’s research showed that pre-service teachers can practise teaching skills in Second Life without having a negative impact on students, and the practice can be performed repeatedly and more easily than in real life, making virtual worlds well suited to provide authentic environments where newly developing pedagogy can be practised and assessed.

Only preliminary consideration has been given to challenges that emerge from the pedagogical, social, and technological aspects of active online learning. While best practices in content structuring may be transferred from stand-alone educational simulations to virtual world-based simulations, metrics and learning objectives for the two contexts should be different. Much more work is needed to derive guiding principles to inform the design, development, and use of 3D virtual environments for learning, especially in cases of solo learning.

In recent years, virtual worlds have been firmly established as an effective means of building social networks and communities of learning (Boulos, 2007). The availability of synchronous communication means virtual worlds provide enhanced interactivity (Petrakou, 2010). Synchronous communication allows for immediate, contextualized feedback, which has been shown to relieve feelings of isolation characteristic of online learning. By utilizing peers to operate avatars, pre-service teachers can interact synchronously; however, such interaction is often not available due to different time zones or conflicting schedules. Bots can fill this gap by enabling asynchronous active interaction in the absence of peers. This flexibility provided by asynchronous interaction supports and enhances solo learning, student–student interaction, and academic–student interaction (Petrakou, 2010). Bots can be useful for distance education when they can interact and undertake conversations with other
human-controlled avatars and increase engagement and motivation of the learning task (Heller and Procter, 2010); they also allow for both passive and active learning (Affiliated Computer Services, 2009). Creating an automated classroom in Second Life where pre-service teachers control avatars to interact with bots provides them with authentic experiences that they are likely to encounter in their professional role as well as a safe, low-risk environment in which to practise, experiment, and react to real-life scenarios to see the consequences of complex decisions (Gregory, Reiners, & Tynan, 2010). This is particularly beneficial for the professional experience of off-campus education pre-service teachers who have limited availability to interact with peers and academics.

Bots are a technology being applied either following the intentions of their inventors or utilized in a completely new way. Technology itself is described by Arthur as an “orchestration of phenomena to our use” (2009, p. 53), which are assembled to achieve individual, group, or society-derived goals. Bots might be defined for a single phenomenon to react on; for example, providing a document when being approached by a human avatar. But then again, the bot may be part of another technology where its function is defined by the overall context—for example, at the entrance of a meeting room to distribute the agenda; or combined with other technology to enhance its functionality, such as mounting the bot on a vehicle that travels through the virtual world to distribute advertisements to as many avatars as possible. Thus, the orchestration of technologies—here the bots and the pre-existing virtual world scenario—creates the experience and purpose for the users, as well as defining their degree of freedom, flexibility, and creativity. From a theoretical perspective, we classify technology based on the scope of action along a scale from soft to hard (see also Dron, Reiners, & Gregory, 2011). In a soft technology environment, the user is able to do as much as possible without many restrictions, whereas in a hard technology, the options are provided by the environment; for instance, each step is predefined and the user can only follow these steps. Soft technology is about the latent possibilities and potential available to human-controlled avatar or bot that enables many creative and flexible uses. Instead of defining or restricting the next activity, a free choice and decision is required to progress in the virtual environment. Hard technology constrains the freedom by aiming for efficiency, replicability, and the elimination of errors (Ellul, 1970). Here, the human-controlled avatar or bot is confronted with instructions on how to proceed with a limited set of well-defined alternatives to choose from. Strictly scripted games often follow this scheme, where the protagonist is challenged.
by a sequence of individual tasks to solve in a certain way. Note that environments have to find the right balance between soft and hard according to the expectations of the user, thus giving some freedom while still directing them to a specified target.

