Games and Simulations in Online Learning:
Research and Development Frameworks

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Chapter VI

E-Simulations in the Wild: Interdisciplinary Research, Design, and Implementation

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Abstract

This chapter examines the relevance of research on scientific discovery learning in simulations to professional legal education simulations. There are striking similarities between the research findings from this domain, and our experience of running simulations in law in the Glasgow Graduate School of Law. However, simulation learning depends on factors that arise not only from the design of the simulation, but also from the environment of implementation. We argue that, while the paradigm of simulation research represented by many of the studies on scientific discovery learning is a valuable one for law and other disciplines, the educational effectiveness of e-simulations also depends critically on three factors: design of learning outcomes, type of simulation field, and the organization of communities of practice around and within a simulation. These factors demonstrate a fundamental need to re-configure design concepts around the potentialities of the emerging new medium in the form of a new "trading zone."

Introduction

The rise and rise of simulation as a form of entertainment is one of the Internet success stories in recent years. Massively multi-user online role-playing games (MMORPGs) have demonstrated the attraction of simulation as a form of social gaming (Castronova et al., 2003). The growth of simulation e-learning, though less developed as an industry, shows similar potential (Chapman, 2005; Gee, 2003) with one report claiming a two to three years' time-to-adoption for educational gaming applications (Horizon Report, 2005). This potential has been some time in gestation: the concept of computer-based simulation has been written about and researched for the last 20 years at least, in fields as diverse as business, mediation, engineering, and bioscience.

The value of simulations has not been lost on occasional commentators in the legal domain. One early commentator noted that simulation and gaming techniques could be used to teach problem solving; and he suggested that such techniques had potential as research and educational tools (Drobak, 1972). The first computer simulation game was used in the context of an urban legal studies program, and was built to enhance students' decision-making roles in a simulated city (Degnan & Haar, 1970). More recently, in their overview of computer simulations, Widdison, Aikenhead, and Allen (1997) observed that most educational computer simulations neglected substantive law, transactional settings, and abstract situations. The authors went on to discuss how these underdeveloped aspects might be expanded in the area of contract law (Aikenhead, Widdison, & Allen, 1999; Widdison et al., 1997). Even in these early papers there was an emphasis on the necessity for interdisciplinary work if computer simulation were to be realized as a viable form of legal education.

It is one function of this paper to explore aspects of that interdisciplinary context and its relevance to legal education—one version, as it were, of Unger's notion of expanded discourse (Unger, 1983). In the second section of the paper we briefly summarize a number of aspects of the research into what might be termed "scientific discovery learning" within the domains of science-based and medical education and draw out themes in user experiences. As we shall see, those themes revolve around the concept of the representation of reality. In a sense this should come as little surprise to anyone familiar with the literature of constructivism and project- and resource-based learning. Representation—literally, the re-presentation of reality—is a problem that surfaces in many educational approaches, including situated learning, problem- and scenario-based learning, constructivist learning, and much else (Herrington, Oliver, & Reeves, 2003; Petraglia, 1997; Shaffer, 2004). In the third section we shall briefly summarize how, on a practical level, we are dealing with these issues in a simulation environment within the GGSL. While a resolution of these issues is not possible in this chapter, in the fourth section of the paper we shall at least begin to sketch possible approaches to a number of these issues, which, on a theoretical level, address the concerns of educationalists and e-learning designers.

Representation in Simulations

The term "computer simulation," in an educational sense, is amorphous, covering a range of different applications and educational concepts. At a basic level, a computer simulation is a set of algorithms that defines a learning environment; but this tells us little about what constitutes the environment, how it is composed, how it is used, and how it affects the learning experience. For the purposes of this paper, I shall define a computer simulation in legal education as a digital environment that is a representation of aspects of legal reality, in which a user can, to a greater or lesser extent, create and manipulate data in order to learn legal procedures, concepts, and values.

There are two issues in this definition that require a little more discussion. Perhaps the key issue regarding computer simulation is that of representation. By its nature, a simulation represents some aspect of reality; but the representational relationship is a complex one. Reality can never be replicated, and therefore design involves the extrapolation from reality of aspects relevant to the educational task. *What* should the simulation simulate? *Why* should it do so, and which criteria will be applied? *How* will it do so? What we have is essentially an overlap of three distinct elements: educational intention and design (why), disciplinary content, in this case legal reality (what), and simulation reality (how). Each of them is highly complex in its own right. When overlaid, the complexity can easily spiral out of control if all three are not managed within a design environment that takes account of the relationships between the three elements.

Take for instance the relationship between educational design and what might be termed the reality of legal action and process. Paradoxical as it may seem, simulations are not a mere *mimesis* of reality. The very concept of reality of legal action involves one in choosing, shaping, and representing that reality according to educational design and intention. This relation is not causal only; it is synergistic on two levels. At a deep level, simulations can be used to critique principles and practices in law, and to raise awareness of injustices, ethical contexts, or inefficiencies in the legal system. On a more procedural level, the shape and function of a simulated transaction is determined by the shape and function of the legal process it represents, and therefore legal reality as well as educational design and intention, affects the form and content of a simulation.

The second issue is whether simulations are useful tools for learning complex concepts and values or whether their primary purpose is in the teaching and learning of merely surface procedures and tasks. In their substantial overview of the research, De Jong and van Joolingen (1998) make the distinction between simulations that contain "*conceptual* models" and those that are based on "*operational* models." Conceptual models focus on "principles, concepts and facts related to the 'class of' system(s) being simulated;" while operational models "include sequences of cognitive and non-cognitive operations (procedures) than can be applied to the (class of) simulated system(s)" (p. 180). As examples of the former they cite economics models, and as instances of the latter they cite radar control tasks.

The distinction between conceptual and operational models of simulations is useful for categorizing simulations. However, there are a number of problems associated with the dichotomy that is created by the distinction. First, there are always cognitive models in

users' minds when they begin to use a simulation. Users always come to simulations with a schema of what they are about to do, and this is an important part of their view of both a simulation and the learning that they undertake within the simulation.

Second, professional procedures, even the merest of operational tasks, are always based on embedded concepts. It is difficult to think of any legal process, for example, that does not contain concepts or principles that are an essential, if sometimes unseen or at least inert, part of the process. It is when operational procedures break down or go wrong in some way or another that such concepts are called up and analyzed in a procedure. Eraut expressed this well when he described how the context of use affects the learning of theoretical knowledge:

It is misleading to think of knowledge as first being acquired and then later put to use. Not only does an idea get reinterpreted during use, but it may even need to be used before it can acquire any significant meaning for the user. Thus its meaning is likely to have been strongly influenced by previous contexts of use; and the idea will not be transferable to a new context without further intellectual effort. (Eraut, 1994, p. 51)

The problems encountered by de Jong and van Joolingen's attempt at formal categorization are endemic in all simulation definitions. Other examples include the distinction made by de Jong and Njoo (2000) between *transformative* and *regulative* learning processes; or Klahr, Fay, and Dunbar's (1993) theory of scientific discovery as dual search (SDDS) in two spaces, that of *hypothesis* space, where hypotheses based upon rules can be formed regarding phenomena observed, and *experiment space,* where learners perform experiments upon phenomena. Research such as this is useful in that it describes a normative model of scientific discovery, and makes this available to educationalists interested in scientific discovery. However, as Maharg (2000) has argued elsewhere, we must be cautious about the use of descriptive procedural models for prescriptive ends in learning environments. Rather, it might be helpful to examine the experience of experts and of novices, each in their communities of practice, to determine how best to shape a simulation environment and the learning that might take place there. Rather than attempt formal categorization based upon cognitive research alone, we need to consider the experience of the simulation simultaneously as designer and user. We shall see examples of later in the chapter.

One of the ways we have attempted to categorize our simulation practice in the last five years is by means of a spectrum model with, at one end, the simulation of a "bounded field" of practice, and at the other, an "open field" of practice. Adaptivity to practice, both educational practice and the field of legal practice, is the key element of this model. We would define the spectrum operationally as on a scale where users have more or less control over their actions within the simulation. The characteristics of each end of the spectrum can be summarized in Table 1.

