SimPharm: Authentic immersion and reading the world as a pharmacist

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Learning to become a pharmacist involves, beyond acquiring knowledge, learning to "read the world" as a pharmacist. This value-laden act highlights what counts as salient for pharmacists and forms the base upon which they make professional decisions. In this paper, we contend that our case-based method, based on an in-house developed computer simulation *SimPharm*, offers a virtual world that can guide students in adopting the shared values of pharmacists. Using data gathered from three sources (pharmacists who had trialed *SimPharm*, postgraduate students who were assessed using this simulation, as well as undergraduate students who had engaged with *SimPharm* in a classroom context), we suggest that *SimPharm*'s virtual world features a level of authenticity that has the potential to enculturate students to interpret the world as pharmacists do.

Keywords: computer simulation, virtual worlds, distance education, pharmacy education

Introduction

The University of Otago's School of Pharmacy has provided the educational underpinning for many pharmacists over the last 45 years (University of Otago, 2009). Adopting a holistic approach to education, this institution aims to develop the knowledge, skills, and behaviours of students in three domains of expertise: quality of medicines, access to medicines, and quality use of medicines. Mastering the latter domain—the skilful use of medicines—has often posed challenges because such skills are best developed with the *experience* of 'doing pharmacy' and not easily learned in a typical university setting. The skilful use of medicines is also steeped in the professional values of pharmacists, the appropriation of which forms a crucial part of becoming a member of that group. In this paper, we adopt the stance of schools as sites for "the production of persons" (Packer & Goicoechea, 2000, p. 235) and emphasise the identity development of pharmacists as an important educational goal.

While the typical transmission-acquisition model of learning may be appropriate for knowledge acquisition, it is a poor match for inculcating professional values in students. In this paper, we contend that our case-based method, based on an in-house developed computer simulation *SimPharm*, offers a virtual world where students—through the surrogate experience of 'doing pharmacy'—are guided to adopt the shared values of pharmacists. These shared values (e.g., minimizing avoidable harm) fundamentally guide decision making and the way we "read the world". We first describe *SimPharm* and address the link between becoming a member of the community of pharmacists and making sense of the world *as* such a member. We then report our evaluation methodology and early results, concluding with a discussion on directions for further work.

SimPharm

Interest in using simulations for learning has surged in recent years (Aldrich, 2005) and we aspire for *SimPharm* to join the ranks of simulations used for medical education. Other healthcare-related simulations used in recent years include *SimHealth*, a computer game on public healthcare policy creation as featured in Prensky (2001). Shaffer (2006) also presented *The Pandora Project* where players take on the identities of mediators managing a new biomedical breakthrough. Specifically in pharmacy education, Seybert *et al.* (2006, 2008) used mannequins to teach performance-based pharmacotherapeutics. The use of mannequins with detectable breathing and pulse provided more realism, but was not efficient: a human facilitator was required to manually change the mannequin's physiological parameters. Another example involved a computer simulation of a patient with open-angle glaucoma used in a pharmacotherapeutics course (Kinkade, Mathews, Draugalis, & Erstad, 1995). This program, however, concentrated solely on drugs prescription and was mainly driven by system-generated questions that students answered.

While the rationale for using simulations is well-accepted in the health care sector, their adoption has been slower than in other high-risk professions such as aviation and the military (Ziv, Wolpe, Small, & Glick, 2003). A review of technology use in pharmacy education (Zarotsky & Jaresko, 2000) found that much of the work with simulation focused on specific aspects of pharmacy, notably pharmacokinetics (Bolger, 1995). This is due in part to the relative ease in simulating more deterministic processes in well-defined systems. Biological systems are not currently understood to the same level of detail as aviation, for example. Simulating biological systems, characterised by stochastic processes, was hence a key challenge in infusing *SimPharm* with a higher degree of authenticity. *SimPharm* simulates biological systems at the level of observable phenomena (using rules), not at the level of the underlying physiological mechanisms.

