Journal of
Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

Volume 3, Number 1
October 2010
The Researcher's Toolbox

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November 2010

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jvwresearch.org ISSN: 1941-8477

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Using Design-Based Research for Virtual Worlds Research Projects

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Abstract

Due to the characteristics of educational virtual worlds, this manuscript underlines the need for a research model that considers the social context as part of its unit of analysis instead of just the individual's cognitive process and learning. It is proposed that such a research approach could be design-based research (DBR), because the methodology employed by the DBR perspective thoroughly meets the challenges related to understanding how learning occurs inside a complex context of activities and interactions like those that usually take place inside an educational virtual environment. To accomplish this, the DBR employs an iterative methodology, which consists of repeating cycles of design, implementation, analysis, and redesign. This systematic procedure allows theory to emerge during the process; thus, using DBR, a researcher not only understands how to improve the quality of a certain virtual world, but also addresses issues regarding the theoretical background on which her design was based to revise and extend it. The main objectives of this article are to propose the use of design-based research as a viable methodology to do research in a virtual world like Second Life and to describe in detail how to do it. First, the design-based research approach is explained in terms of its origins, its methodological resources, and its theoretical underpinnings. Secondly, considering the characteristics and affordances of virtual worlds, an adaptation is proposed and explained to employ it for a virtual world research project. Finally, an example of a research project is built to show how the proposed design-based research methodology can be applied to plan it and revise its underlying theory.

Keywords: Design-based research; Multi-user virtual environments; Constructivist pedagogy; Situated cognitive paradigm

Using Design-Based Research for Virtual Worlds Research Projects

Introduction

From a situated learning perspective, learning in a virtual world is conceptualized as a process distributed across avatars, the environment, and the learning activities in which they engage. If we accept this assumption, we must employ a research paradigm that considers the social context as part of its unit of analysis instead of just the individual's cognitive process and learning to understand more profoundly how cognition and learning occur within a virtual world. One such research approach is design-based research that was developed with the assumption that the context affects learning; it also offers a methodological tool kit to systematically and iteratively test and improve a designed learning environment. Most importantly, as conceived by Ann Brown (1992), a researcher uses design-based research (DBR) not only to test a certain design to find out how it is working, but also to generate theory. This perspective maintains that theory development is linked to practice (Brown & Campione, 1996, cited by Wang & Hannafin, 2005). That is, through the DBR methodology a designer of an educational experience within a virtual world can address issues regarding the theoretical background on which her design was based to revise and extend it.

The methods however, differ from those used in laboratory-based experiments to control variables and test hypotheses. Design-based research, in contrast, looks for multiple dependent variables to encompass most of the complexity of a natural context. Its basic aim is to explore how a design works in practice (Dede, Nelson, Ketelhut, Clarke, & Bowman, 2004); in this way, it "lay[s] open and problematize[s] the completed design and resultant implementation in a way that provides insight into the local dynamics," (Barab & Squire, 2004, p. 8).

In view of these arguments, the main objective of this manuscript is to propose the use of DBR as a viable methodology to do research in a virtual world such as Second Life and to describe in detail how to do it. First, the DBR approach will be explained in terms of its origins, its methodological resources, and its theoretical underpinnings. Secondly, considering the characteristics and affordances of virtual worlds, an adaptation will be proposed and explained as

used for a virtual world research project. Finally, an example of a research project will be constructed to show how the proposed DBR methodology can be applied to plan its evaluation and revise its underlying theory.

Why Design-Based Research?

During the past two decades, a new model for research has been emerging to study learning in natural contexts called design-based research. Two factors have promoted its emergence:

1) concerns about the low impact of educational research on educational practice
2) the extended use of constructivist situated theories.

DBR basically emerged as an attempt to: first, address the general concern that educational research has not been dealing with the problems and issues related with educational practice and all its complexities, and secondly, to acknowledge that many of its findings have had a rather small impact on educational practice and theory (Dede, 2005a; Design-Based Research Collective, 2003; van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). This situation is considered to be true in the field of educational technology as well because its research has also been characterized by some as being trivial, with poor ties to theory and practice, and use of inappropriate methods (Squire, 2005). Several authors consider using the DBR model in education to address these issues as a promising solution, because it addresses practical issues related to human learning in real-world contexts, and its aim is precisely to modify educational practice. DBR is indeed a "methodology for understanding how, when, and why educational innovations work in practice" (Design-Based Research Collective, 2003, p. 5). Answering these questions, it addresses both empirical and theoretical issues. In fact, as indicated by Dede (2005b), DBR has been addressing research weaknesses in the educational technology field, and has contributed to the growth and increased quality of its body of research.

