Pedagogical Considerations and Opportunities for Teaching and Learning on the Web

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Chapter 12
The Agile Hour in a Virtual World:
Teaching Agile Methods with Open Wonderland

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ABSTRACT

Multi-User Virtual Environments (MUVEs) are the subject of increasing interest for educators and trainers. In the context of software development, they are beginning to see increasing use both as learning spaces and as a richer means of collaboration for virtual teams. This chapter reflects on a project that developed and evaluated a virtual agile software development workshop hosted in the Open Wonderland MUVE, designed to help learners to understand the basic principles of some core agile software development techniques. The work took a design-based research approach, following a reflective path of development through two major iterations. The authors trace the research process from a real world implementation of the "agile hour" workshop to its virtual incarnation, describing the design philosophy and the constructed virtual artifacts. They conclude by reflecting on the insights into learner perceptions and practical implementations gained from building and evaluating the Open Wonderland workshop.

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INTRODUCTION

Interest in virtual worlds by educational organizations is growing as they explore ways to gain advantage from these online environments. The potential for collaborative, dispersed but immersive learning has only just begun to be widely explored and there appear to be many opportunities to deliver interactive education in cost effective and innovative ways using Multi User Virtual Environments (MUVEs) (Schultze et al., 2008).

This chapter reports on a research project that seeks to translate an existing face-to-face workshop on agile software development into an online interactive learning experience based within a virtual world. Although the face to face workshop is designed to address the needs of both students and professionals, the virtual world implementation described here is evaluated in the context of tertiary education. In this chapter we chart the journey through two iterations of development. The project takes a design-based research approach that supports a theory based, iterative cycle of learning through the development and experimental phases of the workshop.

The workshop is used to explore the roles of different agile techniques in software development and enables us to explore the concept of utilizing a MUVE in a virtual learning situation. Using an established workshop as the focus of the experiment allows us to draw on the experiences and expertise of the team member involved in creating, developing and delivering the original material. This supports a more accurate distinction between challenges created by the delivery method and issues that might be attributed to the workshop content.

This chapter reports on our experiences of building and evaluating the workshop environment in the Open Wonderland MUVE. The contribution of the research lies in two areas. Firstly, we have evolved and carried out preliminary empirical testing of a conceptual framework that informs virtual world learning. Secondly, we offer findings from the evaluation of the learning that the developers achieved that will contribute to the growing literature on the development of MUVE learning initiatives and opportunities.

LEARNING IN A VIRTUAL WORLD

The use of IT for teaching and learning purposes has generated a vast range of literature as researchers and educators seek to understand how best to use software in an educational environment. The use of technology is arguably well suited to active learning where the learning involves the accumulation of knowledge through problem solving, understanding of the knowledge domain and discussion of the tasks achieved (Mayes & Fowler, 1999; Hadjerrouit, 2004). There has been an early recognition of the concept that if learning is to be achieved, software must be designed to make people think, with the emphasis on the task-based learning to be achieved rather than the technology (Mayes & Fowler, 1999). Similarly, Dickey (2005) recognizes that technology tools do not evoke the dynamics of the learning community but that these arise from the interplay of content, instructors and learners. This focus on the learning is further highlighted in Dalgarno and Lee's (2010) exploration of the potential learning benefits of 3-D virtual learning environments. They use the term *affordances* rather than *benefits* to underscore the argument that it is the 'tasks, activities and underpinning pedagogical strategies' that are supported by the technology and that it is not the technology that provides the learning (p. 18).

The use of virtual worlds as learning environments has given rise to a very broad range of literature from many disciplines and the need for the adaptation of frameworks to guide researchers in rethinking traditional learning approaches. Dalgarno and Lee (2010) offer a model of learning in virtual world environments that presents two broad categories of representational fidelity and learner interaction. The former addresses the quality of the learning environment such as the need to provide quality visual displays, consistency of object behaviors and, most importantly, the user representation. User avatars allow for construction of an individual's online identity, fostering confidence in their presence in the environment that contributes to their social interactions. Quality of representation also appears in de Freitas et al.'s (2010) study of immersive learning experiences where they include fidelity, immersion and interactivity as factors of representation in their four dimensional framework for exploring learning activities in virtual worlds.

In Dalgarno and Lee's category of learning interaction they highlight the ability of the avatars to support embodied action both visually and verbally (gestures, facial expressions, text and voice). The 3-D learning environment also provides for more user input in terms of control of environmental attributes and behavior and construction of objects. The focus on learner control is also identified by de Freitas et al. (2010) who argue that learning gains are enhanced for learners who have an element of control over their learning within an environment that encourages engagement, learner-generated content and peer supported communities.

These emerging models and frameworks are required to underpin the extensive range of learning activities evident in virtual world learning environments where many initiatives remain in the early stages of development. Types of educational delivery vary from simple meeting rooms for distance learners (Doesburg, 2008) through to more immersive experiences such as navigating through foreign or historical cities or studying the ecology of wetlands (Kuo & Levis, 2002). More complex situations are created through the development of gaming techniques to create learning spaces where complex tasks simulating real life activities such as medical procedures can be experienced (Levine, 2006). The contextualization of learning to improve the transfer of knowledge and skills to real situations is found to be a major affordance of the virtual world environment (Dalgarno & Lee, 2010). In designing virtual educational delivery there is some consensus that the completion of tasks is a key learning outcome where the virtual environment provides communication activities that support collaborative assignments with a practical output (Dalgarno & Lee, 2010; de Freitas et al., 2010; Dickey, 2005).

Despite the level of activity in developing virtual world learning there remain concerns that there is little concrete evidence of the advantages that are being gained (Dalgarno & Lee, 2010) and it is difficult to ascertain the significance of current training efforts in this virtual space. Salmon and Hawkridge (2009) note that researchers may either be near the beginning of a major development in learning technology or moving towards the end of developing its potential. Researchers have reported considerable difficulty in creating learning programs that can be deemed successful with challenges being reported in economic, technical and social spheres (Bainbridge, 2007; Schultze et al., 2008; Eschenbrenner et al., 2008). Atkins and Caukill (2009) sound a further note of caution that the difficulties in developing programs to meet complex knowledge requirements will create significant problems for educators and trainers. Nevertheless, there is strong agreement that virtual worlds offer innovative ways to exploit immersive environments that can engage learners in a world that replicates their physical environment or can offer new experiences (Jäkälä & Pekkola, 2007; Phang & Kankanhalli, 2009; Eschenbrenner, Nah, & Siau, 2008). The international educator community has certainly begun to embrace the potential for collaboration in building immersive learning environments, sharing both ideas and virtual artifacts (Hearns et al, 2011.)