SimPharm is a web-based simulation platform that features a time-sensitive, persistent world where students take on the role of hospital clinical pharmacists and are tasked to provide pharmaceutical care to their patients. Each episode in the simulation is based on a long case (a dynamic case contextualised within a patient care scenario). Replicating the professional practices of actual pharmacists working in hospitals, *SimPharm* allows learners to ask specific questions of their patients, to order laboratory tests, to recommend new medicines or prescribe different doses, and to live through the consequences of their actions as pharmacists. These consequences are defined (by the case developer) as a collection of rules that specify the effects of actions. These rules prescribe the effects of drugs on underlying metabolic conditions. For example, prescribing a certain drug *may* lead to increased blood pressure (which, in turn, will affect the laboratory test results). We use the term "may" to allow for stochastic elements that can be brought to bear. The rules also define specific responses: a certain drug may lead to a change in the patient's condition which may be displayed as a complaint from the patient (Figure 1) or a note from the nurse or doctor. These rules can have probabilities (set by the case developer): a given consequence will only occur some percentage of the time. The probability of these events will also be affected by other concurrent events.

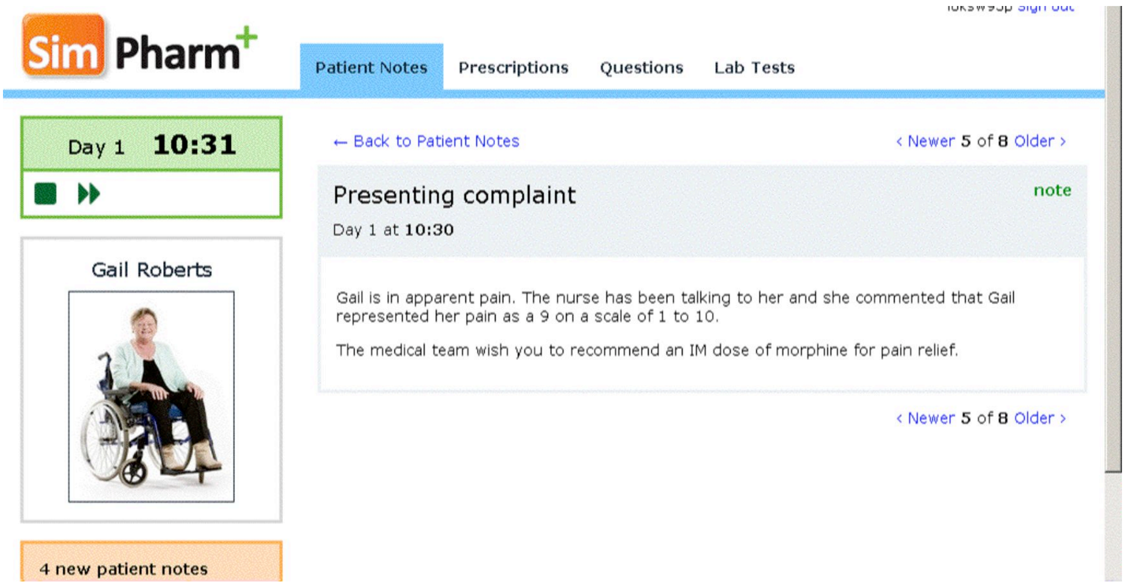

Figure 1: Gail presenting complaint on Day 1 (10h31)

To augment the authenticity of the student experience, a pharmacist who is currently working in a hospital co-authors the long cases with faculty members. Artefacts from daily practice (e.g., medication charts) are also featured to increase the fidelity to the thinking required in real-life settings (Olsen, 2006). *SimPharm* operates over a long time scale (i.e., days) and students are expected to interact with it for several short periods each day in order to simulate a typical clinical experience. All the students' choices and the consequent patient outcomes are recorded in a log file that may be reviewed and discussed between tutor and students after the in-simulation experience.