The other cause that has justified the use of the DBR methodology in education is the fact that during these past two decades—also as a response to the growing dissatisfaction with the education systems, as Tobias and Duffy (2009) affirm—an important approach to the design of instruction has been the use of theories grounded in the epistemological perspective of constructivism and its pedagogical variants like the situated cognition paradigm and the design

and use of effective learning environments. The situated perspective affirms that culture affects knowledge building, the context and the activity in which it occurs (Brown, Collins, & Duguid, 1989). Literature defines learning environments as contexts where students can socially build knowledge by collaboratively performing authentic learning practices to acquire high-level cognitive abilities (Jonassen, 1999; Perkins, 1992; Wilson, 1996). Both concepts stress the central role of context in the learning process; thus, to study instructional artifacts based in the constructivist view, like a new instructional methodology, a distance-learning course or an educational virtual simulation, we need a research model that includes context as one of its central variables. From this perspective, isolating variables in a laboratory to understand learning seems like a very limited lens through which to analyze and encompass the whole experience of cognition in context. For this reason Collins, Joseph, and Bielaczyc (2004) have concerns about the narrowness of measuring single variables such as learning content or skills with a multiple choice test—for example—to explain some rather complex aspects of human interaction during learning. Considering these constructivist issues, several authors propose that the methodology employed by the DBR perspective thoroughly meets the challenges related to understanding how learning occurs inside a complex context of activities and interactions like the one that usually takes place inside a constructivist learning environment. In this sense, Squire (2005) affirms that DBR "provides a useful framework for developing technology-enhanced learning environments and better pedagogical theory" (p. 9). In addition, Reeves (2005) states that design-based researchers "make a fundamental commitment to developing interactive learning environments in the contexts in which they will be implemented" (p. 49). That is, DBR deals with theoretical questions regarding the nature of learning in the real world (Collins et al. 2004) and sees context as one of its central variables (Barab & Squire, 2004).

Of course, the DBR methodology can also be used to study designs based on other theories besides the constructivist view because education is generally accepted as being an applied science. That is, educational practitioners, no matter their theoretical background, are commonly interested in designing interventions to improve learning, applying their designs in real world settings to understand how they work in practice and in refining the theory on which the designs were based. However, as we stated before, several researchers believe that, since DBR methodology is focused on understanding learning within the messiness of real-world

teaching and learning practices which include context as an essential variable (Barab & Squire, 2004), it is well-suited for the constructivist theoretical underpinnings. It is worth mentioning here that some other authors (see Willis, 2009) believe that DBR, strictly speaking, cannot be considered constructivist in nature because one of its main goals is the generalization of its findings in the form of design principles; this is a fundamental objective of the positivist position and, thus, incompatible with the constructivist paradigm. However, Willis accepts that DBR is an appealing option because its basic characteristics (like addressing problems in real contexts, conducting rigourus and iterative studies, and defining new design principles) depart, in fact, from the traditional positivist approach; it also envisions a middle position between the constructivist research posture and the generalization interests of DBR. That is, a posture where, on the one hand, it is accepted that what is learned in a study can be found useful by other researchers and, on the other, that the final findings are not to become universal laws in the positivist sense of the term.

What is Design-Based Research?

A comprehensive list of characteristics of DBR is proposed by Wang and Hannafin (2005). They say that DBR is:

1) Pragmatic, because its aim is to address practical issues regarding the teaching and learning process.
2) Grounded, because it is conducted in real-world settings maintaining a multivariable perspective while using quantitative and qualitative methods, and supported in relevant educational research, theory, and practice.
3) Interactive, because during the research process researchers collaborate with the local practitioners addressing contextual issues.
4) Iterative, because it is done in iterative cycles of design, implementation, analysis, and redesign, the idea being that after each cycle findings are used as input for the following cycle so that, during this systematic process, data accumulates and theory emerges.
5) Flexible, because the instructional artifact, the object of research, is not fully developed initially so that, during the cycles, necessary changes emerge.
6) Integrative, because it combines methods according to how the research evolves, like observations, tests, surveys, document analysis, etc., always observing scientific rigor.