IDENTIFYING THE ISSUES

The increasing amount of literature on MUVEs supports the identification of some of the current issues facing the development of learning initiatives. While there are a wide range of such issues including aesthetics, culture and legal concerns (Hadjerrouit, 2004) and concentration, social presence, 3D realism and enjoyment (Phang & Kankanhalli, 2009) this section uses an economic, social and technical challenges structure to discuss them (Bainbridge, 2007; Schultze et al., 2008; Eschenbrenner et al., 2008).

From an economic perspective a serious drawback is that MUVEs are often created for economic reasons in a sector that has yet to stabilise. MUVEs are, in some cases, commercial operations subject to both the laws of the country in which they reside and to the regulations, whims and infrastructure imposed by the owner of the virtual world (Guest, 2007; Sidel, 2008). This makes for an unstable environment for investment although Mennecke et al., (2008) argue that creating a MUVE for a specific purpose within the corporate environment would be a potential solution to control issues. Unfortunately those tools available for such deployments, typically open source tools such as Open Wonderland, are generally less well developed than the commercial alternatives. This increases the cost of development, which can be very high (Schultze et al., 2008; Jacobsen as cited in Dalgarno & Lee, 2010). Virtual worlds are also susceptible to disruption, fraud and other security issues where standards or governance procedures are the responsibility of the MUVE owner (Mennecke et al., 2008; Guest, 2007).

The social aspect of virtual world learning is seen as a benefit in that it enhances the sense of presence that is so often lacking for traditional distance learners (deFreitas et al., 2010). The ability for learners to communicate and collaborate is enhanced when text interaction is reinforced or replaced by voice and by social cues expressed through the body language of avatars (Dalgarno & Lee, 2010; de Freitas et al., 2010). However there is a downside to the virtual social context. Beyond the control of instructors or learners, social concerns arise in commercially owned MUVEs where dissatisfied customers have noted the high level of regulations that inhibit activities, such the case of Linden Labs, which has been likened to a dictatorship by a number of bloggers and wiki contributors. Anti-social behaviour has also been widely reported and rogue users or 'griefers' can cause serious disruption within a MUVE. For example, Guest (2007) has documented the specific case of a virtual mafia group led by a character known as Marcellus Wallace. While the challenge to a learning environment appears small, the lack of control by participants remains a concern for educators.

In the technical domain, challenges to establishing effective learning initiatives are extensive with steep learning curves for users and developers (Berge, 2008). Dispersed users require access to the computing power necessary to engage in a virtual world and need to develop at least basic level skills in order to maneuver and operate within the environment, often without physical help. For developers it may 'take dozens or hundreds of hours…to gain the skills in scripting and the time for creating or building anything that is substantial, creative or innovative' (Berge, 2008, p. 29). For learners there may be real barriers to adapting to a virtual world where some experience little affinity with the virtual environment, finding it non-intuitive and intrusive. Others have been found to experience a steep learning curve in adapting to the demands of the virtual world such as creating and operating avatars and communicating via text (de Freitas et al., 2010). In the same study de Freitas et al. (2010) found that connectivity and the capabilities of the hardware contributed to learner frustration as Internet speeds, firewalls and graphics impeded the representational fidelity of the experience. Such concerns have been identified in other studies where for example Mennecke et al. (2008) reported problems with scaling and significant time lags as more avatars joined an online meeting. Further technical issues raised by Mennecke et al. (2008) include questions regarding the performance, design and technical capacity of the applications and the need for discussion around the issue of technical standards.

Nonetheless, the perception of substantial potential benefits encourages ongoing development in this area. The richly interactive environment supports the use of avatars to represent a physical presence that enhances the learning experience and dispenses with the need for physical co-location (Suzuki & Huang, 2004). Perhaps most importantly, MUVEs offer the ability to simulate conditions that would be unrealistic in real life; to create in software 'things that never were nor could be' (Brooks, 1995). Bainbridge (2007) suggests that avatars can replace humans in experiments on modeling the spread of virulent diseases or manipulating experiments that require large numbers of participants. Collaborative tools also support a high level of social interaction where the avatars can represent the users by walking, talking and making friends, thereby replicating the socializing advantages of face-to-face learning situations (Suzuki & Huang, 2004).

VIRTUAL WORLDS IN THE COMPUTING DOMAIN

There are examples of highly innovative learning activities in various discipline within the general field of computing, including computer science (Ritzema & Harris, 2008) software engineering (Ye, Liu, & Polack-Wahl, 2007), and artificial intelligence and artificial life (Au, 2006). Phelps et al developed their own virtual world (MUPPETS) and used it to teach programming and computer graphics. Activities related the broader context of software development, such as conceptual modeling (De Troyer et al, 2007), team work (Jaeger & Helgheim, 2011) and project management (Conrad, 2011) have also been developed. In the sphere of software engineering education, Ye et al. (2007) use a game-based approach to encourage students' learning. The use of games in the virtual space is often seen as not 'respectable' although there is evidence that people learn more effectively when they are immersed within the enjoyment of the learning environment (Rieber, 1996, p. 43). Rieber reflects on a long history of research, arguing that play is a powerful mediator for learning and Phang and Kankanhalli's (2009) exploration of flow theory found that concentration and enjoyment were key constructs of learning within a virtual world. Ye et al.'s. (2007) experiments with virtual world games resulted in positive feedback from the majority of students who believed that their learning experience had improved their learning of the fundamentals of software specification activities and the principles of software development processes. The virtual game-based approach was seen as enjoyable, to have enhanced team communications, and encouraged interactivity. Adverse comments from student feedback related almost entirely to the representational fidelity (Dalgarno & Lee, 2010) of the environment with comments on time lag, connectivity, buggy software and bad graphics.

A further study into the delivery of a computer programming course via Second Life revealed similar feedback from students on the element of enjoyment and the benefits of communication (Esteves et al., 2009). This course aimed to overcome difficulties students find in learning computer programming and aimed to teach them how to design a solution to a problem and to motivate students in the learning of abstract concepts. Esteves et al. (2009) found that where the learning project was found to use the characteristics of the virtual learning environment to the full (e.g., interactivity and movement) the students were more engaged. The strong visual impact was interesting to the students and allowed for the right level of complexity to be judged through the displaying of actions as students progressed through their tasks. Students were then able to instantly correct their errors as they moved forward, which stimulated critical thinking and encouraged collaborative programming.