SimPharm was designed to support pharmacy education in general and we will focus on the course entitled *Advanced Clinical Pharmacy* in this paper. This professional postgraduate course is a distance-taught course and a compulsory segment of the Masters course work in the Professional Postgraduate Programme. *SimPharm* addresses the following learning objectives of the course:

1. To have an independent and advanced approach to problem solving; and
2. To have an advanced understanding of clinical decision-making for patients with multiple pathologies and in specialised medical populations, within typical resource constraints.

We now briefly describe a possible episode in the simulation. A 2-minute video clip of this episode is available at http://unitube.otago.ac.nz/view?m=blDwdC7jSk. Having fallen over at home, Mrs. Gail Roberts enters complaining about a severe pain around her hip. The medical team asks for the student's recommendation of a dose of morphine (Figure 1). The student, after gathering the necessary information (e.g., via her medical history, by asking questions), recommends a dose of 8mg of morphine intramuscular injection every 6 hours (Figure 2).

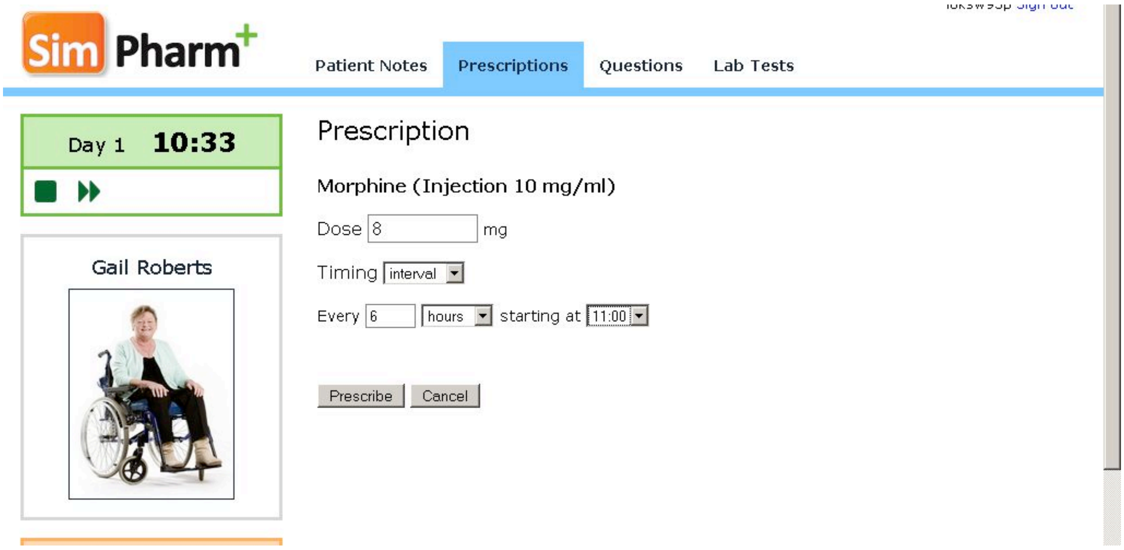

Figure 2: Student prescribing morphine to Gail (10h33)

Beyond recommending the correct medicines (over all the other alternatives), the student also needs to identify the optimal dose, route, and frequency of administration based on patient- and drug-specific data. If deemed necessary, the student can order a range of laboratory tests (e.g., O_2 saturation, renal function tests). Judging that nothing else is needed, the student logs out. Six hours later (real world time), the students logs in to check on Gail and finds out that the patient had unexpectedly experienced mild respiratory depression (possibly a side effect of the morphine dose) while the student was logged out.