7) Contextual, because it stresses relating findings to the research process itself and local context where it is conducted, always documenting the whole process as much as possible.

In an effort to summarize DBR characteristics van den Akker et al. (2006) propose the following list of attributes:

- Interventionist: the research aims at designing an intervention in the real world.
- Iterative: the research incorporates a cyclic approach of design, evaluation, and revision.
- Process oriented: a black box model of input-output measurement is avoided, the focus is on understanding and improving interventions.
- Utility oriented: the merit of a design is measured, in part, by its practicality for users in real contexts.
- Theory oriented: the design is (at least partly) based upon theoretical propositions and field-testing of the design contributes to theory building (p. 5).

Cobb, Confrey, diSessa, Lehrer, and Schauble (2003) identify several DBR features that complement the definition.These authors also agree that DBR results in theories related to the teaching and learning process, although they talk of humble theories because they are related to the particular research circumstances in the setting where it is conducted, like a school classroom. They remark that its methodology is very interventionist because it involves the investigation of how a new design improves education, and explain its iterative characteristic in terms of testing a set of initial conjectures, resulting in the creation of new conjectures, which are also subject to evaluation, and so on and so forth.

Wang and Hannafin (2005) offer a rather complete and thorough definition of DBR that includes most of the characteristics and features stated before, when they define it as:

> A systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories. (p. 6)

We see from the previous definitions of DBR, that when an educational researcher has a design perspective, his or her main interest is not to carry out studies where variables are isolated and controlled to prove a certain hypothesis and, in this way contribute to the generalization of results and establish universal principles and laws. Instead, his central interest is to identify practice-driven problems and test solutions (designs) while working collaboratively with the local participants and considering other solutions to similar problems published by researchers working in the field. The assumption is that in this way, systematically, a rich body of usable disciplinary knowledge develops.

DBR Methodology

The research methods advocated by DBR arise from the concepts explained in the previous paragraphs. They come from the writings of Ann Brown, who focused on the complexities of intervening in real-world settings and proposed that researchers systematically and iteratively implement and change their designs so that during the process, theory is created in naturalistic contexts (Barab & Squire, 2004). That is why the methodology proposed by most researchers using DBR follows these lines. For example, Collins et al. (2004) recommend a set of guidelines for doing DBR, which well ground Brown's ideas.

In this section, the six guidelines proposed by Collins et al. (2004) will be explained in detail because they will be used later as the base for this manuscript's proposal. The cited authors propose the following guidelines for DBR:

1) Implementing a design. Each setting where a design is applied is different, thus, it is important to match the design's elements to the particularities of each case.
2) Modifying a design. Part of the procedure of DBR is to apply a design iteratively so that it can be systematically modified and improved; thus, after each cycle, design failures are identified and corrected. This is why documenting the whole process extensively is crucial. Nelson, Ketelhut, Clarke, Bowman, and Dede (2005) recommend documenting each cycle of the iteration in terms of describing implementation, findings and implications.

3) Multiple ways of analyzing the design. To better understand the design, Collins et al. (2004) suggest evaluation at the following levels:
    - Cognitive level. The students' previous knowledge and how it changes during the process. This can be assessed by analyzing students' representations (visual) and explanations (verbal); this data would help researchers understand the students' thought process.
    - Interpersonal level. Refers to student-student and student-teacher interactions. Qualitative research methods are used to observe people in action.
    - Group level. The dynamics (structure, power relationships, etc.) of the group as a whole. Qualitative research methods are also used to observe the group (e.g., in a classroom).
    - Resource level. The resources available to students and how well they integrate into their learning process. Assessed using structured interviews and surveys.
    - Institutional level. Refers to how the institution's organization (e.g., administrators) and outside community (e.g., parents) affect the design's implementation process. Assessed using structured interviews and surveys.
4) Measuring dependent variables. The authors propose assessing three types of dependent variables:
    - Climate variables. For example, students' engagement, cooperation and effort. Assessed through qualitative methods like participative observation or video analysis.
    - Learning variables. For example, students' learning of content, reasoning and dispositions. To assess these variables qualitative and quantitative assessment designs are used, like observation, and pretest-posttest.
    - Systemic variables. For example, adoption and sustainability of the design, and its diffusion to others in the institution. Structured interviews and surveys are used.
5) Measuring independent variables. These are variables related to the context in which the research is being conducted. Some are:
    - Setting. e.g., school, workplace, museum
    - Nature of learners. e.g., age, socioeconomic status.
    - Required resources and support for implementation. e.g., technical, administrative support.