These two studies confirm findings that designing the learning outcomes to reflect a combination of communication activities that support collaboration, leading to a practical output, enhances the advantages of a virtual world learning environment (Dalgarno & Lee, 2010; de Freitas et al., 2010; Dickey, 2005). However, Esteves et al. (2009) confirm Atkins and Caukill's (2009) view that developing virtual world learning environments is very demanding of educators, requiring skilled planning and design as well as intensive preparation to support students through the learning process.

AGILE METHODS IN VIRTUAL WORLDS

Thus far, work on agile methods in virtual works has been largely the focus of professional software developers, rather than academics. For professionals involved in agile software development, particularly those working with distributed teams, the use of virtual worlds is a natural progression from the use of other electronic communication and collaboration tools. While most of these teams still use more traditional tools (e.g. video calling), there has also been some pioneering work done on exploring the potentials of virtual worlds (Voos & Hileman, 2009). Krebs (2010) describes how various aspects of agile development can be embedded into a virtual workspace, for example using them for estimation tasks and presenting burndown charts. He also outlines how virtual worlds avoid the problems of video conferencing, such as unnecessary bandwidth use and difficulty in setting up environments. He also stresses the additional benefits of 'presence' available in a virtual world. The same author describes the use of a number of tools, including the Second Life and OpenSim virtual worlds, for broader aspects of business training (Krebs, 2012).

There is also the beginning of some interest by academic researchers into the possible synergies between agile methods and virtual worlds. For example, in considering user involvement challenges in agile projects, Xu et al (2012) discuss the potential for using virtual worlds to develop scenario videos, while Rodriguez, Soria & Campo (2012) discuss the support of virtual meetings in distributed Scrum teams.

THE AGILE WORKSHOP

One of the key success factors for a virtual world activity is good task design (Vallance et al., 2010.) One approach to ensuring good task design is to take a successful real world task and host it inside a virtual world. In this chapter we describe the implementation of a virtual world workshop activity for teaching about agile software development techniques. This activity meets many of the commonly stated criteria for potential success as a virtual world activity that have been previously discussed, including communication, collaboration and practical output (Dalgarno & Lee, 2010; de Freitas et al., 2010; Dickey, 2005.)

In order for this project to be understood it is necessary for us first to describe the real world activity that has been moved into a virtual world. The 'Agile Technique Hour' workshop (Parsons, 2008) is a classroom based face to face activity that is designed to provide participants with the opportunity to reflect on the nature of agile software development through experiencing a number of agile techniques. It is based on Cockburn's (2002) concept of the *process miniature*, whereby the key features of a software development process can be explored in a very short time period. There are a number of such activities that have been widely used in the past, including the Extreme Hour (Cunningham & Cunningham, Inc., 2005) and the XP Hour (Peeters & Van Cauwenberghe, 2001.) However these other activities tend to focus on project management aspects of agile methods, whereas research has shown that it is the individual techniques chosen that can have the most impact (Parsons, Ryu & Lal, 2007). The intention of the Agile Technique Hour workshop is to explore a set of core techniques that are used in agile software development. These are; stakeholder participation, co-location, pair programming, test driven development, continuous integration, common coding guidelines and refactoring. The game works over three iterations within which the teams have to design a human powered vehicle. In the first iteration, no agile techniques can be used. In the second, some techniques are allocated and some can be chosen from a set of options. In the final iteration, further allocated and optional techniques are introduced. The intention is for the participants to appreciate not only the value of individual techniques but also to see how they combine together to support a software development process.

In the physical version of the workshop, teams are given sets of pre-written user stories for each iteration, which they must prioritize, based on business value and estimated effort. Each story relates to a required feature of the vehicle, and each feature must be drawn on a single overhead transparency sheet. The overall design of the vehicle is created by laying all the various features on top of one another.

The workshop in its real world form has proved very successful, not only with students but also with academics and professionals, who have participated at conferences and on training courses. However there are some issues that led us to consider the potential benefits of hosting the workshop in a virtual world. The first issue is one of resources. Each workshop requires a suitable room with an overhead projector, which are becoming less common than they used to be in university classrooms. Although the transparencies can be laid on white paper on a table top if necessary, this limits their visibility when working with larger groups. Then there is the issue of the transparencies themselves. Again these are becoming less common as a standard stationary item, and each team can use up to 30 transparencies in one workshop. Since a single workshop can include several teams, this uses a large number of transparencies. A suitable number of overhead transparency pens and story cards also need to be prepared for each workshop, and there is also some attrition of these. The second major issue is that the workshop and only be run when people are physically co-located, but we would like to be able to offer this workshop outside the constraints of local classes and occasional conference workshops. Virtual worlds offer advantages in addressing both resource constraints and physical location that would both be beneficial for running virtual workshop

TAKING A DESIGN-BASED APPROACH

Our methodology was grounded in design-based research, with long iterative cycles. Within these cycles, we have addressed the components of the knowledge base from different perspectives, and the evolution of the various constructed components has also meant that the evaluation stages have had different concerns at different stages of the overall development cycle.

Petter (as cited in Vaishnavi & Kuechler, 2007) maps the process steps of the general design cycle to the broader phases of a particular research project. This is not designed to be a generic view of all research, but it nevertheless helps to contextualize our work. We have adapted this concept to apply the primary concerns of our own research phases to this model (Figure 1). The following sections summarize our research process through Petter's stages of tool evaluation, theories and frameworks, design and assembly, experimentation (with conclusions) and future research.