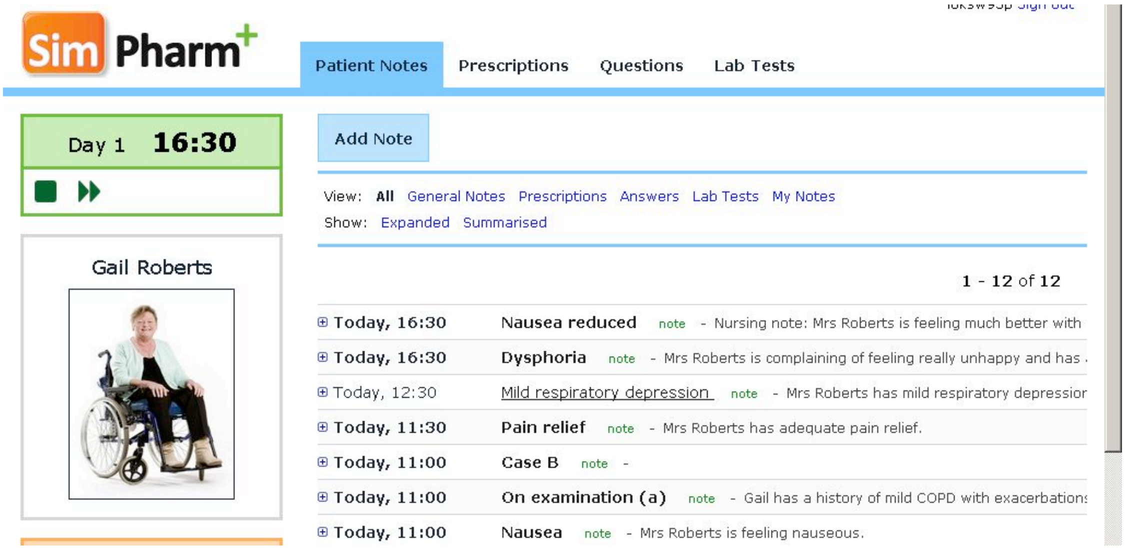

Figure 3: Gail reacting to morphine dose prescribed (16h30)

Based on the assessment of the patient's progress (via patient feedback and laboratory tests), students are expected to re-evaluate the situation to take further actions (if any). In general, pharmacists do not have prescribing rights and allowing or requiring the student to "prescribe" the drug may hence seem unrealistic. However, we encourage the students to think about the prescription as being a recommendation that has been accepted by the medical staff and hence the reality in *SimPharm* revolves around the 100% acceptance of all recommended prescription changes. This is aimed at allowing students to explore options and live through the consequences of their decisions. We further elaborate on this point in the "Results" section.

Becoming a pharmacist

A range of non-academic books defining profession-specific ways of thinking reveal how some authors believe that professionals are distinctive persons by virtue of the lens through which they view and interpret the world. This interpretation of the world is value-laden: the values of a person influence what they regard as important. Moving away from dictating lines of code and recipes to follow, Downet (*How to think like a computer scientist*, 2009) and celebrity chef Colicchio (*Think like a chef*, 2000) concentrate on the distinctive ways in which they *look at* the world and draw upon those lenses repeatedly to help readers develop into creative computer scientists and chefs in-the-making. In *How to read Literature like a professor*, Foster (2003) aspires to have readers see literary texts through the very symbols and patterns with which English professors do their everyday work.

Shaffer's (2006) scholarly work in digital game-based learning rests on a similar premise: that each profession looks at the world in distinctive ways using their own "epistemic frames" (p. 12), a term which he defines as "collections of skills, knowledge, identities, values, and epistemology that professionals use to think in innovative ways" (p. 12). In our work, we believe that learning to adopt the epistemic frame of pharmacists is a crucial part of becoming a pharmacist. One of the outcomes of matching the epistemic frame of pharmacists would be the ability to make sense of and interpret the world *as* pharmacists. We believe that developing students' ability to "read the world" as pharmacists, a value-laden act, should be an important educational goal.

"Reading the world" *as* a pharmacist

We conceive "reading the world" as a value-laden act because it essentially involves selecting which elements are salient for us. Looking at the same phenomenon of a volcanic eruption, what stands out for a geographer is probably different from what counts as important for an artist. The need to focus on salient features has a physiological basis: the information perceived cannot all be dealt with due to the inhomogeneity of our retina (Findlay & Gilchrist, 2003) among other factors. Literally and figuratively, we never see everything (with equal acuity) all the time, but are guided by what we *value* in each context.