Referring to virtual worlds, Figure 8.1 demonstrates the difference between soft and hard technologies. The empty space in Figure 8.1 on the left side is considered a soft technology, as the creativity is not constrained by restrictions placed on it by Linden Lab (the proprietors of Second Life) or the Second Life software program. Thus, the landowner can build, for example along the given Australian theme, change the landscape, or integrate objects from other scenarios, real or not. The second example, on the right side of Figure 8.1, depicts a hard technology as the user is strictly guided by a one-way sign, has to perform specific tasks, and is not allowed to leave this path unless he or she has achieved the defined objective. Here, the user cannot express him or herself, but has to proceed according to the requirements of the technology.

![Figure 8.1](image)

*Figure 8.1 Information being provided to a newbie.*

In relation to bots, the technology is generally hardened as bots have a certain set of functions predefined through their programming. A salesperson bot is unlikely to get involved in actions but, as a result of their programming, will provide the offered goods efficiently, even though their programming might include individual preferences and therefore offer to the user a higher degree of immersion compared to, for example, a vending machine. Additionally, the hard technology can also simplify interactions and provide a recognizable purpose, for example, a bot representing a student in a classroom provides the immersive environment of a classroom in which the user can engage in roles like teacher or observer, as demonstrated by the VirtualPREX project.
Overview of Examples and Technologies for Bots in Second Life

The development of bots in games and MMORPGs (massively multiplayer online role-playing games) has progressed considerably over the past few years. Besides simple scripts reacting to the users’ movements, intelligent algorithms create strategies to increase the immersion, providing unpredictable or challenging actions. Unfortunately, Second Life does not provide major (intrinsic) support for the bot programming required in VirtualPREX, as bots are restricted to simpler and less complex tasks. One reason for this is the design of Linden Scripting Language (LSL), where scripts are part of an object and not avatars (Friedman et al., 2007). Nevertheless, several projects incorporate bots using a combination of Second Life technologies and external applications; some examples are shown in the Table 8.1.

<table>
<thead>
<tr>
<th>Project</th>
<th>Bot functions</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TeachLivE</td>
<td>Bots who talk, look, and even act like students from real classrooms.</td>
<td>Dieker (2011)</td>
<td>Pre-service teachers can practise their teaching skills with bots being controlled by a human or as programmed avatars.</td>
</tr>
<tr>
<td>QoE</td>
<td>Crawler that gathers information about the virtual world that includes a player to playback the collected experiences.</td>
<td>Varvello, Ferrari, Biersack, and Diot (2011)</td>
<td>Explores Second Life to measure the quality of experience.</td>
</tr>
<tr>
<td>Project</td>
<td>Bot functions</td>
<td>Reference</td>
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<tr>
<td>MPML3D (Multimodal Presentation Markup Language)</td>
<td>Specifies communicative behaviour and the interaction of bots using this markup language.</td>
<td>Prendinger, Ullrich, Nakasone, and Ishizuka (2011)</td>
<td>To improve the usability of the scripting language for bots, MPML3D is used as an interface to write XML-based control scripts.</td>
</tr>
<tr>
<td>Team Handball</td>
<td>Moves bots around a virtual handball field.</td>
<td>Lopes, Pries, Santos, Sequeira, and Camerino (2009)</td>
<td>A trainer can control bots through an external environment and inworld. Controls the positions of players to demonstrate different tactics.</td>
</tr>
<tr>
<td>Medical Education</td>
<td>Chatbots that can convey some emotions through facial expressions.</td>
<td>Danforth, Proctor, Heller, Chen, and Johnson (2009)</td>
<td>Simulates doctor–patient communication using AIML technology (similar to Chatbot and Pandorabots).</td>
</tr>
<tr>
<td>Uruk</td>
<td>Embodied conversational agents that can reason and act based on the environment and context.</td>
<td>Ijaz, Bogdanovych, and Simoff (2011)</td>
<td>Simulates the ancient city of Uruk using a very profound integration of the context.</td>
</tr>
</tbody>
</table>

TeachLivE (evolved from TeachME), although not using Second Life, is a project with similar goals to VirtualPREX (see also Dieker, 2011). TeachLivE explores virtual teaching experiences in an automated classroom using a different
medium. It is a mixed-reality teaching environment (Dieker, Hynes, & Hughes, 2008) where bots are programmed by software but rely on an actor controlling the bots via puppetry (known as an interactor), to respond to the teacher depending on whether they use “effective” or “ineffective” teaching methods. This automated classroom can be used for practising teaching skills and can also detect “unfit” teachers early to reduce attrition. Also, as with VirtualPREX, the bots enable pre-service teachers to learn from their mistakes prior to teaching live classes in a risk-free environment.