TOOL EVALUATION

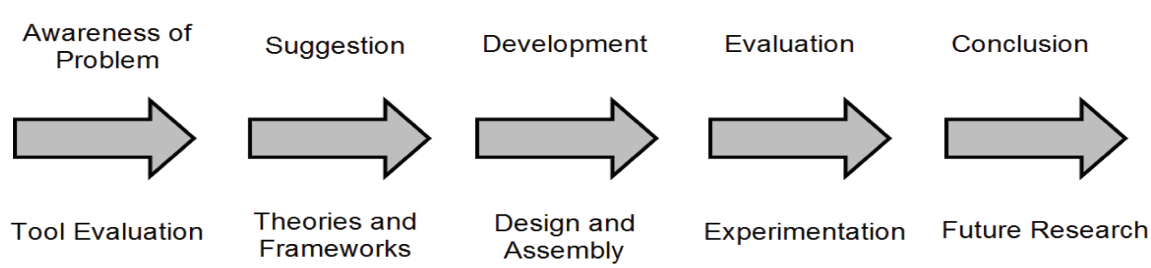
Initially, we undertook a tool evaluation phase to identity the most appropriate tools for implementing our project. Our analysis was based on the economic, social and technical agenda outlined in the introduction. We evaluated three virtual worlds as possible platforms, finally selecting Open Wonderland, a free, cross-platform, open source Java project as the most suitable for our purposes (the others were Second Life and Open Simulator). Originally developed by Sun Microsystems as Project Wonderland, it has sophisticated communication tools and the ability to share applications and documents. Sun's subsequent acquisition by Oracle led to the release of the project into the open source community, and it was therefore renamed Open Wonderland (Kaplan, & Yankelovich, 2011). For the remainder of this chapter it will simply be referred to as 'Wonderland'. A key advantage of Wonderland is it is an extensible open source Java application, rather than a commercial venture with its own scripting language. This offers many programming resources and Wonderland can be used on a local network within a firewall of an organization, without the cost of renting virtual space and material on a third party server. Another important feature is that it does not have the potential distractions for learners of public virtual spaces, nor the danger of external 'griefers'.

Gardner et al. (2008) have identified key issues regarding Wonderland as a virtual world platform for teaching. On the plus side, Wonderland is open source and extensible, and more platform agnostic than many open source alternatives due to its Java codebase. It also enables greater control over resource access, privacy and security than commercial MUVEs. The primary intent of the Wonderland platform is that it can be tailored and integrated by organizations within their own infrastructures (Gardner et al., 2008). A potential issue is that the system works well within an organizational firewall but has problems providing equal access for remote users. For example in order for Wonderland to function correctly a large number of ports must be opened on the server, which may be regarded as creating potential vulnerabilities. Nevertheless our analysis was that Wonderland was an appropriate platform for our work.

THEORIES AND FRAMEWORKS

The work of Gardner, Scott, and Horan (2008) on the evaluation of MiRTLE at the University of Essex draws on earlier work regarding theoretical frameworks in computer based learning. Gardner et al.'s (2008) extension of Mayes' framework identifies three levels or modes of learning. The first mode of conceptualization involves considering the ideas or concepts of others, which leads to construction and 'the building and testing of one's knowledge through the performance of meaningful tasks' (Gardner et al., 2008, p. 138). This in turn

Figure 1. Research phases (below) mapped to the general design cycle (above) (based on Petter as cited in Vaishnavi & Kuechler, 2007)



leads to dialogue between learners, their peers and their teacher that results in new concepts emerging thereby leading back to conceptualization and an iterative cycle of learning. In their subsequent work with SIMiLLE, the same team have extended the dialogue beyond Wonderland itself to integrate with the Moodle learning management system (Gardner et al, 2011.)

In a virtual space these modes of learning can be mapped to the concepts of immersion; psychological, physical and social (Gardner et al., 2008). Mayes' original framework is based on the categorization of courseware, which is divided into primary (subject matter), secondary (environment, tools and tasks) and tertiary (produced by other learners) (Mayes & Fowler, 1999). In Table 1 we have integrated these various perspectives and mapped them to our virtual world workshop activity. This has helped us to understand the nature of the work that we are undertaking in ways that go beyond simply delivering subject matter (conceptualization). We can recognize that our work already addresses some core concepts of construction and dialogue, but are also able to identify the key themes that should continue to be the focus of future work. We are also aware of further perspectives that may help to contextualize our aims and objectives.

DESIGN AND ASSEMBLY

The main requirements of the design of the virtual world for the agile workshop were that it should provide virtual equivalents of the tools used in the face to face workshop; the transparencies, the pens, the story cards and the overhead projector. When we investigated the virtual tools at our disposal, it seemed that we could adapt the Wonderland whiteboard viewer to adopt the same role as the overhead transparencies and pens in the physical workshop. The basic functionality was available to enable a feature to be drawn on a whiteboard in various colors using freehand drawing, text or shapes chosen from the toolbar. The challenges were in emulating the overlaying of multiple transparencies on an overhead projector. In the physical workshop, the fact that the projector is in its own space, apart from the team areas is important as it simulates the deployment of a complete set of features to an integration system. We decided to again use the whiteboard tool to replace the projector, but still place it separately from the team areas to ensure that the step from development to deployment was non-trivial. Therefore a separate customized whiteboard was created to act as this integration space.

Table 1. A conceptual framework for virtual world learning mapped to the agile in wonderland workshop (adapted from Gardner et al., 2008; Mayes & Fowler, 1999)

Framework Concepts	Types of Immersion	Mapping to Agile Workshop
Conceptualization Primary courseware: subject matter Basic resources	**Psychological immersion (abstract space)** Deliberately abstract; explorative; self-directed; experimental; multiple representations/visualizations	**Pre workshop activities** Need to be designed to cater for different backgrounds and experiences, access materials and experiment with tools
Construction Secondary courseware: environment, tools and tasks Interactive resources	**Physical immersion (physical space)** Deliberately concrete; realistic behaviors; manipulative, role playing; multiple viewpoints; tutor directed; expected outcomes	**Workshop context and process** Multiple realistic software development roles, organized by moderator, assessed products and learning outcomes
Dialogue Tertiary courseware: produced by previous learners Creational resources	**Social immersion (social space)** Deliberately situated; localized conversations; identity; reactive avatars; meeting rooms	**Workshop environments** Custom built context, localized team and developer rooms, co-located avatar conversations required

The Wonderland whiteboards did not by default support all the functions required in the workshop. Therefore they had to be customized in different ways to support both the required developer tools and the integration system. In the real world workshop, when a developer has finished drawing a feature on a transparency, that transparency is added to the team's collection of complete features, ready for the next integration session at the end of the iteration. We needed some way of simulating this practice with the whiteboards, once a feature has been created. To do this, we redesigned the whiteboard toolbar to include additional team buttons to allow an image to be sent to a team repository via a button labeled with the team's letter (A, B, C or D), as can be seen on the modified toolbar shown in Figure 2. When the appropriate team button is pressed, the current drawing is stored as a scaled vector graphics (SVG) image ready for integration, and the whiteboard is cleared ready for the next feature to be drawn.