The world is polysemic and open to multiple interpretations. Gee (2005) contends that the choice to interpret the world in a particular way (rather than others) is guided by the social practices of individuals, or in his words, our "Discourse models" (p. 68). These "ways of being "people like us"" (Gee, 2008a, p. 3) guide our choices and encourage us to read and think in certain ways, helping us foreground some things and background others in view of the social role we are playing (Gee, 2007). In a similar vein, Fish (1980) coined the term "interpretive communities" (p. 14) to describe groups of individuals who produce meanings using shared interpretive strategies, who "read the world" in similar ways. We would argue that becoming a member of an "interpretive community" is an important part of becoming a pharmacist, and that helping students understand and produce the "shared social meanings" (Barker, 2008, p. 7) of this professional group should feature as a worthwhile educational goal. It has also been argued that participating or partaking in the practice of a profession (e.g., via simulation) is a compelling way to learn these interpretive strategies (Shaffer, 2006).

Similarly, the virtual worlds in many computer games and simulations (notably role-playing ones) are polysemic and open-ended. They are "designed problem spaces" (Gee, 2008b, p. 26) that are meaningless until players interpret and act on them in certain ways, making them very powerful in inviting students to make their *own* meaning of their virtual experiences. Essentially, computer games and simulations need players to 'complete' them, giving students the joint responsibility of co-constructing meaning (Fish, 1980). All interpretations are, of course, not valid under all circumstances. Within the virtual world of *SimPharm*, the nature of the tasks, player's role, limited resources, and other characters will serve to nudge students to look at and act on the world in preferred ways.

We hence conceive learning with games and simulations very much as learning through "guided participation" (Rogoff, 2003, p. 283): novices typically learn a cultural practice (pharmaceutical care, in our case) by partaking in the very practice they want to learn, all the while being guided by a mentor, other fellow members, and other cultural resources at hand (e.g., laboratory test results). It is through such engagement in a social practice that learners become fuller members of their communities of practice (Lave & Wenger, 1991). The guidance offered by the environment must be realistic for the preferred development to take place. It is hence to the authenticity of *SimPharm*'s virtual world that we now turn.

Authenticity

The authenticity of *SimPharm*'s virtual world is all the more important if one believes that cognition is situated, that learning is inseparable from the activity in which it is meant to be used (Brown, Collins, & Duguid, 1989). In our work, we adopt the stance that meaning-making by the students is situated within *SimPharm*'s virtual world. The authenticity of the role to be taken on, the problems to be solved, and the resources available will directly affect the meaning that students can draw from their in-simulation experience.

There have been many attempts to define what constitutes an authentic learning activity. Following a wide literature review, Herrington, Oliver, and Reeves (2003) proposed ten characteristics of authentic activities, four of which were selected to guide the evaluation of *SimPharm*:

1. Authentic activities are ill-defined (open to multiple interpretations and requiring creative application of knowledge and skills);
2. Authentic activities allow for competing solutions and diverse outcomes (no single and obvious correct answer);
3. Authentic activities have real world relevance and realism; and
4. Authentic activities require students to detect relevant/salient from irrelevant information.

The choice of these four criteria was based on the characteristics of our proposed learning environment (case method supported by a computer simulation) and on what was realistically measurable given our constraints.