Simulation projects that take place within a bounded field allow for less user interaction, fact-finding, or legal options. This could be a project decision by designers based on time and financial limits of the design process, or it could be a decision based on the nature of a legal transaction. Many legal transactions can be reduced to a form of document flow-chart, and it is the function of some knowledge management and risk management strategies in legal practice to create of a legal matter a process that can be streamlined within the organization. Some transactions, though, are by their nature fairly linear processes, with known correct

Table 1. Bounded—open field transactions

		Bounded field (i.e., transaction tends to…)	**Open field (i.e., transaction tends to…)**
1.	Learning outcomes (LOs) & assessment	Precise learning outcomes, with simulation tasks based closely on outcomes—pre-defined LOs	Bodies of evidence required to be produced to benchmark standards, but less emphasis on pre-specified outcomes
2.	Alignment with traditional learning & teaching methods	Teaching aligned with tasks and outcomes, often according to an academic structure (e.g., lecture–seminar; learning is heavily 'pushed' by curriculum structure)	Teaching provided where needed according to learners' needs, often according to a professional, just-in-time learning structure; learning is 'pulled' by learners
3.	Operational model	Linear domain procedures (e.g., predictable document chain—more operationally predictable)	More varied, open or diffuse domain procedures (e.g., transactional guidelines but no specific document chain—less operationally predictable)
4.	Student outputs	Specific documents, drafted to specific standards (e.g., initial writ; fixed or correct versions expected as student output)	Procedures that involve a variety of documentation, or documents that cannot be specified easily in advance (e.g., negotiated agreements; various versions acceptable)
5.	Resources	Resources that are tied closely to tasks and learning outcomes—highly model driven	Simulation resources that are not linked to tasks; learner needs to structure transaction through interactive querying of resources— highly learner driven

outcomes, in which a chain of correspondence is created, and the content of the chain is fairly well defined. A conveyancing transaction might be an example of this. At the other extreme are those transactions that are fluid, with variable (and equally correct) outcomes, and with no specific documentation path. A personal injury (PI) negotiation is a good example of such a transaction, where an employee's claim for compensation is negotiated by lawyers acting for the claimant on the one side, and as the insurer's solicitors on the other. There are of course strict guidelines to the performance of PI transactions in the offices of lawyers and claims handlers; but it is in the nature of the transaction that the negotiation creates of it an open field project, where at points students are not bound to follow specific actions or procedures, or produce a set of pre-defined documents.

The field metaphor has of course analogies with older, classic metaphors—Bourdieu's (1990) field, Minsky's (1975) frame, Schank and Abelson's (1977) script, Chilton's (1988) morphism, to cite but a few. The poles of the spectrum are akin to the Weberian "ideal type," which rarely exists in practical terms, but which serves to define a practice. For us, though, the metaphor helped define the nature and clarify the processes of simulation learning. It is a concept still in the process of configuration, and areas for further research will be outlined in the final section of the chapter. As we shall see in the next few sections, however, it grows from the substantial body of research into learning and simulations, not least that of scientific discovery.

Scientific Discovery Learning Research and Legal Education

The early research on the effect of simulations upon learning presented mixed findings. Ehman and Glenn (1987) reported gains in co-operative learning skills and positive affective outcomes in social sciences. However the meta-analysis of Bangert-Drowns, Kulik, and Kulik (1985) in the domain of science education reported that simulation-based learning did not result in cognitive gains (see also Rivers & Vockell, 1987). Further results in the domain of science-based discovery learning (from where the great majority of simulation studies derive) revealed significant differences between learning from predominantly simulation environments and learning from blended simulation-tuition environments. When simulations were blended with face-to-face tutorials, assessment of students' capabilities in mastering and applying rules demonstrated higher results than if students merely attended tutorials (Rieber, Boyce, & Assad, 1990). The same proved true of simulations alone: in a study where students were given either an unsupported simulation or a tutorial, students performed worse on the simulation (Rieber & Parmley, 1995).

What counts as the measure of better or worse performance, of course, is crucial. According to Thomas and Hooper (1991), the effectiveness of learning by simulations is best measured using "application and transfer" assessments. Their view was substantiated by other studies, for example that of Shute and Glaser (1990) where learning undertaken within the simulation was compared with learning undertaken in a more formal academic setting, and no significant difference was detected. The evaluative measure used was simple rehearsal of conceptual learning.

Findings such as these have led some researchers to conclude that simulation learning is best deployed when learners are required to learn procedures—for example, the process of successful experimentation in the field of scientific discovery learning. They point to the difference between results for procedural knowledge, and those for conceptual learning, where simulations appear to be less effective in enabling learning (e.g., Mandl, Gruber, & Renkl, 1994). However other researchers show, as we shall see, that simulation learning, particularly if it is structured rather than left as a pure simulation, can enable learners to understand and transfer concepts more effectively than a traditional curriculum.

The results therefore are mixed; but further analyses of the studies in the domain of scientific discovery simulation available to us in the last 20 years do yield interesting data (for example, Lee, 1999). In the following summary (Table 2) we are indebted to the work of de Jong and van Joolingen (1998), whose fine meta-review of the research pre-1998 provided many valuable references in the area of scientific discovery learning. Post-1998 we have relied on our own summary of the research in this domain, using the same search query pattern employed by de Jong and van Joolingen.

Within the last five years, of course, the field has changed considerably. The sophistication of Web-based simulation tools and methods has grown, as has the commercial market for MMORPGs, and there are now many more educational simulation applications on the market than there were a decade ago (Brandon-Hall, 2005; Murray, Winship, Stillings, Shartar, Galton, Moore, & Bellin, 2003). There have also been a number of high-profile simulation projects that have built upon the work of educational research reviewed by de Jong and

Table 2. Summary of aspects of research into scientific discovery learning

Area of scientific discovery	Phenomenon	Authors	Brief summary of findings
Design of experiments			
1.	Confirmation bias (learners seeking to confirm, rather than question, a hypothesis)	Dunbar (1993)	Students sought for evidence to confirm their hypotheses, which prevented the formation of alternative hypotheses
2.		Quinn & Alessi (1994)	Students reluctant to use experiments to eliminate possible hypotheses
3.	Inconclusive experiments	Glaser et al. (1992)	Learners vary too many variables in an experiment, and therefore cannot come to clear conclusions
4.		Schauble, Glaser et al. (1991)	Unsuccessful learners gather insufficient data prior to forming conclusions
5.		Inefficient data gathering Kuhn et al. (1992)	Learners did not use all possible experiments before forming conclusions
6.	Experiments do not test a hypothesis	Schauble, Klopfer, & Raghavan (1991)	Learners tried to create the outcome desired, rather than using experiments to come to an understanding of the scientific model
Area of scientific discovery	Phenomenon	Authors	Brief summary of findings
7. Interpretation of data		Schauble, Glaser et al. (1991)	Successful learners identify patterns in data
8. Regulation of discovery learning	Characteristics of successful learning	Lavoie & Good (1988)	Successful learners used systematic planning and monitoring, and made more notes during learning
9.		Shute & Glaser (1990)	Successful learners were more mindful of data management
10.		Glaser et al. (1992)	Successful learners planned ahead their experiments
11.		Glaser et al. (1992)	Successful learners were persistent; but could abandon an hypothesis that proved ill-founded
12.		Charney, Reder, & Kusbit (1990)	Goal-setting was problematic for learners with low prior knowledge of the domain of knowledge

Table 2. continued

13. Simulations and instructional support	Provision of information	Berry & Broadbent (1987)	Provision of information to learners on a 'just-in-time' basis is more effective than making all information available from the start of a simulation
		Leutner (1993)	Permanently available information enabled learners to acquire domain knowledge, but information provided before the simulation was not effective
		Elshout & Veenman (1992)	Domain information provided before a simulation was not helpful during the simulation
	Information tools	Lewis, Stern, & Linn (1993)	Provided learners with an e-notation form to note phenomena, and graphing-tool, to better understand predictions
		Bodemer (2004)	Active external integration of representations, such as textual resources, can improve simulation-based learning outcomes
	Hypothesis generation tools	Shute & Glaser (1990)	Provided learners with a 'menu' of possible hypotheses
		Van Joolingen & de Jong (1991)	Provided learners with a 'scratchpad' of possible hypotheses
	Experiment design tools	Rivers & Vockell (1987)	Provided learner with experimentation 'hints' on how to carry out experiments
	Learning process tools	White & Frederiksen (1990)	A complex simulation model was introduced to students step-by-step.
		Rieber & Parmley (1995)	Learners working in a simulation with increasing control of variables scored higher than learners with full control from the start
	Planning support tools	Tabak et al. (1996)	Questions were used to help learners to set goals
		White (1984)	Simulation with games embedded in it enabled more effective learning of procedures than a pure simulation without games
		De Jong et al. (1994)	Assignments within a simulation increased learners' deep knowledge
	Monitoring tools	Schauble, Raghavan, & Glaser (1993)	Provided monitoring support for learners that included an overview of learner actions, ability to group actions together under outcomes and access to an 'expert view'