The implementation behind this whiteboard toolbar enables a set of SVG images to be collected together for each team and then overlaid as a single image on the integration version of the whiteboard. This whiteboard also has a custom toolbar (Figure 3). In this case, editing is not required (or wanted); the whiteboard is intended for 'reading' rather than 'writing'. The role of this whiteboard is to enable all the features from a single team to be displayed integrated together. At this point in the workshop, the person in the quality assurance role performs a series of 'acceptance tests', looking at the features and accepting or rejecting them according to the test criteria. Because the integration whiteboard just needs to be able to display the results from different teams, the toolbar does not have any drawing tools. The team buttons, instead of clearing the image and sending it to the team repository, as they do on the programmer whiteboard, retrieve the full set of images for that team and display them together.

The other key component was the story cards. We implemented these using PDF viewers that enabled a story board to be placed near a developer whiteboard. The tools provided with the PDF viewer enable the stories to be cycled through by the user.

DESIGNING THE VIRTUAL SPACE

One of the major limitations of the real world workshop is that it always takes place in an ad hoc environment based on the availability of rooms. These are never ideal and do not always contain the required equipment or a suitable arrangement of space and furniture for teamwork. One major advantage of the virtual workshop is that we were able to design our own custom space to host the workshop, designed to support the workshop activities. We built a large virtual building with four separate team workspaces by default, though they can easily be reconfigured with different numbers of workspaces. Figure 4 shows the typical view of an avatar when the client application is first launched. The user begins at the front of a four winged building, each wing containing a separate project team room.

Inside the building, each team workspace comprises a number of developer rooms, each containing a developer whiteboard and a story

Figure 2. The toolbar on the customized developer whiteboard, including team buttons for storing features

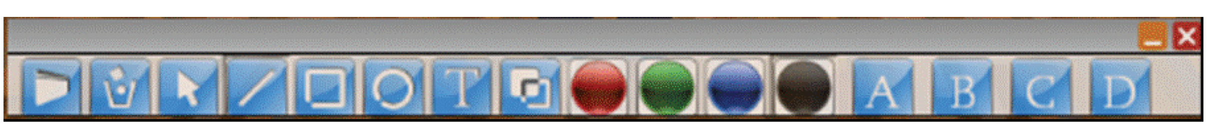
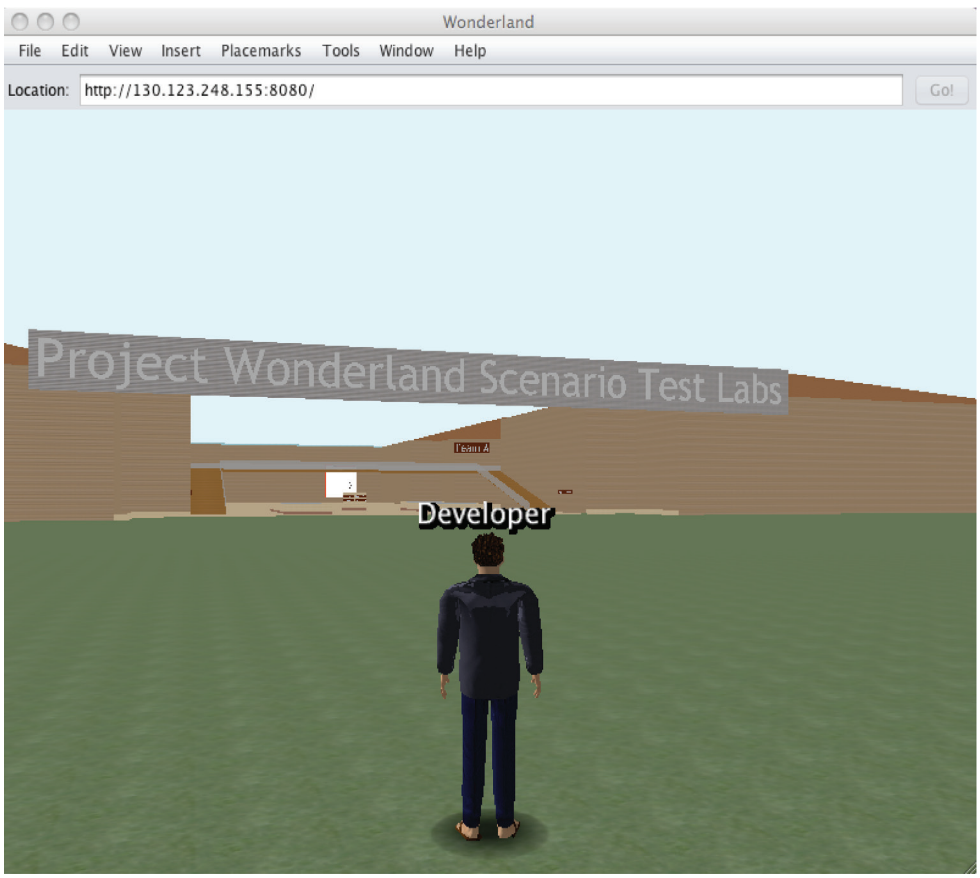


Figure 3. The toolbar on the integration whiteboard, including team buttons for displaying integrated features

Figure 4. The exterior of the workshop building, showing the entrance to the four main team areas



card viewer. Figure 5 shows an avatar inside one of the team areas. Separate developer areas are visible containing the whiteboards and story card viewers.

When an iteration is in progress, developers will be drawing allocated user stories as individual features on whiteboards (one story = one feature = one drawing). Figure 6 shows an example where the user story 'The driver must be protected from attack by wild animals' is being implemented. The developer has drawn a cage-like structure that can be applied to the vehicle. It is important to note that such an activity enables the user to participate in a creational environment (ref. the framework in Table 1).