Methodology

We staggered the evaluation of the *SimPharm* learning environment in three stages:

1. We first conducted a beta-test involving four practising pharmacists during which they each tried one or two cases in *SimPharm* over several days, completed a questionnaire, and shared their views during an interview (attended by two of the four participants). In this paper, we solely report our findings pertaining to criteria 1 to 3 of authentic activities based on the questionnaire and interview;
2. Postgraduate students enrolled in *Advanced Clinical Pharmacy* were assessed using *SimPharm* and then invited to complete an end-of-course questionnaire. For this course, a long case was run over five days (time in this case was measured local to the case). The students were encouraged to access the case twice daily for 20-30 minutes per time. During access times, students solved problems and made clinical decisions. Tutors assessed these postgraduate students by referring to the log that recorded the students' actions and their reasoning (free text notes). After the course, the students completed a questionnaire which included the evaluation of the authenticity of the simulation based on criteria 1 to 3. Having had real-world working experiences as pharmacists, these students were suitable candidates to provide feedback on the authenticity of the *SimPharm* virtual world vis-à-vis their daily working environment (compared with undergraduate students, for example). Of the four postgraduate students, only two submitted replies. This preliminary study is limited by virtue of its sample size. Nevertheless, the level of convergence between all the participants surveyed gave us some confidence in the value of reporting our results here; and
3. 20 undergraduate students were invited to participate in a randomised cross-over study comparing a dynamic case method (enabled by *SimPharm*) and a typical static case method. Each fourth-year student was randomly assigned either to the static-dynamic (i.e., static case first, then dynamic case) or dynamic-static sequence (10 students in each sequence). Every student experienced both case methods at the end of the two sessions (which were spaced out with an interval of four days). The data collected included student responses from post-class questionnaires and audio recordings of both the classroom discourse and post-class focus group interviews. In this paper, we solely report our findings

regarding criterion 4 based on student responses to two questions in the questionnaires and their views gathered during the focus group interviews.

Results

Criteria 1 and 2: Authentic activities are ill-defined and allow for competing solutions and diverse outcomes

The first aspect of authenticity, the open-endedness of *SimPharm* (corresponding to criteria 1 and 2 described in the section on "Authenticity"), draws on questions related to the complexity of the problems posed and the possibility of diverse solutions.

Table 1: Responses regarding open-endedness of *SimPharm*

<table>
<tr><td colspan="6">Practising pharmacists (N = 4)</td></tr>
<tr><td></td><td colspan="2">Yes</td><td colspan="3">No</td></tr>
<tr><td>The problems in SimPharm are complex and require the creative application of my pharmaceutical knowledge & skills.</td><td colspan="2">4</td><td colspan="3">0</td></tr>
<tr><td>The cases in SimPharm allow for competing solutions & diverse outcomes.</td><td colspan="2">3</td><td colspan="3">1</td></tr>
<tr><td colspan="6">Postgraduate students (N = 2)</td></tr>
<tr><td></td><td>1 (Very much so)</td><td>2</td><td>3</td><td>4</td><td>5 (Not at all)</td></tr>
<tr><td>The problems in SimPharm were complex & required the creative application of my pharmaceutical knowledge & skills.</td><td>1</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>The cases in SimPharm allowed for competing & diverse solutions.</td><td></td><td>2</td><td></td><td></td><td></td></tr>
<tr><td>Was the long case thought provoking?</td><td></td><td>2</td><td></td><td></td><td></td></tr>
</table>

Besides one practising pharmacist (who later clarified that she was uncertain because she had not had the chance to retry the case and that she would believe that different people making different choices would lead to different outcomes in the simulation), all the respondents gave positive scores for all related questions. This view was supported by one of the pharmacists (beta-testing phase) who, in comparing *SimPharm* and daily work, mentioned that the long case "requires the *same* initial problem solving on admission, including medicines reconciliation", reinforcing the view that the open-endedness in *SimPharm*'s virtual world was similar to that in a real world hospital. In fact, the two pharmacists interviewed felt that the tasks in the simulation were even more open-ended than their daily work:

> I felt that it required more diagnosis and problem solving than would usually be required from a clinical pharmacist. But it was good in the sense that I couldn't hide behind "recommendations".

Both pharmacists felt that their everyday work was more "charted" and "passive" and that the slight increase in responsibility given in *SimPharm* was both a benefit for pharmacy students learning to solve problems in a simulated setting and an inevitable design feature. In a way, *SimPharm* extends the role of the pharmacist (e.g., by allowing students to "prescribe" and not merely recommend), affording more personal agency to the student so that the latter has full control over the wide range of actions available within a low-risk environment. In this case, a stricter adherence to the roles and responsibilities of a real-world pharmacist would have compromised on the student's ability to learn through experimentation.