The technology of how bots are used varies from unique implementations to frameworks consisting of whole environments and programming languages. The following list is just a sample of existing approaches available to make the bots do almost exactly what the creator wants, with different requirements of programming knowledge. In this chapter we outline an overview of different tools—which can also be combined—to create, in our case, an authentic primary school child bot that can be used in the classroom. All these tools have been created by different developers and are available in Second Life and OpenSim. Note that the list shows only an extract of available tools, as further, often very specialized, systems exist. However, we focus on those being considered—after a preliminary benchmark test—for implementation within the VirtualPREX project.

**Pikkubots** (http://www.pikkubot.de)—enable interactive learning activities to take place between bots and avatars in authentic learning settings. These bots can interact with, and respond to, other avatars in the virtual world. They can make over 500 different comments using a web-based tracking system (Second Life, 2011). For example, Pikkubots can be used to (i) send out notices to other avatars without having to log into the virtual world in the time range specified by the user (Gray, n.d.); (ii) talk with other avatars; (iii) talk around pre-programmed routes; (iv) follow your avatar; (v) drive vehicles; and (vi) greet visitors and give gifts (Second Life, 2011).

**Pandorabots** (http://www.pandorabots.com)—a bot hosting service that enables users to create, design, and publish bots, making them available to anyone via the Internet. Anyone can create an account and set up the script for their bot. Prepared scripts are available, or the user can insert their own text. Responses by bots, verbally through text, to what other avatars say are programmed into the Pandorabot scripts. The script is then placed in a bot made out of objects. Bots
and scripts are both freely available. Pandorabots also have blank templates so that the script can be written from scratch, providing owners with the ability to make a unique personality for the bot. Pandorabots are able to recognize speech, which is transmitted to the bot after the user acknowledges the text.

*The Logic System*—enables users to make choices so that a bot reacts to a human avatar teaching by creating branched, decision-based activities. Simulations, orientations, information kiosks, games, decision-making systems, and interactive stories are learning activities that the Logic System supports (Jamison, 2009). There are now two versions of the Logic System—one that reacts to the human user’s avatar, and one that is linked to a bot (using Pikkubots).

By using the Pikkubots, Pandorabots, and Logic System together, authentic learning, actions, and reactions can take place through conversation, movement, and the provision of different decisions. Figure 8.2 is an example of a human avatar and bots interacting and existing together in the one space.

![Figure 8.2 Bots interacting with one another while a human avatar looks on.](image)

*LIBOPENMV*—a library that implements core functionality like protocols, networking, and programming interfaces for clients to interact with virtual worlds such as Second Life and OpenSim. LIBOPENMV resembles several .NET libraries, is open source and maintained by the non-profit OpenMetaverse Foundation (https://github.com/openmetaversefoundation). The library supports messages currently used by Second Life or OpenSim, and enables their integration in other software projects to gain access to virtual worlds. This use
of messages allows clients access on a system level so that they can achieve further information and control than would be possible via other interfaces like web-based protocols. One of its main applications is the control of bots (Sugar, 2011), and the library is also part of toolkits like SLbot (http://www.niondir.de/slbot) and the infamous CopyBot, used to access and archive objects from Second Life (see Second Life Wiki, 2011).