Table 2. continued

	Structuring process	White (1993)	When qualitative predictions within a simulation were measured, learners using the simulation out-performed learners using a traditional curriculum
		Njoo & de Jong (1993)	When 'qualitative insight' was measured, a group of earners whose simulation was highly structured outperformed a group working with only the simulation
		Shute & Glaser (1990)	When recall of concepts was measured, a simulation environment showed no significant difference in comparison to a traditional curriculum
		Lewis et al. (1993)	When understanding of concepts was measured, learners using a structured simulation environment to predict experiment outcomes performed better than students using a traditional curriculum
		Swaak, de Jong, & van Joolingen (2004)	Simulations are to be considered only when clear benefits of discovery are expected, and only with complex domains, sufficient learning time and freedom for students in the assignments to engage in discovery
		Zhang, Qi Chen, & Reid (2004)	Learning supports in a simulation environment should be directed towards three perspectives, interpretative, experimental and reflective, to invite meaningful, systematic, and reflective discovery learning
		Windschitl & Andre (1998)	In a study of the effect of constructivist and objectivist learning environments on student epistemological beliefs, the former enabled greater conceptual change for learners with advanced beliefs; learners with less advanced beliefs learned more from the objectivist environment
		Swaak & de Jong (2001)	One group of subjects was free to choose their own sequence while exploring the simulation environment. The sequence of a second group was largely controlled by the environment. Results showed no gain in definitional knowledge but a gain in intuitive knowledge
	Feedback	Veermans, de Jong, Wouter, & van Joolingen (2000)	Providing learners with adaptive feedback had a different and beneficial effect on the learning process compared to more traditional predefined feedback.

Table 2. continued

		Ronen & Eliahum (2000)	Simulation was a source of constructive feedback, helping students identify and correct their misconceptions and cope with the common difficulties of relating formal representations to real circuits and vice versa

van Joolingen. As the table demonstrates, the research involves multiple disciplines. But while it is multi-disciplinary, it may not seem at first glance to be truly interdisciplinary, or capable of being applied in other disciplines. If we take the example of legal education, for instance, it may be argued that the work of de Jong and van Joolingen, sited as it is in the domain of scientific discovery learning, can have little relevance for education in this domain. Not only is the substantive area wholly different, but ways of knowing (hypothesis, experimentation, etc.) and therefore the types of simulation environments constructed by researchers appear to bear little resemblance to legal educational methods and legal epistemic norms. However there are a number of resemblances and parallels between the fields that show that the comparison is not as odd as it may first appear.

First, scientific discovery learning is fundamentally a self-directed activity within well-defined modes of procedure, as is professional legal learning, though the content of that activity differs. Second, science students are required to construct an understanding of the experimental process (and the research outlined in the table in Table 2 shows how problematic that is for students and faculty). Law students similarly are required to construct what jurists call "the theory of the case." The phrase can mean quite different things, depending on who is using it in which sub-domain of law—jurists, court practitioners, and so forth. But a common denominator is the sense of underlying legal logic, based upon either legally relevant facts, or legal sources (case law and legislation), or jurisprudential theory, or a combination thereof. The educational methods that underlie this meta-activity are similar to the learning of scientific experimental process and logic. Third, while a number of simulation tools used in scientific simulations can be inappropriate to the subject matter of law (graph interpretation, dynamically generated graphs and charts, etc.), others can be used to present the results of learner activity to the learner, and thus stimulate reflection on learning. Such use of tools is appropriate to almost all disciplines in higher education, and we shall consider some examples in the domain of law.

Perhaps most important of all, the collection of studies in Table 2 analyzes educational design issues generic to simulation environments, which are applicable to the use of simulations in all disciplines. For example, one generic concern is that simulations, particularly those built upon constructivist theoretical design, favor weak students over strong. In their study of the use of computer simulations to enhance conceptual change in commonly held alternative conceptions within science education (conceptions held of the human cardiovascular system), Windschitl and Andre (1998) investigated the role that a constructivist approach played *vis-à-vis* an objectivist approach on student epistemological beliefs. They discov-

ered that a constructivist approach resulted in significantly greater conceptual change for some but not all alternative conceptions. More interestingly, they observed that there was a correlation between epistemological belief and conceptual change within the constructivist environment. Those students who, accordingly to Windschitl and Andre, held more advanced epistemological beliefs about cardiovascular concepts learned more within a constructivist environment; while students with less developmentally advanced beliefs learned more with an objectivist or instructivist treatment.

Windschitl and Andre do claim in their conclusions that "some evidence was obtained consistent with the view that providing learners with overly detailed procedural instructions to solve problems in a simulated environment could be deleterious to conceptual change" (p. 158). But they also discovered that learners more easily open to misconceptions regarding cardiovascular concepts learned more effectively in more highly structured, instructivist environments. Why should this be so? They suggest that the major factor may be that such students are less motivated by a constructivist environment; but they are frank enough to admit that this explanation "may not be entirely satisfactory" (p. 157). They postulate that more sophisticated students may be simply frustrated by a more highly structured learning environment, and therefore "perform poorly under such conditions" (p. 157).

These are interesting findings for the implementation of simulation environments in any discipline, including law. It may be argued that it is easier within the domain of science education to define what might be considered to be more or less advanced beliefs. While all disciplines construct and re-construct their fundamental processes, the theory of the experimental process, at the level to which it is taught to undergraduate students, is fairly well established. In legal education it may be more difficult to discern what might be more or less advanced arguments; or at least there is likely to be more debate surrounding the distinction. Nevertheless, the general conclusions that Windschitl and Andre reach are useful guidelines to simulation building for legal education. Their work demonstrates the value of an interdisciplinary approach to simulation research and applications, and the value of the research in Table 2 to legal education, which we shall demonstrate later. To do this we shall describe our own simulation environment, in use for the last five years in legal education, before describing in outline the function and content of two simulation projects within it, and then noting the parallels between our work, and the body of research in scientific discovery learning.[1]

Ardcalloch: A Simulation Environment in Professional Legal Education

The simulation environment described next was used on a postgraduate professional educational program called the Diploma in Legal Practice at the Glasgow Graduate School of Law (GGSL). The program is mandatory for all undergraduate LLB students who wish to practice as either solicitors or advocates in Scotland. It is hosted by five providers in Scotland, with a total intake of around 500 students. This year in the GGSL, approximately 280 will take the program. These students will have studied a minimum of two years of law (if they arrive *via* a fast-track graduate program) or four years (if they come, as most students do, *via* an Honours undergraduate program). They are therefore familiar with a body of academic

law; and it is the function of the Diploma to introduce them to professional practice and law in practice and thus prepare them for two years of traineeship, which, if successfully completed, will result in the award of a practicing certificate.

Since 2000 at the GGSL we have been developing a range of e-learning environments for our students. Foremost among these has been a simulation environment within which students carry out legal transactions. The transactions are both a learning and an assessment zone. Simulations have often been thought to be useful professional and vocational teaching tools (Rystedt & Lindwall, 2004). While this is often assumed to be the case, the models of effective simulation construction are still imperfectly understood, as Table 2 amply demonstrates (see also Brooks, Robinson, & Lewis, 2001). Based on our reading of some of the scientific research, but more on constructivist models of learning, we constructed a fictional town on the Web, called Ardcalloch, to facilitate the legal transactions we wished our students to complete. Within this town students would play the role of solicitors. They would have virtual legal offices, be able to contact other professionals, institutions, public bodies, and so forth, to obtain information and play the role of a solicitor in practice. Other roles would be played by online tutors or facilitators who would masquerade as characters over the Web in order to communicate in role with students. Note that our aim was not to replicate reality—impossible, and not necessarily a productive educational heuristic—but to simulate aspects of it for educational purposes.