Figure 5. Outside the developer rooms, showing whiteboards and story card viewers

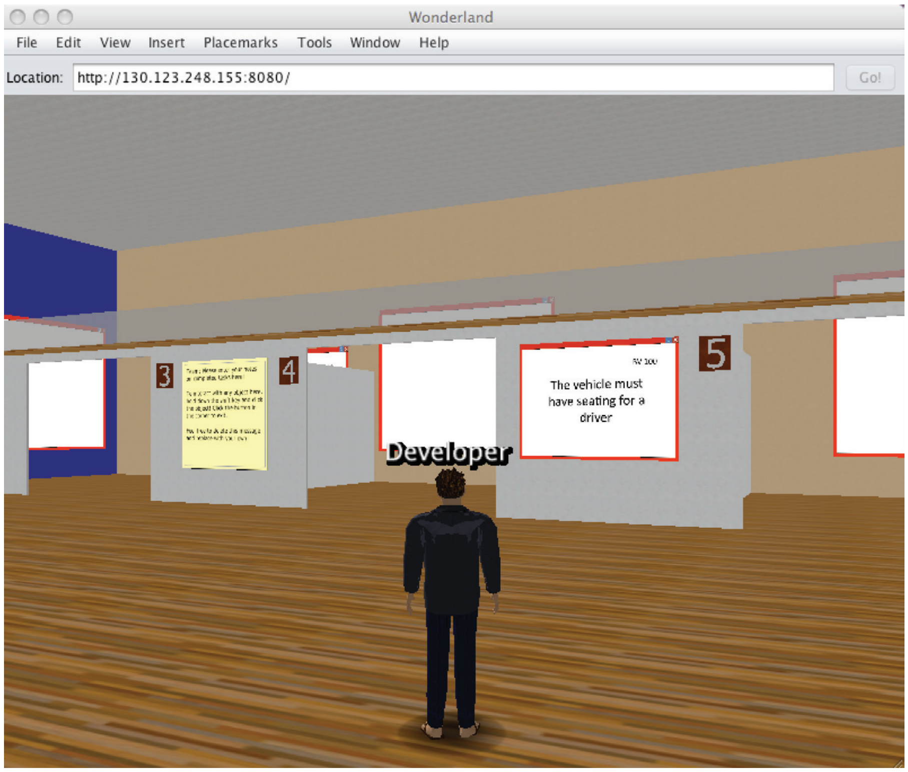
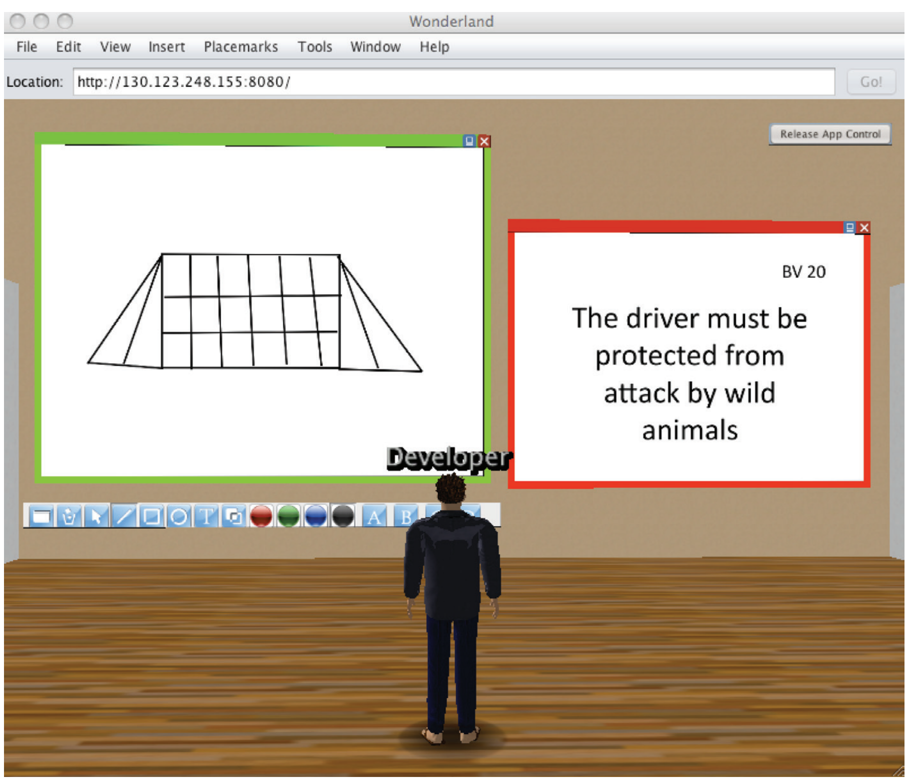


Figure 6. Implementing a user story on a developer whiteboard



Each time a developer completes the implementation of a specific user story, s/he commits that feature to the team repository by clicking the appropriate team button (A, B, C or D) on the whiteboard tool bar, storing the feature drawing and clearing the whiteboard ready for the next feature. Figure 7 shows the same developer working on the next user story; ‘The vehicle must be able to travel over rough and uneven ground’. Again, on completion of the drawing, the feature will be committed to the team repository.

In a complete iteration, there will be four developers simultaneously working on a number of user stories. To simplify the figures, the example here shows only the two story implementations from Figures 6 and 7. At the end of the iteration, the teams will gather round the integration whiteboard. Each team’s overall design, consisting of all the individual features layered together, can be viewed by selecting the team’s identifier from the integration whiteboard toolbar. Figure 8 shows the two features from our examples being combined for the team. This is a further aspect of a creational environment; the components created by individuals are combined to create on overall artifact created by the team as a whole. At this point, construction leads on to dialogue (Table 1).

EXPERIMENTATION

The practical tests and evaluation carried out have focused on technical performance and qualitative measures of system usability. There were two sessions of experimental testing after each iteration, using postgraduate students. The first set of tests and evaluations was carried out in two stages, the first within the university before a second test was run overseas. Some results of these tests led to a