Criterion 3: Authentic activities have real world relevance and realism

The second aspect of authenticity, the real world realism of *SimPharm* (corresponding to criterion 3), draws on questions comparing this simulation's problems, case details, and range of options available with that of the real world.

Respondents gave disparate scores for this criterion. It was unfortunate that none of them gave more details in their free-text comments and that we did not have further opportunity to clarify the scores with them (e.g., the two pharmacists who gave negative scores were unable to join the post-trial interview). One of our hypotheses lies in the nature of their jobs: the two pharmacists who submitted negative scores

Table 2: Responses regarding realism of *SimPharm*

<table>
<tr><td colspan="6">Practising pharmacists (N = 4)</td></tr>
<tr><td></td><td colspan="2">Yes</td><td colspan="3">No</td></tr>
<tr><td>The problems in SimPharm are similar to the ones I encounter at my workplace.</td><td colspan="2">2</td><td colspan="3">2</td></tr>
<tr><td>The options in SimPharm (e.g. prescriptions, lab tests) are similar to the type and range available at my workplace.</td><td colspan="2">4</td><td colspan="3">0</td></tr>
<tr><td>The case details (i.e. patient outcomes, answers, & test results) in SimPharm are accurate and as I had expected.</td><td colspan="2">3</td><td colspan="3">1</td></tr>
<tr><td colspan="6">Postgraduate students (N = 2)</td></tr>
<tr><td></td><td>1 (Very much so)</td><td>2</td><td>3</td><td>4</td><td>5 (Not at all)</td></tr>
<tr><td>The problems in SimPharm were similar to the ones I encounter at my workplace.</td><td></td><td>1</td><td></td><td>1</td><td></td></tr>
<tr><td>The options in SimPharm were similar to the type and range available at my workplace.</td><td>1</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td>The case details in SimPharm were realistic and as I expected.</td><td>1</td><td></td><td></td><td>1</td><td></td></tr>
</table>

worked in other roles (namely, drug information pharmacist and advanced clinical pharmacist) besides that of the hospital clinical pharmacist portrayed in *SimPharm*. Although the undergraduate students were not surveyed regarding this simulation's realism, at least three of them expressed (via free text comments and focus group interviews) that the role they played in *SimPharm* was more closely related to the hospital clinical pharmacist (than the community pharmacist, for instance).

Criterion 4: Authentic activities require students to detect relevant from irrelevant information

The fourth aspect of authenticity, the need to pick out salient elements of the case independently (corresponding to criterion 4), draws on the following two questions.

Table 3: Responses regarding the need to detect relevant information

Undergraduate students (N = 18)			
	Mean	Mode	Median
I had to identify the important features of the case myself.	1.44 (1 signifying "Very much so")	1	1
I had to interpret the important features of the case myself.	1.56	1	1

All the undergraduate students—besides one—gave a score of either "1" or "2" for both questions, suggesting that *SimPharm* offered the students a high level of interpretive freedom in order to solve a case. During the focus group interview, one student considered the need to frame the problem herself as an indication of the simulation's authenticity:

> When it's written on paper, it's very much spelled out, what's wrong with them. Whereas when you've got the computer program, you have to kind of search for the problems which is probably more realistic. I mean, you're not going to get a person come in and say "I've got elevated liver enzymes".

Another student added that they had to spot the complicating factor via the various actions they could take (e.g., laboratory tests):

> In this one, you had to look for the factor that was going to complicate the morphine dosing but then when you decided what to do, then there'd be consequences from that and then you had to work through those, so it keeps extending a little bit more.

We believe that this degree of interpretive freedom gives learners the chance to make their own meaning of their in-simulation experience.