Our fictional town has a number of elements, namely the:

- Backdrop for legal transactions—what might be termed the "realia" of professional legal work. The term realia derives from archival work, and includes a vast array of objects in that domain, such as scrapbooks, newspaper clippings, advertisements, photographs, wills, bank books, account books, and so forth. We have created many such objects in the virtual town. These objects may be thought of as the surface structure of the simulation, but as we shall see, their presence and the relationship of them to their actual objects in reality contribute to the credibility and therefore the success of the simulation (van Ments, 1984).
- Characters, institutions, professional networks with which students can communicate in their transactions.
- Virtual offices within which aspects of legal transactions were replicated as they would be performed within a law firm.
- IT communicational systems embedded within the virtual community and virtual legal offices.

The key elements of the environment are:

1. A schematic map, interactive and zoomable, with Web sites embedded in it, and a thumbnail and pictures associated with topographical details in the town (Figure 1)
2. A directory, organized according to business, institutions, law firms, and citizens, and consisting of several hundred items (Figure 2)

3. A history of the town, from its early medieval foundations to its 21st century revival (Figure 3)
4. Virtual law firms, consisting of a generic front page (Figure 4) and a passworded intranet (Figure 5)

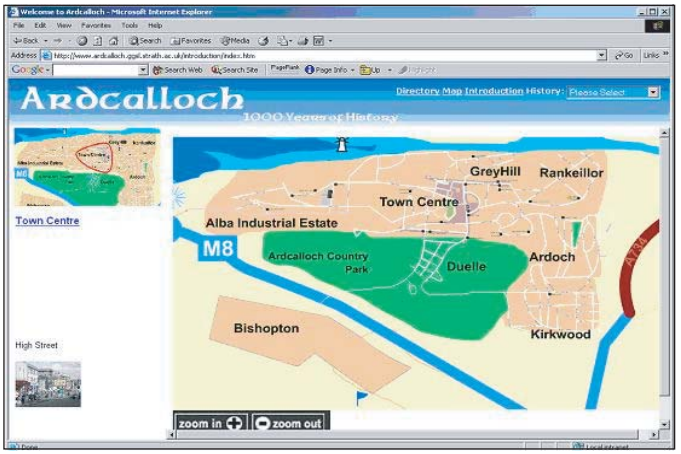
Throughout the construction of the town, verisimilitude to social and urban systems was what we aimed for, not the replication of reality. As the work of Couture (2004) shows in the area of scientific discovery learning, the realia of a simulation contributes powerfully to its credibility as a learning tool. Verisimilitude, though, as Couture acknowledges, is a complex issue that goes well beyond the representation of real items. It involves the choice of which items learners will want to use in the simulation environment, the communicational networking value of the tools, their look and feel on the screen, triggers for the adaption of willing suspension of disbelief in the simulation by learners, and much else. This included a forum on the firm's intranet so that they could communicate with each other in general, and one on each transactional project page; links to the Practice Manager tutor; links to their activity log and personal log. The requirement for these types of tools is generally acknowledged in the literature—see for example Leemkuil (2003).

Clearly we had to be aware of cognitive overload during use of the environment. Feedback from the first year or so of simulation use revealed that students needed support in order to integrate their activities within the environment, and this is borne out by research. Bodemer and Ploetzner (2002), for instance, integrated different representations of reality within an environment and followed user interaction. Analysis of evaluation of such interactions showed that active integration improved learning significantly, and that structured interaction helped improve comprehension. We therefore designed an induction to the environment that included RoboDemo movies, and sandbox orientation activities that allowed the students to play and experiment in the environment before having to use it for actual learning and assessment purposes in the course proper.

The environment is under constant review, as we take account of student feedback and add and amend features of the environment. Our information about student learning is derived from three sources. The first is end-of-module student feedback, taken from feedback questionnaires, which are reviewed annually. The second is student reflective reports, which are written for a module on Practice Management, and which provide valuable insights into use of the environments within the virtual firms (Barton & Westwood, 2006). The third source is small, intensive project work on student learning (McKellar & Maharg, 2005) which has included the use of user logs and student interviews.

On one level, what we have created is a learning management system (LMS), one that is specifically developed for students who are at the professional stage of legal education. Viewed another way, it is a problem-based learning environment, one that builds an online community of educational interests, and one that is focused on legal transactions. These transactions, and the theory behind them, are the core of the environment, and as illustrations we shall give two case study examples of transactions. The first is an open field transaction, the second much more of a bounded transaction.

Figure 1. Map of Ardcalloch



Case Studies: Personal Injury Negotiation; Private Client

In a sense, Ardcalloch is a type of online community, but quite unlike other online communities in the normal meaning of the phrase. These have been extensively studied by anthropologists and others, such as Sherry Turkle, whose work has demonstrated the power of the Web to create online communities and sustain them from the earliest days of MUDs and

Figure 2. Ardcalloch directory

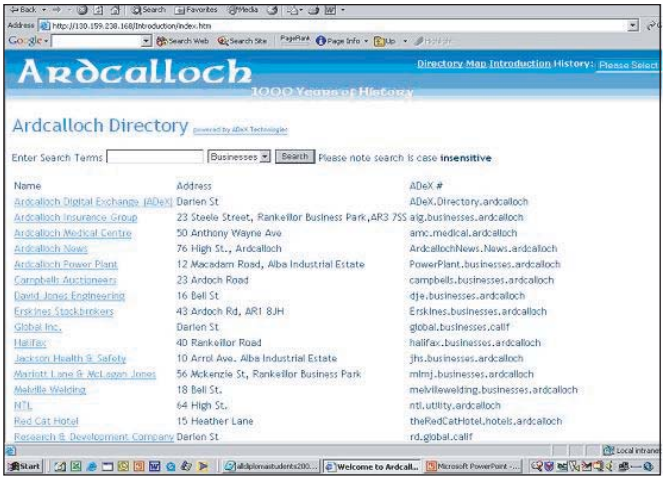
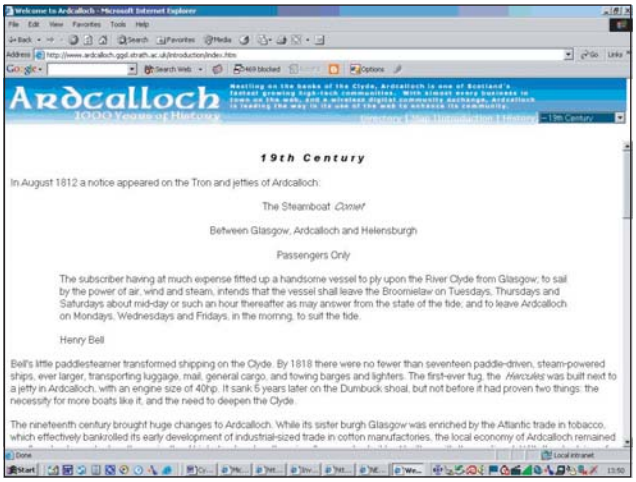


Figure 3. History of Ardcalloch; the drop-down box, top-right, gives access to seven different periods from early medieval origins to the twenty-first century



MOOs (Turkle, 1995). Of course, the power of the interaction that is present in Ardcalloch is very much restricted when compared to that of online games. Real students, playing the part of trainees in their virtual firms, can slip in and out of character quite easily, and the environment is rarely as wholly immersive as, for example MMORPGs such as EverQuest can be to sophisticated users. However, as we shall see from the feedback that they gave us, students were able to learn from the activity of "trying on" or fitting their real self into