As we mentioned, the scripting in Second Life using only Linden’s script language limits the possibilities such that external systems are needed to improve the quality and functionality of bots. To our knowledge, there exists no standard for designing and implementing bots in Second Life. Although various technologies have been developed over previous years (see Table 8.1), none of these systems have established a common denominator for creating bots; that is, allowing bots to exist in more than one virtual world or even enabling complete interworld communication between bots. From a technological perspective, bots in Second Life have come a long way, and by combining approaches in a common framework, educators can model the behaviour they desire in them without advanced programming skills. A standard would allow for bots that are interchangeable across platforms which can be easily set up. New behavioural scripts could be integrated into the same framework, or parts could be re-used from other technologies.

Bots in VirtualPREX

In this section, we discuss how bots can be integrated in VirtualPREX to provide an interactive, immersive classroom for the pre-service teacher. In the pilot study, pre-service teachers participated in a workshop where, through role play, they taught a lesson to their peers acting as primary school students in order to establish ways in which to immerse and engage the whole class in the lesson. By using bots, pre-service teachers will be provided with increased opportunities to practise, try out skills, and apply concepts in an authentic and immersive learning environment, asynchronously through interaction in and with the bots. Bots will provide more opportunities for off-campus pre-service teachers to practise, as they are not usually afforded the opportunity to synchronously role-play with their peers.

Pre-service teachers can immerse themselves in high-quality education as they are provided with opportunities to interact with bots and peers in authentic learning environments, real or simulated (Gregory & James, 2011). The rather soft technology of a classic classroom would leave pre-service teachers without any guidance with respect to how to proceed when dealing with keeping
students engaged and attentive. “Hardening” the classroom by adding scripted bots specifies the scenario such that the pre-service teacher is restricted to certain methods available to them through interaction with the bots. The same applies to, for example, exams where each pre-service teacher is supposed to have the same conditions and reactions. There are a variety of behaviours that bots can display to interact with the pre-service teachers. It could be as simple as the bot ceasing to misbehave and interrupt the class when the teacher walks closer. After all, links with reality are provided through authentic learning environments. Teaching methods (analogous to soft technologies) that pre-service teachers learn in the classroom can be translated through VirtualPREX by practising in a virtual world. The hardening of these soft technologies in defined scenarios with scripted bots offers pre-service teachers an opportunity to repeat and experience certain situations in an immersive space. Both automated and role-play activities that are modelled on the real world, like VirtualPREX, can provide a greater sense of presence and realism than non-3D spaces (Dalgarno & Lee, 2010).

The prototype bot is lifelike, interactive, automated, and looks and behaves like a primary school student. This bot is programmed to respond in a variety of ways to the pre-service teacher by reacting to basic terms and questions using a combination of several different programmed systems available in the virtual world. In general, the prototype bot is based on the LIBOPENMV library.

Bots can be used to act as any required character, such as on-task or off-task school students—a common use for non-player characters (see Mahon et al., 2010; Jolie, Katzky, Bredl, Kappe, & Krause, 2011). The learner can engage with bots who undertake multiple roles where they have predefined reactions to events that occur in the teaching scenario (paying attention, writing, drawing, disturbing the class, throwing paper planes, etc.; see Figures 8.3 and 8.4). The pre-service teacher can practise the same teaching scenario multiple times without variation. Conversely, bots can be configured in advance so that they will react to different teaching strategies when they have changeable behaviours using script libraries.

By using original avatar technology, Second Life provides an environment where most users can program bots with a high level of sophistication. The framework that is currently being developed is demonstrated in Figure 8.3, which consists of inworld and external components. Complete inworld control of avatars is, on the one hand, too slow due to the script engine, and on the other, is also restricted by the functionality that the script language (LSL) used in Second Life offers (Ranathunga, Cranefield, & Purvis, 2010; Kumar et al., 2008).
Figure 8.3 depicts one of the two intended systems to implement the bots for VirtualPREX. The classroom is situated in Second Life where avatars are either controlled by humans or through the system (bots). The behaviour of the bots is configured in advance, even though live modifications are possible if someone is observing the classroom. The basic configuration is done by assigning each role in the classroom to either a human or a bot. The bot can be programmed with a variety of behaviours (state of the bots) which are...
triggered by teacher actions (such as his or her proximity or him or her addressing the bot). The behaviours are assigned depending on the teacher’s actions, to provide him or her with a number of scenarios that may occur in a “normal” classroom. Underneath the surface, a server is recording all events in the classroom: the movements of avatars, gestures, or objects being passed between students. Based on triggers, the server initiates actions. For example, an off-task bot student who is not noticed by anyone starts throwing paper airplanes at the teacher. See Figure 8.4 for an example of how the bot is triggered to throw a paper plane as soon as the teacher turns away without implementing a strategy, such as leaving a book to keep the student busy.