Figure 7. Implementing a second user story after the first has been committed

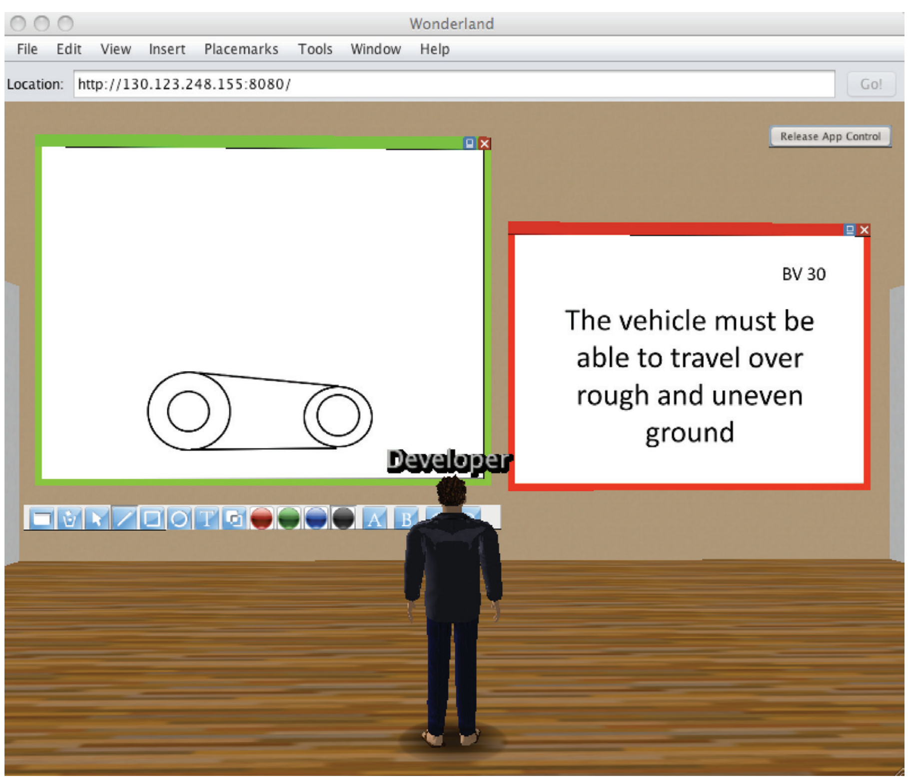
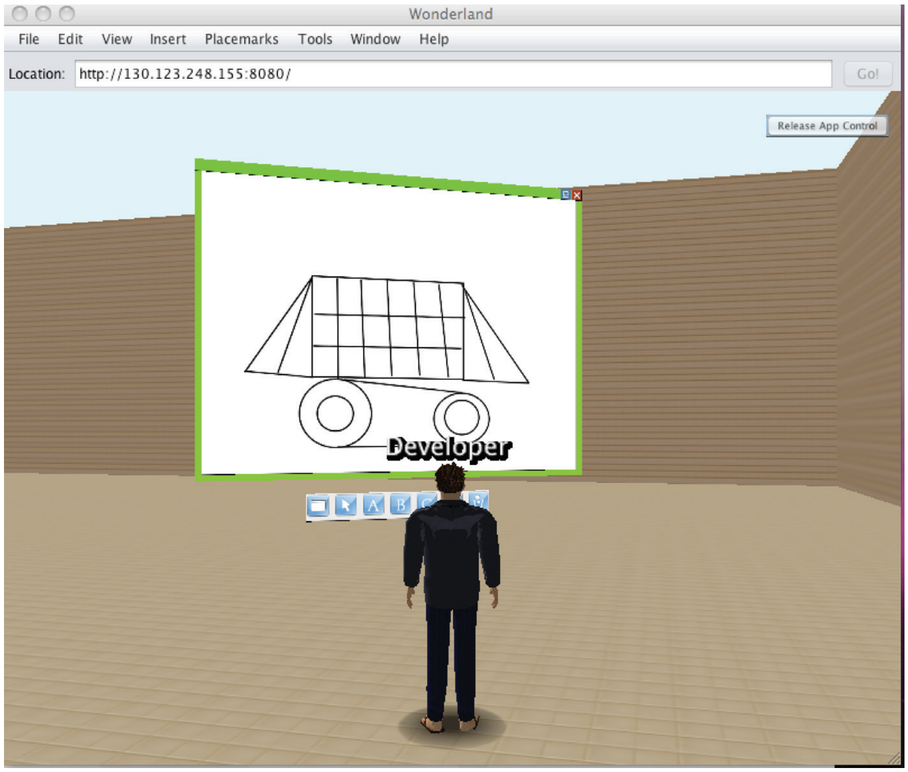


Figure 8. Combining user stories on the integration whiteboard



number of technical guidelines being produced to enable the workshop to run smoothly, including environmental settings, platform configuration and login procedures, as well as changes to the actual workshop environment and tools (more detailed results from the first iteration can be found in Parsons & Stockdale (2010). In the evaluation session that concluded the second technical iteration, a group of nine postgraduate students were asked to qualitatively assess the virtual world workshop as part of their normal classroom activities in a course exploring agile software development methods. Table 2 summarizes our research questions, variables, levels of analysis, methods and

Table 2. Research questions, variables, levels of analysis, methods and instruments for evaluation (Santos, 2010)

Research Questions	Variable	Level of Analysis	Methods	Instruments
What do users perceive as the potential advantages and disadvantages of a virtual world workshop?	Contextual	Group	Brainstorming	Trigger questions
What is the users' level of engagement during learning?	Learning	Cognitive	Observation	Observation guide
How were the collaborative learning activities performed?	Climate	Group	Observation	Observation guide
How do the virtual world resources scaffold learning?	Contextual	Resource	Observation, Reflection	Observation Guide, Trigger questions
How well does the virtual world support the intentions of the activity?	Learning	Group	Reflection	Trigger questions

instruments for this evaluation using the format for design-based research suggested by Santos (2010).

As part of the evaluation process the students first participated in the real world workshop. Having completed this, but before participating in the workshop activity in the virtual world, they were asked to reflect on what they thought the potential advantages or disadvantages there might be in delivering the workshop in a virtual world. The intention of this reflection process prior to experiencing the virtual workshop was to gain unbiased feedback prior to the participants having experience of the particular design approach we had taken. Of course we had our own ideas about why we thought implementing the workshop as a virtual activity might be of value, but we wanted to get other perspectives. The feedback reported here is summarized from notes taken during wide ranging discussions that often went beyond the original trigger questions. The main advantages identified by the group included:

- The ability to deliver the workshop independent of spatial constraints
- The ability to deliver the workshop independent of time constraints, including across time zones
- The socially leveling nature of being in a virtual world, where it was less likely that certain individuals would be able to dominate the proceedings
- The equalizing nature of being an avatar, whereby disabilities or other limitations would not be so obvious to other participants
- The ability to create artifacts that could not be created in reality
- The saving of various kinds of resources, including removing the cost overheads of travel and materials

The main disadvantages were considered to be

- Participants not taking the workshop as seriously as they would in real life. Discussion centred on the way that some people tend to behave on line in contexts such as chat rooms and social networking sites
- Technical limitations. This discussion centered on the idea that in theory, a virtual world could do anything (e.g., the Holodeck from Star Trek, or the Matrix), but that in practice there would be major limitations on what would be possible with current technology, particularly in terms of interaction modes.