Figure 4. Public-facing front page of a student law firm

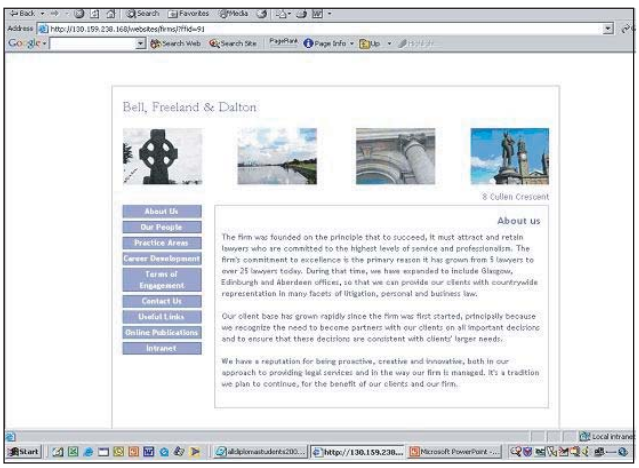
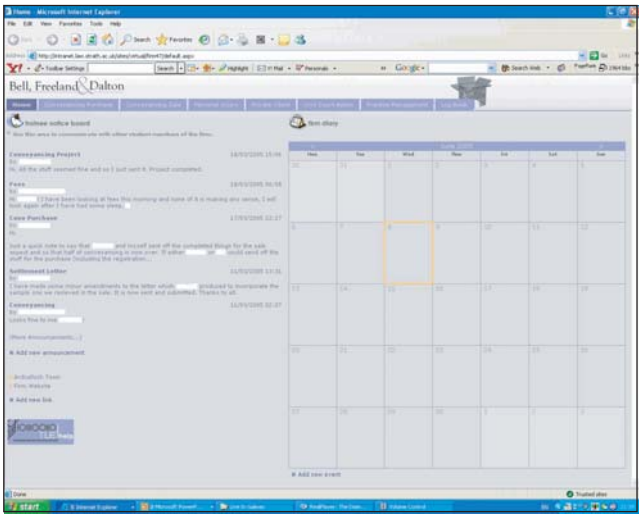


Figure 5. Student firm's intranet home page (with discussion forum — student names removed for privacy); note the tabbed links to transactions below the firm name



their online selves as legal professionals. This, after all, is what many of them are going to do for real in less than a year's time, and we make it clear to them that the period of the Diploma is the time for them to practice simulated roles and transactions, which will be actual in the coming few years.

Personal Injury Negotiation Project (Open Field Transaction)

The first project around which the environment was constructed was the Personal Injury Negotiation project, first implemented in 1999. This had been created three years earlier at another university as a simple e-mail negotiation between teams of students. There were no realia, no virtual community tools, and no Web-based functionality. In 1999 the first sense of an online space given to students was a Web page consisting of photomontage, later developed as a rather crude schematic map with no interactive features. We now run the project with resources that include video interviews with the client, photographs of the locus of the accident, extensive document sets with multiple sets of variables to discourage plagiarism, and a Web-based communications structure that enables students in the virtual firms to contact each other, their opposing law firm, and any institution, business, or citizen in Ardcalloch. Seven postgraduate students and Maharg feed the firms real-time communications, reacting to their queries for information. The students are trained to answer in persona, normally around 10-15 personae per transaction; and Maharg communicates with the postgraduate students *via* a discussion forum on a protected Web page of project resources.

Students are given around nine weeks to achieve a negotiated settlement of a personal injury claim (an employee injured at work). Half of the student firms represent the claimant; half are the insurer's solicitors. Each firm is required to provide four bodies of work to create the transaction: fact gathering and interpretation from Ardcalloch; legal research (online or paper-based, including topics such as contributory negligence and quantum of damages); negotiation strategy; and performance of that strategy. Each firm is assessed on the quality of the complete case file they produce.

The normal academic forms of study and communication are largely absent. Students are given no tutorials; there is no prescribed reading, no office hours for project staff, no formal examination. There is an introductory lecture, a final feedback lecture, and during the course of the project there are voluntary "surgeries," held by a practitioner-tutor, should firms wish to discuss the progress of their file. Static information in the form of an FAQ, archived discussion forums, and transactional guidelines (a week-by-week guide as to what students should be doing on the project) were available to students. All other communication with students is *via* discussion forums (one for each side of the adversarial transaction), from which they obtain information about the dynamic transactions as they developed within the simulation. The forums were thus crucial channels to tutor feedback and feed-forward. They enabled two project coordinators to comment on proposals for action by the students.

We can see this in operation if we briefly analyze the following forum postings. In the first, Sarah is unsure how to form a strategy for obtaining medical information. She sought an answer on the forum, and watching her question were around 130 other students. This is her posting, headed "Medical Records":

We have been discussing the best way to obtain medical evidence of the injury sustained by the claimant. Since the accident resulted in a hospital visit, we feel that the records made by the hospital and the GP at the time of the accident would be relevant. I notice that there has been a lot of prior discussion in past years regarding medical mandates although this seems a very detailed topic. Would it be competent for the client to obtain copies of his medical records and simply pass them onto our firm?

From the point of view of the facilitator (Maharg), this is an interesting posting. Sarah has obviously thought about the issue before posting to the forum. She has scanned the archived forum, and has a sense from them of how she might proceed. She thinks she wants to see the records, but is not entirely sure. She is also aware that obtaining mandates, writing to hospital administrators, and the like takes time and effort and understandably she wants to streamline this process, but in a way that fits with practice. She has arrived at a solution that seems to sever the Gordian knot of information retrieval at a stroke. But she is unsure if this is "competent" on several levels: can one communicate with the client in this way? And are students allowed to do this on the PI project?

Maharg's response was as follows:

This is an interesting point, Sarah. I'll deal with your ingenious solution first. It's doubtful whether the client will be in a position (either from a medical or a legal point of view) to pass on to you the information that you're seeking. He's also liable to wonder why he's pay-

ing you to represent him when he has to visit medics, come away with records, be told that these are not quite what you were looking for, and asked to go back again for more.

If your firm were to ask for medical records from hospital or doctor, the same general point about medical competence would apply. Suppose that the hard-pressed admin staff in Ardcalloch Royal sent you sheaves of your client's medical records. Which are relevant to the accident? And are you going to be able to interpret (or even decipher) medical shorthand, scribbled notes, medical jargon, etc.?

Best to request a medical report; and for that report to be focused on specific points that you want clarified as to the nature and extent of injury, and other related matters. And for that, your doctor or consultant will need your client's mandate. Don't get too involved in it: mandates can be more complicated, but they aren't in this project. Just a simple two-liner will do. Your client will return it, signed, and you can forward to whomever with a letter stating what you want.

The reply addresses the transactional issues and the project issues. The student is given advice as to the procedure to follow, and why practitioners do it this way. She is also, in the last paragraph, given directions as to how realistic the simulation is. In this respect the forum performs an interesting function on the margins of the simulations that take place in Ardcalloch. It mediates between three domains: the wholly simulated world of Ardcalloch, the reality of the Diploma as a program of study, and the reality of personal injury transactional practice. It is also an online space where students can step out of role in the simulation and get advice on what they have done, or are about to do, before they step back into the simulation again. If at first it seems shallow and superficial, the space itself, mediating between three domains of information, knowledge, and professional practice, actually performs a sophisticated educational role.

Moreover the forum follows general guidelines as to good practice, without making this too overt. We have a list of protocols for students, but the unseen protocols were there too. We encouraged students to participate, but if they did not, we assumed they were content with the information on the forum or had consulted previous forums, or had found the information they needed elsewhere, for example in practitioner journals or texts. We were content if the majority of students "lurked" on the forum. Amongst a number of summaries of this aspect of the literature, we could take Klemm's (2002) helpful synopsis, and compare it with our own practice.

Private Client (Bounded Field Transaction)

Private Client is the subject on the Diploma that deals with the winding up of a deceased client's estate, and all matters pertaining, for example, inheritance tax, trusts, and so forth. Hitherto, this subject had been assessed by four brief open-book class exams. However, this method of assessing students was unsatisfactory for three reasons. Foremost was the fact that the form of assessment was an uneasy mix of academic and professional practice. The examinations were in fact drafting activities carried out by the whole student body in an exam hall to ensure that there was no plagiarism and that the same activity was being carried out under the same conditions. The examination form of assessment was therefore

used for specifically functional reasons, not because it was the best form of assessment for the subject. Secondly, students were asked to draft documents under pressure of time and often without access to the style books that they would have had to hand in the office. Finally, the academic examination structure did not produce results that were satisfactory to the practicing lawyers who taught the course. Students could gain as much as 80% and more in an examination, and yet fail the assessment because they might have made an error with the result that, in practice, the document would have been rejected either by a court administrator such as the sheriff-clerk, or by supervisors in traineeship.

For these reasons we decided to design four online assignments. Students would use the online office environment to carry out the tasks as if the work had been passed to them by a Private Client supervisor in the firm, and their tutors would take the role of supervisor in assessing their work. The fiction of the virtual firm would thus mimic the situation they would find themselves in during traineeship, and therefore be a much more appropriate assessment. Students were given two opportunities to pass each of the four assessments. If all assessments were passed the first time, the firm was awarded a merit. If one of the learning outcomes was failed at first attempt, students were given online feedback by the tutor and required to re-submit. Failure at second attempt could lead to withdrawal from the project and to presentation for a subject examination.