- Professional development. e.g., teachers' training, practices, workshops.
- Financial requirements. e.g., equipment and service costs.
- Implementation path, variables related to the implementation process. e.g., initiation, duration, etc.

6) 6. Reporting on design research. The final research report should have the following sections:
    - Detailed description of goals and elements of the design.
    - Description of the setting where the design was implemented.
    - Description of findings and changes done during each cycle in the iterative process.
    - A final integration of all the findings describing how the design evolved including limitations and failures.

Adapting the DBR methodology to a Virtual World research project

The objective of this section is to propose a methodology to carry out a research project to study an educational virtual world applying the concepts and research methods of the DBR model discussed so far. In Figure 1, the basic structure of the methodology is represented. The methodology is organized as a procedure including three steps: 1) describing the virtual world; 2) iterating and documenting cycles of implementation-findings-implications; and 3) writing a final report integrating the findings of all cycles.

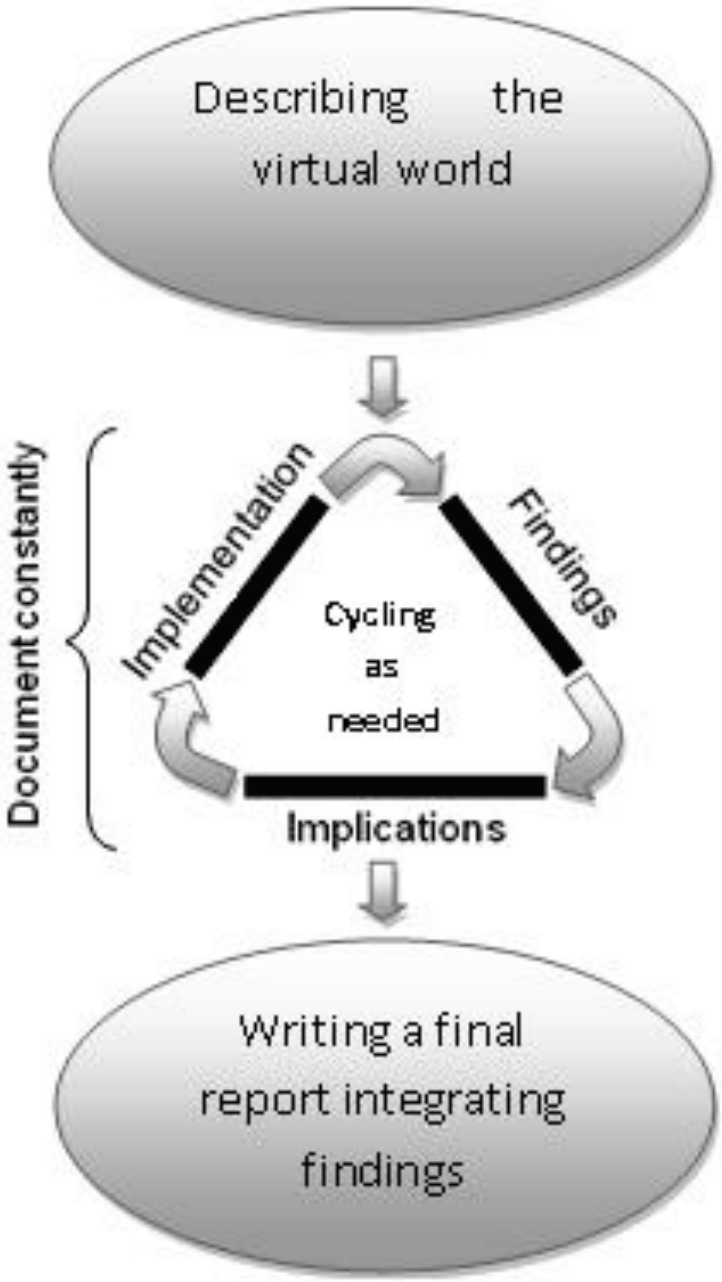

Figure 1: DBR methodology for a virtual world research project.