Time sensitivity

One aspect of authenticity that did not feature in Herrington *et al.* (2003) but that is specific to *SimPharm* is time-sensitivity. For *Advanced Clinical Pharmacy*, for example, the students ran the simulation in real world time (i.e., one minute in the simulation equals one minute in the real world): hence, patient outcomes, laboratory test results, and the effects of the medicines were all timed and triggered accordingly and the students had to log into *SimPharm* periodically throughout the five days as if they were working in a hospital. We measured this quality via the following question.

Table 4: Responses regarding time-sensitivity of *SimPharm*

Practising pharmacists (N = 4)					
	Yes		No		
The time-sensitivity of *SimPharm* made the tasks more authentic.	3		1		
Postgraduate students (N = 2)					
	1 (Very much so)	2	3	4	5 (Not at all)
The time-sensitivity of *SimPharm* made the tasks more authentic.		1	1		

Respondents gave mostly positive scores in relation to the persistence of the *SimPharm* virtual world. During the post-trial interview, one of the pharmacists did highlight *SimPharm*'s time-sensitivity as an important factor contributing to its authenticity:

> Realistically it's the same as if you were at work (…) you'd think "oh I guess I won't be going up this afternoon, nothing will happen" (…) and you get back the next day and hell has broken loose and no one has called you in when they should have.

One commercially-available simulation that shares this characteristic is the 1997 *Tamagotchi*, a 'cyber-pet' that lives within a small, portable LCD screen and that needs to be taken care of *constantly*. Turkle (2007) reported that such virtual entities exhibited behaviours that had the potential to have people believe in their sentience and emotional reciprocity. Some children were even reported to have described their virtual pet as being alive and to have developed a relationship with it.

Suspension of belief

While we did not intend to measure the degree of suspension of belief (which Herrington *et al.* believed to be an indication of authenticity), during the beta-testing phase, the two pharmacists did express that they had felt "anxious" and "nervous" during the times when they were not logged into *SimPharm* and one of them declared of having "definitely bought into it". These are all indications that give us the confidence that *SimPharm* does provide the appropriate and authentic guidance for students to learn how to "read the world" as pharmacists.

Conclusions

In *To kill a mockingbird*, Harper Lee (1960) wrote that "(y)ou never really understand a person until you consider things from his point of view (…) until you climb inside of his skin and walk around in it" (p. 35). It is this specific and almost visceral kind of understanding that we are attempting to develop in our students. As Rogers (1995) so eloquently argued:

> Knowledge about is not the most important thing in the behavioural sciences today. There is a decided surge of experiential knowing, or knowing at a gut level (…) At this level of knowing, we are in a realm where we are not simply talking of cognitive and intellectual learnings (…) Instead we are speaking of something more experiential, something having to do with the whole person, visceral reactions and feelings as well as thoughts and words. (p. 6)

Arguing for game-based learning, Gee (2007) similarly highlighted that such situated and immersive learning environments are more appropriate for developing intuitive or tacit knowledge (rather than verbal knowledge). We are exploring how students *become* pharmacists more holistically by partaking in the appropriate cultural practice, by walking around in a pharmacist's skin within an authentic (albeit simulated) environment.

In this paper, we have presented early evidence that *SimPharm*'s virtual world features a level of authenticity that has the potential to enculturate students to "read the world" as pharmacists do, notably in terms of the open-endedness of its problems, the need to pick out salient elements in its cases, and its time-sensitivity. We believe that appropriating such interpretive strategies constitutes a significant part of becoming a member of that community. And we are convinced that having students partake in such cultural practices (notably within computer simulations which can be deployed on a massive scale) is a promising way to learn such interpretive strategies.

We will continue to seek more clarification regarding the real-world realism of *SimPharm*. Also, we are in the midst of analysing the audio recordings of both the classroom discourse and focus group interviews from the cross-over study. Preliminary discourse analyses point to some differences in the ways the students conceptualised what "patients" are and what "learning" is in both settings (i.e., static and dynamic case methods).

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