Table 3. Comparison of Klemm's protocols with practice on the PI project

Klemm's anti-lurking protocols		Our practice
1.	Require participation—don't let it be optional	Lurking was acceptable to us—the forums, after all, were just one more resource for students. And if students had no questions, and no useful comments, we were happy for them to learn from others.
2.	Form learning teams	Student virtual firms were just that
3.	Make the activity interesting	Feedback from students told us the transaction was interesting and highly relevant. The degree of activity observed supported this.
4.	Don't settle for opinions only	Students asked precise questions and were given precise answers
5.	Structure the activity	Better still—students structured their own activity, based on our guidance (and the forums contributed to that set of guidance)
6.	Require a 'hand-in assignment' (deliverable)	Students required to achieve the negotiated settlement that was the end-point of the transaction.
7.	Know what you are looking for and involve yourself to make it happen	Students were clear about the aims of the forums, and two tutors answered postings on them.
8.	Peer grading	We did not use this nor do we consider it useful, given our students' inexperience in PI transactions. However next year we shall introduce self and peer grading of perceived effort (in terms of quality and quantity of effort).

Students were given instructions, and required to follow the practice that was outlined by practitioner-tutors in face-to-face weekly tutorials that supported student learning in the simulation. There were initial problems with the complexity of the document sets (effectively a different set for each of 70 firms, with variables generated and set within a SQL database structure). However feedback from students in the recent course evaluations demonstrated the effectiveness of the simulation, with at least 70% of last year's respondents agreeing that the simulated transactional assessment had enhanced their learning and was relevant and practical:

- *Assignments were excellent from a practical point of view—I would feel confident enough to complete these tasks in the office now. Our assignments were also returned promptly which was great.*
- *Assignments were a good way of bringing together knowledge obtained at tutorials. It is a practical subject and it makes sense to assess with practical assignments.*
- *Again excellent practice for traineeship.*
- *Realistic and a very reasonable form of assessment.*
- *Provided with good feedback when made mistakes with any of these assignments.*
- *Allowed us to complete them properly the second time around. Good idea that students have an opportunity to correct work as I feel that I learned more and got more from the exercise as a result.*
- *Support and advice was given by the tutor on relevant problem areas of the assignments.*
- *Very good assessments—helped understand work done in tutorials. Very useful.*
- *Good learning tool—feel I learned more doing this than just reading about it.*
- *Each of the assignments was useful as a basis for understanding how an estate would be administered and will prove helpful for practice. They also worked in well with the tutorials and the two complemented each other.*
- *It* [the transaction] *was very useful and practical for future work in a law firm and indeed my personal life. This was by far my favourite course.*

Discussion: Ardcalloch and Scientific Discovery Learning

In terms of the research data on scientific discovery learning, these two case-study projects present an interesting contrast. The PI project is clearly an open-field simulation: students have much more control in determining the quantity of communications, the direction of factual and legal research, and the timing and overall shape of the transaction. The progress of the transaction is much more in their hands. The Private Client transaction, by contrast, is a bounded simulation: strict deadlines are associated with the tasks; sets of learning outcomes underpin each task; and each LO is supported by seminar and tutor-led activities.

Student performance in the PI project demonstrated many of the features of student performance in science discovery learning simulations listed in Table 2. Some firms gathered insufficient information from Ardcalloch for their case file. As one student described it in her reflective report:

Another aspect which should possibly have been covered was to get a second medical report determining the long-term prognosis for [the client] Mr. Graham. As we did not have this, we proceeded on the basis of the first report stating more or less that Mr. Graham almost had full use of his wrist back but still suffered some discomfort. We, as a group, took this to mean that Mr. Graham was suffering very little eight months on from the accident, nonetheless I feel now, reflecting back, we should have requested more information on this area.

Others focused on the wrong sort of information:

With hindsight, the condition of the equipment and the work practices of A&B DIY Ltd were in fact more important than Mr. Graham's actions leading up to the accident. Therefore next time I would insist on an independent engineer's report examining the above aspects.

Others sought to confirm their hypothesis about the accident, rather than critically examining the information they were given from a variety of sources, and from which there emerged factual contradictions that were required to be resolved. Others accepted the information given by their clients uncritically:

There was information that we failed to check (for example, we accepted Mr. Graham's word as regards his level of loss of earnings. This turned out to be false and we should have asked for a copy of his pay slips for the months proceeding and immediately after the accident). In saying this however, I do not feel it hampered our case against A&B DIY LTD as they soon pointed out our mistake as regards to Mr. Graham's pay cheque.

Others learned lessons about the importance of what they did with information they obtained, how they felt about it, and how they represented it to the opposition in a negotiation:

Our lessons for the future are not concerned with increased preparation or a more definite structure, both of which I feel we possessed, although this wasn't necessarily brought out in the negotiation. Instead I believe that confidence played a major role. We were immediately thrown by the opponent's assertions and, as such, we failed to adhere to our plan. While trying to salvage our position we did not question the other side thoroughly enough regarding the substantiation of their claim. In the future constantly seeking justification for the arguments put forward would be a prime aim. It would also be beneficial to set out the facts that can be agreed between us at the outset of the negotiation. We did not possess the confidence to rely on our other information to proceed nor did we have a back up plan in the event of our tactics being rendered useless. As a result we neglected to maintain factors

previously considered to be key to negotiation. Essentially we began to panic and instead of leading we were constantly chasing to regain the initiative.

All of these learner experiences within simulations are represented in the summary of findings under "Design of experiments" in Table 2. A detailed comparison reveals a striking parallel of learning experiences in two very different disciplinary domains, brought together by the similarity in method of learning.

We found that, in our assessment of process, successful firms in the PI Negotiation project were able to identify patterns in the information they had, could assess the value of the information they had, and gaps in the information structure that were required to be filled (Schauble, Glaser, Raghavan, & Reiner, 1991). They all worked systematically—some more than others. But it was not necessarily the case that all firms who achieved good results for their clients were those who were more systematic (e.g., made more "notes to file" during the simulation—see Lavoie & Good, 1988)—there were too many other variables involved in this open field project, including the performance of the other side. However it was always the case that firms who were careless of information and process management achieved poor results (Shute & Glaser, 1990).

The findings of Charney, Reder, and Kusbit (1990)—that goal-setting was problematic for learners with low prior knowledge of the domain of knowledge—may at first glance have been true of the PI Negotiation project. Some firms confirmed that goal setting in this unusual learning environment was problematic:

The beginning of the project was somewhat daunting; I wasn't entirely clear on what we were to do. Nevertheless, I found myself really getting in to and enjoying the project as time went on.

However the predominant problem for most of our students was not one of low prior domain knowledge, as suggested by Charney et al. (1990) in their study. Our postgraduate students all had prior experience of many of the sub-domains of law that contribute to a personal injury transaction—Delict, Tax, and so forth. Rather, a significant number of firms found it problematic to transfer their knowledge of these sub-domains and apply their substantive knowledge within the context of the transaction. They also found it difficult to identify and enact at any particular stage the case management skills and legal knowledge that the project demanded:

The project was a very valuable yet very difficult assignment… The project was difficult for a range of reasons, ranging from ensuring we all met two to three times a week to agreeing the nuances of the settlement. It was complex because not only were you trying to agree with the other side but also within your group and with your client. Thus, for the very reasons the project is difficult, it is inherently valuable.

Comments such as this one demonstrated a version of the findings of Schauble, Klopfer, and Raghavan (1991)—that learners tried to create the outcome they desired in an experi-

ment, rather than attempting to come to an understanding of the scientific experimental model. It might be said that, in wanting our students to be client-centered, and to do their best for their client, we encouraged them to do what Schauble et al. (1991) saw as a fault in learner understanding of scientific process. In this sense the scientific discovery and legal transactional approach to simulation may seem to differ considerably. And yet the difference is not so great as might first appear. After all, our simulation aims to help students come to an understanding of the complexities of the legal transaction, in much the same way as the scientific discovery process is the centre of the research detailed in de Jong and van Joolingen's (1998), and Lee's (1999) meta-analyses. For us, there is an important distance between client-*centered* approaches, and client-*led* approaches to a professional matter, and it is critical that students appreciate this in their project work. Not all did; or if they did, they found it difficulty to operationalize this insight in their relationship with their client.