Most of the methods described herein are subject to adaptations and modifications according to each researcher's background and interests.

Step 1) Describing the virtual world

Before starting the research process, it is assumed that the researcher is interested in testing a virtual world and in revising the theory that underpins it. It is expected that she would be comprehensively familiar with it; perhaps because she was part of the team that created the virtual world in question or because she uses it in her teaching practice. Therefore, as part of the first step, she is able to describe the educational virtual world in detail in terms of the:

- Theory that supports the virtual world.
- Teaching and learning principles used to design the virtual world.
- Settings where the virtual world would be used.
- Relevant learners' characteristics.
- Stated learning objectives.
- World's contextual characteristics.
- Learning activities that users are expected to perform inside the learning environment.
- Goals that users are expected to achieve performing the learning activities.
- Resources needed.
- Financial requirements.

Step 2) Iterating cycles of implementation-findings-implications

As part of the planning done to initiate the first implementation, it is helpful to create a table like the one shown in Table 1. As can be seen, the first column lists the research questions. Of course, these questions would vary according to the type of virtual world we are investigating; that is, according to its objectives, theoretical base, and technical characteristics. In Table 1, I included as an example, a set of research questions relevant to the study of a virtual world which was designed using the situated learning paradigm as its theoretical base. In the second column, each question is categorized, according to Collins et al. (2004), in terms of the type of dependent variable that it is addressing. The third column registers the level of analysis. Notice that a contextual type of variable is added which refers more to the physical ambience. In this case, it is considered relevant because we are investigating a virtual world based on constructivism theory. Finally, in the fourth and fifth columns, the research methods and instruments employed to gather data are stated. From the table, the researcher can further develop the specific procedures for the research and create the necessary materials to carry out the first implementation of the project, such as instruments to gather the data, chronograms, and logistics. The idea is to develop

the table before initiating the first cycle; in addition, after each cycle it is important to revise the table and make the necessary changes so that, before each cycle of investigation, a revised table is generated to serve as its methodological base.

Research Questions	Variable	Level of analysis	Methods	Instruments
How much previous knowledge do users have about the stated learning content?	Learning	Cognitive	Pretest – posttest comparison	Pretest and posttest
How is users' level of engagement during learning?	Learning	Cognitive	Observation (video recording, or movie making if inside Second Life, could also be used)	Observation guide
How do users solve the problem-related activities presented to them?	Learning	Cognitive	Observation	Observation Guide
How is the users' motivation during learning?	Learning	Cognitive	Structured interviews	Structured Interview guide
How do the teacher-student interactions affect learning?	Climate	Interpersonal	Observation Unstructured interviews	Observation guide Unstructured interview guide
How do the student-student interactions affect learning?	Climate	Interpersonal	Observation Unstructured interviews	Observation guide Unstructured interview guide
How were the collaborative learning activities performed?	Climate	Group	Observation	Observation guide
How is the social process within the virtual world?	Climate	Group	Observation	Observation guide
What are the different social roles that users take during activities?	Climate	Group	Observation	Observation guide
How do the virtual world resources (physical, instructional, etc.) scaffold	Contextual	Resource	Observation	Observation guide

learning?				
How has the use of the virtual world diffused to other teachers?	Systemic	Institutional	Structured survey	Survey

Table 1. DBR design

After finishing the first implementation, which included carefully documenting the implementation process itself, the findings, and the relevant implications, the DBR methodology suggests repeating the process several times to revise the design and let the theory emerge. Thus, the set of implications that are reported as the product of the first cycle is carefully studied to plan the next cycle of implementation-findings-implications. Before doing another cycle, it is important to reflect upon the reasons for going into it. The number of cycles is a function of the nature of the research project itself, the researcher's interests, and time and financial limitations. For example, Nelson et al. (2005) report four cycles when they made a study to investigate the multi-user virtual environment (MUVE) called River City, which is a very complex and well-funded project. For the first cycle, researchers focused on investigating usability, motivation, learning, and the virtual world's classroom application. They gathered data using quantitative and qualitative methods and instruments such as tests, questionnaires, narrative analysis, and observations. After analyzing the data, the researchers found that the MUVE was motivating and usable, but found weaknesses that led them to refine content and pedagogy through changing several of the MUVE's attributes, including the ways students interact with the virtual world's citizens, and how they move inside the virtual environment. Then, the revised MUVE was implemented a second time, focusing in this occasion on investigating how the changes affected the students' responses. Again, they learned new and relevant aspects about how students were learning inside River City, such as how students became easily lost in the virtual world. They identified further modifications and repeated the process of implementation-findings-implications for a third and fourth cycle. With each cycle, the researchers were better able to focus their research questions and to gain more comprehensive information about how the MUVE worked with the selected students and teachers, and about the theory behind it, such as students' motivation and self-efficacy while learning inside virtual worlds.