The main findings from this session were that the students paid much more attention to the possible social benefits and drawbacks of using a virtual world than we had done as designers.

To ensure that we had taken proper account of the conceptualization stage of the adopted framework, the students were then given a supervised orientation session in the virtual world, one week prior to doing the virtual workshop activity. This orientation session consisted of configuring the client so that it would work correctly in the network environment of the computer lab, navigating around the virtual environment and learning to use the whiteboard tools and story viewers. The participants were all in the same computer lab during the orientation session so that they could be assisted where necessary. They were also invited to spend further time in the virtual world whenever they wished to between the two sessions, so they could explore the world truly as a virtual experience, and become more familiar with the tools and environment. Since the client runs via Java Web Start, the only requirements for their own computers were a web browser and the Java Runtime Environment. The following week, the same group performed the workshop activities in the virtual world, and were then asked to reflect on their experience, and comment on the way the workshop had been implemented in the virtual world. This session again took place in a single lab, to enable the students' interactions with the virtual activities to be observed for evaluation purposes.

In the post hoc reflection session, the general responses were positive in terms of the design decisions regarding the use of whiteboards in place of overhead transparencies. The participants suggested that the whiteboard tools were better than using the transparencies because it was easier to arrange the drawings, and in particular it was easier to move features that were rejected by the quality assurance role, or were being replaced as part of a refactoring process. In the real world workshop the management of the overhead transparencies had proved increasingly difficult for this group through the various iterations, particularly when they had chosen 'refactoring' as one of the optional techniques. The main problem with the whiteboards appeared to be the difficulty in telling apart the developer and integration whiteboards, because the customized toolbars only appear when control of the whiteboard has been taken. Prior to that point, all the whiteboards look much the same, apart from their size.

A number of comments were made about the slow loading of the client, and it was suggested that the world was too large, and spent too long loading in components that were never used, including a whole set of 'cones of silence' that were not used because the voice tools were disabled by a lack of open ports. However our previous evaluations suggested that making the world smaller and simpler did not seem to help much in terms of performance. Even so, the size of the environment was also criticized for making it harder to navigate around.

Perhaps the most disappointing aspect of the evaluation session was that the students seemed quite happy with the design of the virtual world and its tools, whereas we had hoped that we might have given them the opportunity to provide some more imaginative feedback.

CONCLUSION

Despite Berge's (2008) assertion that there are few activities in Second Life that cannot be taught via websites, there are many features of a MUVE that can provide a unique value proposition. These include initiatives that would be difficult if not impossible to deliver by other means such as Yellowlees's experiment in psychiatry (Berge, 2008) or the British Literature Classroom (McDunnough, 2007). While this type of unique value does not apply to our virtual workshop, which is already presented in a face-to-face situation, we believe there are benefits to be gained from experimenting with learning initiatives in MUVEs. These benefits can be realized through the hedonic element of social interaction within the workshop that contributes to the ability of participants to gain the required skills. Agile methods require focus on context and relationships to achieve the best outcomes from applying the techniques. We have endeavored to capture this idea in the workshop environment within the dialogue concept of the framework. The virtual environment is well placed to enhance this social dimension if the design provides the creational resources for social immersion.

In terms of resources there are several forces to be addressed. While it is possible to begin using virtual worlds at a very low cost, these costs quickly escalate both in terms of the direct costs of supporting a facility (e.g., renting virtual space) and in development requirements (i.e., time and skills). As Hiltze remarked when asked if there is a future for business game simulations in a MUVE; 'yes…. if I had a grant and a smart graduate student who could do all the programming for me' (in Schultze et al., 2008, p. 366). There is also the hidden cost of access; it became clear in our tests that a powerful computer with a good graphics card was required to run the Wonderland client, which was more demanding on hardware resources than, for example, the Second Life client. We had decided to use an Open Source virtual world largely due to the economic and social issues outlined in the introduction; we had not fully absorbed the implications of the technical costs from an end user's perspective. Our experience to some extent mirrors that of Apostolos, Andreas & Thrasyvoulos (2010) who experienced various usability and performance issues when trialing open source MUVEs, in contrast with proprietary solutions. Our conclusion at the end of our second cycle of evaluation was that it was not possible to assume that a typical university lab would be suitably equipped for running the Wonderland client software in a reliable manner.

The implications for practice that arise from our project are, as yet, to be well defined. Initiatives of this type are certainly in their infancy as far as formal learning is concerned, though educational institutions have made significant contributions. Priority and visibility are given to initiatives that emphasize the unique value proposition that MUVEs offer and require substantial resources to develop. However, the potential for learning initiatives are extensive and projects such as this indicate the path for small, low resourced research teams to develop the skills that will keep them in the vanguard of MUVE developments.

In terms of implications for theory, we leveraged and further evolved a framework that facilitates our work and drawn on a design-based approach to inform our cycles of iteration and reflection. Overall, we anticipate that our project will contribute to the development of more sophistication in the further development of learning opportunities in virtual workshop based activities.

FUTURE RESEARCH

A characteristic of the condition of design science research effort is that 'it is the result of satisficing' (Vaishnavi & Kuechler, 2007, p. 21). Thus whilst our final artifacts may not yet be in perfect harmony with our original intentions, nevertheless we can judge that outcomes are the source of valuable knowledge, and the root of further research efforts.

Further work lies in the need to develop the workshop to a level that can be tested and evaluated in everyday rather than experimental contexts, in other words to feel as confident about running the workshop in virtual world as we currently are in the classroom. There is also more work to be done on testing the virtual world toolsets to gain a clearer understanding of the pros and cons of adopting a particular platform. A valuable contribution of future work would be to make an in depth comparison of a range of virtual world platforms and their ability to support specific types of virtual world learning, bearing in mind the types of hardware and internet connectivity that the average student is likely to have available.

With the amount of growing activity in virtual worlds, there is vast scope for future research, both in creating artifacts and as Bainbridge (2007, p. 427) notes MUVEs in offering 'great potential as sites for research in the social, behavioural, and economic sciences, as well as in human-centred computer science.'

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