The findings of the scientific discovery literature regarding information management within simulations matched our own experiences as simulation designers. We found that provision of "just-in-time" information *via* "surgery" meetings with staff and *via* the discussion forums was valuable in helping them to deal with skills-based and knowledge-based deficits (Berry & Broadbent, 1987, confirmed Rieber, 2005). We also discovered that, after the first few weeks of the project, students were unlikely to use the guidelines or the FAQ, unless directed to them by a posting on the discussion forum—in part, validating the findings of Leutner (1993) and Elshout and Veenman (1992).

All firms made use of the communication tools on their virtual firm. Least used was the calendar; most used was the drafts section in which students could store draft communications. Earlier iterations of the virtual office environment did not integrate resources well (Bodemer, 2004), and this was remedied in later iterations. In other projects within the virtual law offices, for example, Conveyancing (where students completed both sale and purchase of land) and the Virtual Court Action (in which they progressed a civil court action for payment of a debt), we provided them with banks of document styles. As ongoing research proves, careful design and integration of such tools are essential to the success of effective student learning. As Ellis, Marcus, and Taylor (2005) point out, "The benefits from case-based learning such as authenticity and active learning can be threatened if issues closely associated with qualitative variation arising from incoherence in the experience are not addressed" (p. 240).

In neither project did we provide learners with a menu or scratchpad (Shute & Glaser, 1990; van Joolingen & de Jong, 1991). Instead, we gave them hints in the PI Negotiation transaction (Rivers & Vockell, 1987), and the Private Client transaction procedure was introduced by stages in tutorials (White & Frederiksen, 1990), with tasks to perform that would increase their understanding of the process of winding up a client's estate. In this latter transaction, learners had tasks to carry out equivalent to the assignments described by de Jong, van Joolingen, Scott, de Hoog, Lapied, and Valent (1994), and students noted that they found this helpful.

As pointed out previously, the literature does show that gains can be made in "qualitative insight" or "intuitive knowledge" in simulation environments (Njoo & de Jong, 1993; Swaak, de Jong, Wouter, & van Joolingen, 2004). At no point did we use simulations specifically to support *recall* of concepts. Simulations were used to enhance knowledge of process, and procedural knowledge and skill (Lewis, Stern, & Linn, 1993; Shute & Glaser, 1990). But—and at a more profound level—the simulations gave students practice in enacting the

value-system of the Scottish legal profession. Even at a simple operational level, this is illustrated by the extract from Sarah's posting to the discussion forum in the PI transaction quoted above; and there are many other more sophisticated examples that arose from the correspondence between firms and fictional characters.

We would agree with Swaak et al. (2004) that "clear benefits" should be communicated to students and that complex domains, sufficient learning time, and freedom for students to explore assignments are necessary to the success of simulations. We would argue, though, that there can be a variety of clear benefits, and that these are not necessarily clear to either staff or students before students start the simulation. What is important is that students understand the reasons why they undertake simulations, and the nature of the simulations, whether bounded or open. Above all, we would claim that regardless of whether the environment is, in our terms, open or bounded there are clear gains in terms of verisimilitude to transactional reality if learners are given the freedom to make errors, receive feedback, and rectify those errors. As Swaak and de Jong (2001) pointed out, freedom to explore can result in gains in intuitive knowledge learning; and when enacted in collaborative environments, such learning extends beyond the boundaries of substantive knowledge of a domain into professional knowledge, skills, attitudes, and values.

E-Simulations in the Wild: A Research Framework

Much of the work on scientific discovery learning in the 1990s was based upon a paradigm of cognitive experimental studies, often involving pre- and post-test research studies under specific and limited conditions. This work focused on the design and use of specific simulation engines within learning domains as diverse as epidemiology, programming, electrical circuits, and control theory in mechanical engineering, and in doing so it provided an essential multi-disciplinary body of research. But e-simulations also need to be studied in the wild, where the context of use is much more complex and multi-factorial. The disciplines that underlie the technical, educational, cultural, workplace, and ethical issues, to name but a few, need to converge to form what Galison (1997) terms a "trading zone." In his use of the anthropological term it denotes the ways in which different scientific communities such as physicists and engineers draw together and form creolized discourses and common languages, in which important concepts can be traded and understood. Interdisciplinary blogs such as Terranova (http://terranova.blogs.com) are one example of such a zone in the study of games and simulations, and how the zone can be a useful resource for e-simulation practitioners and researchers.

Meanwhile there are three areas for research that we would emphasize as being crucial to the design of e-simulation projects within environments such as Ardcalloch, where learning is frequently collaborative, and where it is distributed throughout the curriculum. These are the design of learning outcomes, the effect of the depth of simulation field, and the organization of communities of practice.

Design of Learning Outcomes

The use of outcomes is critical to the design of simulation learning. As Swaak et al. (2004) put it, "[f]or research and practice, this implies that simulations are to be considered only when clear benefits of discovery are expected, and only with complex domains, sufficient learning time and freedom for students in the assignments to engage in discovery" (p.225). But expected by *whom*—simulation designers, teaching staff, students? As Jonassen (2004) has pointed out, the distinction between intention and attention is important here. What designers intend learners to do within or understand from a simulation may not be what learners' attention is focused upon. This is inevitable: complete control of learner attention in any form of learning activity is impossible. Indeed, it is probably antithetical to learning processes, precisely because the designer's desire to control learning leaves little space for learners to construct their own meanings. Learning outcomes are useful in defining clear benefits; but there is a substantial body of education research on the tradition of aims, objectives, and outcomes that reveals that outcomes can also constrain learning within complex simulations and domains (Stenhouse, 1975). As we have seen from the previously discussed case studies, simulations can be open field or bounded. Learning outcomes should be aligned with the activities that learners undertake in the simulation. But they also should be derived from the transactional reality that the simulation enacts. Thus, in the PI project there are no learning outcomes. Instead, students are required to present four bodies of evidence completed to pre-specified standards in fact-gathering, legal research, negotiation strategy, and performance of strategy. The assessment criteria thus match the freedom of movement that learners have in this transaction in the simulation environment. By contrast, in Private Client the learning outcomes are much more specific and precise, directing learners to forms of drafting and writing practices that are essential for this fairly standard legal procedure. We would argue that, given the uncertain nature of the research results indicated in the research table above, both approaches to simulations are valid for learning. Critical factors are the content and procedure of the authentic legal task, the nature of the activities to be undertaken within the simulation, and the complexity of the simulation environment. Much more work is required, though, to map out the relationships of these factors, and this can be achieved by tracking learner activity within actual curricula and investigating the phenomenographical implications of this activity.

Depth of Simulation Field

The metaphor of the field references the type and extent of learner activity within the simulation. But we also need terms to describe how objects or realia are placed within that field, and how they are used by learners. Is everything there of the same importance to learners? Or is there a process of prioritisation of objects and tasks that takes place in the real world that should also be enacted in the simulation world? We therefore need to extend the shallow metaphor of open-bounded field by adding *depth* of simulation field.

The phrase comes of course from visual arts, where depth of field refers to the zone of sharpness of image within a particular field. When there is little depth of field, only the images in the foreground of an image are in focus, and the rest is indistinct. Greater depth of field

allows the viewer to see more detail within the background of the image. Depth of field is critical to photography, because it is one of the focal and compositional elements that can be altered (pre-photography, painters tended to represent all detail in the painting's field as equally distinct).