Considering the iterative dynamic of this methodology, which evolves over time, it is crucial to document systematically the whole process because it is very important to identify the changes as they occur. Researchers use several methods to do this. For example, they use extensive writing of field notes and research diaries, or even video recording the process as much as possible.

Step 3) Writing a final report integrating findings from all cycles.

The main objective of the final research report should be to integrate and interpret the findings and implications that emerged during the research process into a cohesive whole. Hence, the report can have the following sections:

- **Introduction**

  The main objectives of the research are stated and the virtual world in question is described as was done in Step 1 of this methodology. That is, state:

  1. the theory underlying the virtual world, underscoring the teaching and learning principles used;
  2. the settings where the virtual world was used (a classroom, a training industrial environment, a museum exhibition, a teachers' home, etc.);
  3. relevant learners' characteristics;
  4. specified learning objectives;
  5. world's contextual characteristics;
  6. learning activities;
  7. goals that users are expected to achieve performing the learning activities;
  8. resources needed;
  9. financial requirements;
  10. the design and procedures of the research.

- **Cycles of investigation**

  Each process of implementation-findings-implications is described extensively corresponding with each cycle of investigation that was carried out. For each cycle, research questions, objectives, failures, and successes are described.

- **Conclusion**

Present a final integration and interpretation of all findings and implications, describing how the design evolved—including limitations and failures—and state general conclusions that would clarify what was learned about how the virtual world works, about its underlying theory, and about the teaching and learning principles employed for its instructional design.

Using DBR methodology in a Virtual World research project

In this section, an example of the application of the methodology proposed in the previous section will be presented. The methodology will be used to build a plan to investigate the prototype of an educational virtual world still under construction in Second Life called the "SimEscuela" (Spanish for SimSchool). Due to the nature of the present manuscript, a briefer version of the research design will be described; however, enough details will be presented while following the three stated steps, so that the reader can comprehend how the methodology could be applied.

Step 1) Describing the virtual world: The theory that supports the virtual world

The SimEscuela virtual world was created to offer teachers a virtual learning environment where they could build a learning community to acquire and refine their teaching skills. Its instructional design was based on the situated cognitive paradigm, which proposes a different view of the nature of human learning. Briefly, this paradigm claims that the processes of cognition and learning are modified by the situation in which they happen. For this constructivist perspective, doing and learning are intricately related, or as Maturana and Varela (1987) put it: "All doing is knowing and all knowing is doing" (p.27). That is, our knowledge building is affected by the culture, the context and the type of activities we engage in when using it (Brown et al., 1989). Thus, when our students are at school, they are not only learning content, but are also going through a process of enculturation because they are, in addition, relating with those cultural aspects that define the communities of practitioners, mathematicians, historians, etc. that created the content. In this way, a student learns their values, the symbols they use to communicate, and the tools they employ when performing their professional practices. From this view, learning is reconceptualized in social, cultural, and historical terms (Lave & Wenger, 1991) and as participation in a community of practice (Wenger, 1998). From this definition of situated

learning, it is possible to understand how well this theoretical perspective lends itself to produce a virtual world. (For more details in using this paradigm to design virtual worlds see Author, in press).