![Figure 8.4](image)

**Figure 8.4** Example of an event the student bot triggers based on the teacher avatar’s behaviour.

In VirtualPREX, bots require the capability to perform at least four activities, and furthermore, the design of the system should not limit further extensions and scenarios (Gregory et al., 2011, p. 498):

1. All roles/characters are either assigned to a human-controlled avatar by wearing the corresponding outfit, or a bot is initialized by requesting the external server to log in and take control.

2. Bots must be able to configure the mood, behaviour, event, and solution for each avatar. For human-controlled avatars, this is only a guideline, as the software cannot influence their behaviour. Bots, on the other hand, perform based on these settings; e.g., A2 is off task (mood) and will throw paper airplanes (behaviour) whenever the teacher’s area of observation is not on the student (event; see Figure 8.4). Asking the student to draw a picture or keeping the area of observation on him can prevent the behaviour. At this stage of the project, only a single event or
action has been programmed. The configuration board can be in Second Life (e.g., hidden behind a flipchart that only the teacher can turn around) or on external clients.

3. During the experiment, all events (including chat, movements, and actions) have to be observed and archived for later analysis. This can either be done by the developed system or by inworld objects that report all events to an external server.

4. The results must be exported in different formats depending on how they are later used. For analysis, quantitative (e.g., timing, success rate, grading, movement) as well as qualitative (e.g., chat, screenshots) data are archived. Furthermore, all movements and events can be recorded as a script to be later reused for replaying a scenario to a pre-service teacher for analysis or training bots for future scenarios.

VirtualPREX uses bots based on a similar approach to LIBOPENMV (see Gayle & Manocha, 2008; Prendinger et al., 2011; Ranathunga et al., 2010). With the current trend of mobile applications (apps), we decided to develop VirtualPREX for platforms like Android and iPad to give lecturers the flexibility of observing and controlling the classroom from any location rather than just desktop computers. The interface is adapted for simple use and quick access to functionality as well as protocols from courses for later analysis. The focus for the interface is on “easy to use” elements that allow users to intuitively control the bots’ reactions to events and define actions that teachers have to perform to modify the behaviour of the bots, such as eliminating delays during a session. From a technological perspective, the design only allows server-based bots, so that no human observer or controller is needed after setting up the scenario. For benchmarks as well as backup, VirtualPREX also incorporates a combination of Pikkubots, Pandorabots, and Logic System, which provides the user with a selection of bots to be used for interaction. Figure 8.5 outlines a bot schematic to demonstrate how the bots are programmed depending on the action (or non-action) from the teacher.

A more complex schematic that outlines the step-by-step process of programming the bots is displayed in Figure 8.6. This schematic demonstrates how the bots would be programmed depending on the actions of the teacher. There are random branches where the bot may move to on-task behaviour, stay off-task, or become more problematic, requiring teacher intervention to guide the bot back to being on-task.
Discussion and Outlook