We can appreciate this if we take an analogy from the field of aesthetics, and in particular the work of Roland Barthes. In describing how a photograph appears to the viewer, Barthes defined the intentional agenda of a photograph as its *studium*—for instance, a group of men wearing suits, with similar pose and attention, standing on several steps outside a hotel, all looking beyond the man in front of them who is speaking at a podium toward an audience. We treat this as the genre of conference photograph, and know it for what it is even before we notice the caption that tells us this is a photograph taken of the G8 summit in Gleneagles, in which Tony Blair gives his closing address in front of the world's leaders to the world's press (Lewis, 2005). The photograph's overt agenda is clear to us from its structure, which is part of its *studium*. But photographs can never completely control the reality beyond the lens. Incidental happenings, odd things creep into the careful structure created by the photographer. Barthes describes this as the *punctum* by which our eye is caught and held: "[a] photograph's *punctum* is that accident which pricks me, but also bruises me, is poignant to me" (Barthes, 1981, p. 27). Thus, to take the example of the photograph described above, from the formal array of figures facing forward there are two exceptions: George Bush stares not straight ahead but to the side, over at the security personnel in the mid-foreground and background, while Jacques Chirac half turns to the person on his left, Vladimir Putin, and looks to be commenting *sotto voce*. Is he really? Did the photographer intend these poses to be caught? Perhaps the most intriguing *punctum* is the small object that floats above Blair's head—is it a microphone, a camera, or a helicopter in the far distance? We cannot be sure. The process of noticing and interpreting leads us to construe the intentions of the photographer, leads us to think about contextual events around the photograph.

For designers of simulations, the problem of depth is less one of navigation and control (though of course these issues are essential for user interaction) and more of what needs to be foregrounded, structured and overt, and what can be left as background, incidental, implicit. The *studium* of a simulation, its depth of detail, needs to be carefully planned. Not everything can be shown in perfect detail. Some elements will be in focus, others out of focus, and some so indistinct that they cannot be clearly discerned at all; and this is an interpretive process that is central to learning simulations. In a real legal case, as in all professional transactions, focus of attention is a constantly shifting lens. Practitioners move between details, between documents, bringing one under scrutiny, then another, querying background information, linking evidence, drawing conclusions, making hypotheses about actions and documents, planning their own actions, and much else. They constantly vary the lens of attention to focus on different objects. It is a mark of a sophisticated simulation environment that instead of giving learners fixed objects in a field, it allows students to vary the amount of information they can acquire and allows them to vary the focus of their attention lens. This requires complex learning objects to be placed within the field, and for tasks to be designed so that students are required to vary attention, make choices, alter focus and distinguish for themselves between the important and the unimportant in a field.

There are many examples one can take of this distinction. In Ardcalloch, photographs attached to streets give a visual sense of place to the town (see Figure 1, bottom left-hand corner).

This is important for the long-term development of the project in a number of ways. First, the town becomes recognizable as a west of Scotland provincial town, perhaps around the size of Ayr, and much smaller than Glasgow (many of the photographs were taken in similar towns such as Port Glasgow, Greenock, Paisley, and were added to the map). Secondly, the map photos help to give a sense of "distributed identity" to the various districts within the town, from leafy upper-middle class suburbs to dockland slums. Thirdly, there is a synergy between environment and student projects. Clearly the environment must support the projects; but it also has the capacity to be more than the backdrop or *studium* for a transaction (Maharg, 2004; Maharg & Paliwala, 2002). Thus photographs of the locus of the accident in the PI project can be treated as background; but if opposing firms ever care to compare their photographs, they discover that they have representations of different staircases, and therefore are required to establish between them the exact location of the accident. Looking beyond law, if the town is to be used by other disciplines within the university and beyond such as architecture, engineering, planning, urban studies, social work, and the like, then the representation of place becomes important also for their students.

The distinction also applies to the design process of the simulation environment. The design of the Web pages in the Ardcalloch directory is an example of s*tudium* and *punctum*. As the number of Web sites grew, it became important to manage their development as mini-projects, and to consider the interface with users of the virtual environment. It was not possible for us to create a generic Web template for our town sites. In reality, commercial and institutional Web site design is really only limited by the funds available, the creative flair and, it might be added, the taste, good and bad, of the designers. It was necessary for us to create sites that gave a presence of a business or an institution to the viewer, without importing into the site all the actual functionality of a real commercial site; and so many of our sites are "brochure" sites. Some have more extensive and complex text than others—in part this is due to the enthusiasm of particular designers, and we were happy to give them relatively free rein on this within a loose framework. After all, if the Web sites in the town all had a similar look and feel, or simply dealt with matters relating to the projects, there would be no sense of realia, of the sheer randomness of reality, about the town.

There are, however, many issues associated with depth of field that require further research. Which tools would enable users to move focus efficiently between objects? How does depth of field affect the design of the simulation and the design of tasks and learning outcomes? How can we match authentic real-world depth of field to transactional contexts? There are deeper issues here, too, of research methodology and language. Depth of field, particularly in longitudinal simulations such as Ardcalloch, can only be studied using a "combination of mixed methods and design research approaches" (Rieber, 2005, p. 551). But is part of the problem that we do not possess a technical vocabulary to discuss the new environment of learning within an e-simulation? In many respects educational terms such as outcomes seem to be ill fitted to a simulation environment where open-field transactions may take place. Such environments are closer to architecture or environmental art; and it may be that as e-simulations become ever richer and more complex we shall require a new critical and aesthetic language to describe the experience of designing, working, and learning within such environments.

Organization of Communities of Practice

A simulation has the potential to be a world entire to itself. While all MMORPGs are sold on the basis of absorbing activities, of being parallel worlds that draw users into them, an educational simulation such as Ardcalloch is much less ambitious as to "flow." However, a parallel urban reality has the ability to draw around it communities of practice, drawn by similar ways of thinking, working, planning, and so forth. All such environments develop associations, habits of thought, and epistemic assumptions that derive from the professions that use it, and the designers who develop it. At least two communities are currently emerging around Ardcalloch:

Law Profession

Law students, practitioner-tutors, and the GGSL design team participate in the learning and assessment of learning that takes place in Ardcalloch. Students are thus surrounded by a community of practice that embodies distinct epistemic norms and assumptions; and it is a key part of the value of the simulations that students use it to learn what constitutes the values, attitudes, and ethics of the professional legal community in Scotland by actively participating in it. As we have seen from the research literature on scientific discovery, "intuitive knowledge" is increased when simulations are used in learning. Simulations can be used in the more complex realm of professional ethical conduct, so that students can begin to internalize the values of the profession.

But simulations can also be used to facilitate identity-change. The Diploma, like the Legal Practice course in England and Wales, is often referred to as a "bridge" program between undergraduate academic study of law and postgraduate legal practice. It is also a structure that helps students to envision not just what they will do but who they will be in the profession. This may seem to be a considerable claim for the efficacy of simulations. But research has shown that for users in simulation video games such as Sony's EverQuest their physical selves have a number of digital identities that they can take up and use as extensions of their selves (Yee, 2005). This is similar to aspects of identity-formation and use within the real world. Social psychology theories of identity within the real world such as symbolic interactionism are highly pertinent to the analysis of avatars as identity-constructs, and as such, of interest to educationalists (Goffman, 1959). In a simulation world such as Ardcalloch, learners can try out professional identities for size, and find which fits best.[2] How can we best enable learners to work within the problems and issues that arise when professional identity is first formed? Which approaches to design best enable identity change, and provide models of professional practice for learners?

Developer and User Communities

There is a growing circle of developers and academics interested in the creation of simulations within higher education. These include e-learning centers such as Futurelab, and staff within GGSL, Worcester University College, RechtenOnline Foundation, University of

Rotterdam Law Faculty, College of Law, and others. The successful implementation of the learning environment depends not just on articulation of surface project procedures, but of approaches to learning at a much deeper level. Moreover, simulation environments such as Ardcalloch cannot function well unless one considers the context of such learning environments. Viewed as an isolated artefact, its use may become problematic. But if it is planned as a piece of social software in which not only learners but designers and tutors too can examine their professional practice and improve it as part of a coherent approach to professional learning, then it becomes a much more powerful and compelling tool for learning. The question, of course, is: How can we enable this change to take place? In this respect the literature of culture change, as well as the hermeneutic and interpretive traditions, and the tradition of action research, which in the UK has been a presence in education since at least the 1970s, has much to offer the e-simulation user and design community (Gadamer, 1975; Stenhouse, 1975).

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Endnotes

1 The first person plural is essential: the simulation environment of Ardcalloch is a collective effort of our academic colleagues in the GGSL, Patricia McKellar and Fiona Westwood, and the Learning Technologies Development Unit, in particular Scott Walker, development officer, and Michael Hughes, applications developer.

2 The simulation environment is also viewed by students with a healthy sense of irony. The sheer number of law firms within the town was the subject of comment in the Ardcalloch News, an online newspaper (written by students), who noted in a weekly column that there were more lawyers than nurses in Ardcalloch, and wondered whether this development was good for society.