2) Instructional Principles

Some of the situated learning instructional principles that were adapted to form the theoretical base for the SimEscuela were:

- Users learn in the SimEscuela performing problem-related activities collaboratively. During these activities they freely negotiate meanings, and discuss, reflect, and share information.
- SimEscuela simulates a traditional Mexican school so that participants can involve themselves as members of the community of practice formed by Mexican teachers.
- The problems that users solve in the virtual world are authentic; that is, they are very similar to the type of problems that teachers solve in their everyday practices.
- The objective is to solve a problem collaboratively and gain information during the process.
- The environment constantly fosters reflection.
- New users should be allowed to interact with experts as legitimate peripheral participants so that they can learn with and from them.
- The teacher performs activities for the learners so that they can model expert performing.
- The teacher closely supervises the participants' activities and gives relevant feedback; however, he reduces his supervision as users become more experts.
- The environment offers resources so that participants can easily store the information that they produce during their learning activities.
- The users' performance should be constantly evaluated so that participants know how they are learning in the virtual world.

3) Settings where the virtual world would be used

Because the main objective of the SimEscuela is to serve as the learning platform for a community of Mexican teachers in Second Life, it is expected to have participants from all over

the country. The virtual environment was planned for K-12 teachers that belong to the public sector of education. Thus, the setting where it will be most often used is the computer lab of the different schools that form the public educational system in Mexico. Working individually in the computer lab, a teacher will access the SimEscuela and meet there with colleagues from other Mexican states to work collaboratively. The strategy will be to disseminate its use as much as possible among the teachers using the official channels. Teachers are usually involved in several types of training, therefore, it is expected that the use of the SimEscuela will be integrated into their training programs.

4) Relevant learners' characteristics

- All the teachers have at least an undergraduate degree in education with majors in the different domains of content taught at the schools, e.g., mathematics, history, etc.
- Many have completed graduate studies.
- Technological literacy is low.
- Most have access to a computer with wideband Internet in their school computer labs.

5) Stated learning objectives

It is expected that teachers interacting inside the virtual world will:

- Develop the abilities to perform as an active member of a learning community with the purpose of building teaching knowledge collaboratively.
- Develop the higher order cognitive abilities to solve problems collaboratively.
- Apply their learning in their corresponding real life classrooms.

6) World's contextual characteristics

The virtual world SimEscuela was built to simulate a traditional Mexican school (See Figure 2). Its first version (the prototype) was created with only two classrooms because it is going to be tested with a small sample of teachers. One of the classrooms serves as the place where they can meet (in groups of five due to limitations regarding avatar movement in Second Life) to interact, share information, reflect with the facilitators, access relevant contents, and identify the learning problem-solving activities that they will need to perform to achieve their learning objectives. The other room simulates a traditional classroom where teachers can go to practice their newly

acquired teaching abilities doing role-playing games with the other members of their team. Moreover, in the school's courtyard, there is an auditorium with a screen where teachers can display and explain their solutions to larger audiences.

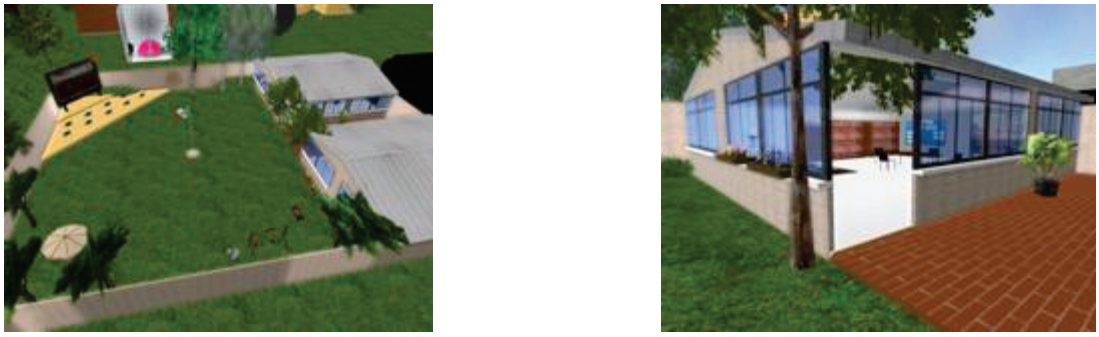

Figure 2. Snapshots taken of the virtual world SimEscuela in Second Life

7) Learning activities that users are expected to perform inside the learning environment

- Meet together to identify a common problem; for example, a group of five teachers can decide that they need to better understand how to integrate the use of the computer in their teaching practices.
- Build a learning plan including a chronogram.
- Read relevant materials at the SimEscuela.
- Investigate relevant information from other sources.
- Perform tasks preplanned by the facilitators to learn specific content, such as the differences between learning "about", "from", and "with" technology.
- Present their final products to other teams to obtain feedback.
- Ask facilitators to evaluate their learning and do the corresponding evaluation activities.
- Go to small workshops where they can learn specific abilities, like how to move inside Second Life.