We envisage that VirtualPREX will lead to the creation of bots that will be able to react for different lessons. The aim is to slowly build up the repertoire of types of lessons that the pre-service teacher and bots participate in, to eventually enable a suite of curriculum subjects to be taught across different teaching levels, and thus offer an alternative to the traditional classroom with humans interacting with one another in role playing exercises. This will be beneficial, especially in the case of distance education, where obstacles like time zones, connection quality, bandwidth, and language can all hinder pre-service teachers from achieving full immersion and the ability to interact. In the VirtualPREX virtual classroom, the opportunities to practise role-play situations independent of other pre-service teachers or academics, at any time, provides the freedom to distance learners to use the environment matching their pace and timetable. Further, pre-service teachers will be able to repeat scenarios for additional practice without the need to be monitored by their teacher, therefore allowing them to build more confidence in their teaching.
Figure 8.6  Bot schematic with step-by-step procedures.
There are risks with using bot-based role play, or any bot as a learning tool, as the user must be mindful that they are interacting with a bot and not a real person, even though the bot may respond and act realistically. Although bots can be authentic, this is also a limitation, since users may forget that they are dealing with a pre-programmed avatar. Bots are not able to interact spontaneously with the teacher avatar as is possible in peer role plays and the real-life classroom.

Bots are programmed for certain situations and are not able to act out of their scope of predefined functions. The programmer, based on focus group feedback and evidence in the literature, has to predict as many actions and behaviours as possible that the pre-service teacher may demonstrate. The programmer has to define default actions for cases outside the teaching scope to prevent unrelated, and therefore confusing reactions. Similar to non-player characters (NPCs) in computer games who use phrases like “Sorry, I do not understand you” when asked unexpected questions or comments, bots in VirtualPREX should be able to respond to the pre-service teachers about actions they do not understand so that the pre-service teachers are able to reconsider and try different approaches to achieve a given task. For example, if the bot anticipates a certain input to change its state (e.g., from off-task to on-task) and the pre-service teacher is providing something similar but not the exact input, the bot will not react. In reality, the combination of multiple activities (words, gestures, different items) might work, but these are almost impossible to map to a scripted environment.

Most important for improving the bots is an analysis of pre-service teacher behaviour in the virtual classroom. While the first bots will represent the experience from real classroom settings over several years, the transfer to an immersive space with a pre-service teacher acting on his or her own represents a completely new environment, with its own rules and events. With each conducted run of the classroom, the results will be used to learn about the deviation from the real classroom and to improve the bots’ behaviour by adapting or enhancing their scripts. The hardened system, with restricted bots and little room for freedom, is softened again as the bots are adapted to the pre-service teachers’ behaviour. Even though the immersive space still has restrictions, it provides more flexibility as bots responses are not limited to just one answer but allow for different teaching approaches.

Future Directions and Conclusion

In this chapter, we took a closer look at bots in Second Life in the VirtualPREX project focusing on how they can be used to improve inworld teaching and learning. Our main interest was in current developments being undertaken by
the VirtualPREX project, where bots are to be used to interact with pre-service teachers while teaching a class. The VirtualPREX project is aware of the limitations of using bots to teach in a virtual world classroom, as not all scenarios can be created, and it is impossible to predict how a real-life school student may respond to different actions and statements by teachers. Therefore, it is important to emphasize that the VirtualPREX teaching scenario bots are a tool to be used to practise teaching and can never take away from the need of real-life professional experience in classes with real primary school students.

Although in its infancy, VirtualPREX role-play interactions with bots has the potential to be a widely used and sought after resource for pre-service teachers to add to their repertoire of skills to take to the classroom. While the first version of bots will provide sufficient functionality for basic learning scenarios, the feedback will be continuously used to improve their capabilities for interacting with pre-service teachers. One might say the bots need to face the same challenges as the pre-service teachers, especially as the challenges of the immersive space are not equivalent to the real classroom. Without doubt, the first results of the VirtualPREX pilot study indicate that there are a variety of ways different people react in role-play scenarios and one way forward is through the scripting of bots. Through the use of VirtualPREX bots, pre-service teachers will be able to asynchronously practise teaching in their own home, on their own time, and at their own pace, giving them the opportunity to repeat the practice to perfect their teaching skills. This can supplement their real-life professional experience and lead to major innovations in how they prepare for the real world classroom.

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