8) Goals that users are expected to achieve performing the learning activities

- Identify a common problem related to their teaching practice.
- Solve the selected problem working collaboratively.

- Transfer the learned abilities in the SimEscuela to their everyday teaching practices.

9) Resources needed

- Technical support to aid researchers and participants.
- Graduate student assistance.
- Administrative support.
- Materials.

10) Financial requirements

- The salary of at least one expert technician for computer equipment.
- Funds will be needed to offer graduate students academic units.
- The costs related to the production of all the materials.

Step 2) Iterating cycles of implementation-findings-implications

To carry out the implementation of the first cycle of investigation according to the second step of the proposed methodology, the following table was created:

Research Questions	Variable	Level of analysis	Methods	Instruments
How is users' engagement during learning?	Learning	Cognitive	Observation	Observation guide
How do users solve the problem-related activities presented to them?	Learning	Cognitive	Observation	Observation guide
How is the users' motivation during learning?	Learning	Cognitive	Structured interviews	Structured Interview guide
How do the teacher-student interactions affect learning?	Climate	Interpersonal	Observation Unstructured	Observation guide Unstructured interview

			interviews	guide
How do the student-student interactions affect learning?	Climate	Interpersonal	Observation Unstructured interviews	Observation guide Unstructured interview guide
How were the collaborative learning activities performed?	Climate	Group	Observation	Observation guide
How is the social process within the virtual world?	Climate	Group	Observation	Observation guide
What are the different social roles that users take during activities?	Climate	Group	Observation	Observation guide
How do the virtual world resources (physical, instructional, etc.) scaffold learning?	Contextual	Resource	Observation	Observation guide
How has the use of the virtual world diffused to the teachers' real life practices?	Systemic	Institutional	Structured survey	Survey

Table 2. Research design for the SimEscuela prototype

As can be seen, Table 2 offers enough information to plan the procedure for this research project. In this case, at least three iterations are planned. The first implementation will be done with a small sample of five local teachers since, initially, we are interested in doing an overall test of everything, and we want to be able to closely watch how every user interacts with the SimEscuela and with other teachers. During this first cycle, all the designed instruments will be evaluated and teachers will be constantly interviewed during their learning process to identify any major failures. With the information gathered, the following two cycles will be planned. The second and third cycles will be done with larger samples from all over the country.

After the three cycles have been finished, the final research report will be written making an effort to conclude relevant issues related to the virtual worlds' general performance and about the stated teaching and learning principles and theories. The report should include suggestions of how to improve the virtual world SimEscuela for future versions.

Conclusions

Globally, the use of virtual technologies is already playing a relevant and promising part in our educational endeavors. However, we are still at an early stage of adaptation of this technology (Richardson and Molka-Danielsen, 2009) and have questions that have not been adequately addressed by current research regarding how we can take better advantage of its educational potential. I agree with the authors that propose that, at present, multi-user virtual environments are still mostly used to replicate real life experiences and are seldom developed to teach significant learning objectives (Berge, 2008; Dieterle and Clarke, 2005). To reverse this tendency, we need more potent theory that could, on the one hand, aid our practices as designers and creators of educational virtual environments and, on the other, explain how humans learn engaging in the types of social interactions that are possible between them (Gunawardena et al., 2009). An important part of the literature believes, as has been discussed in this manuscript, that a great aid to develop this type of theoretical body could be the design-based research model because it begins with the premise that theory and practice are closely related. With these ideas in mind, in this article, the theoretical underpinnings and methodological proposals of the Design-based research model were described to be able to use them as the base for research projects interested in investigating virtual worlds. Then, a methodology to use DBR in virtual worlds was proposed and a case was built to explain how to apply it.

We still have a long way to go before we can satisfactorily conclude that the use of the DBR methodology in education in general, and in instructional technology in particular, produces the results that we are looking for to advance the field in the right direction. However, due to this research model's innovative characteristics, I believe that its use is indeed very promising and that it is worth the effort to carry out further research projects based on its methodology to study educational virtual worlds.

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