Transforming Professional Healthcare Narratives into Structured Game-Informed-Learning Activities

by Michael Begg, Rachel Ellaway, David Dewhurst, and Hamish Macleod

A cornerstone of professional education is the practicum, "a setting designed for the task of learning a practice. In a context that approximates a practice world, students learn. . . by undertaking projects that simulate and simplify practice; or they take on real-world projects under close supervision" (Schön 1987, 37). In the healthcare professions, one of the ways the practicum is reified is in the form of internship programs in which students gain real-life clinical experience through structured interactions with doctors and their patients. However, student clinical experience has become ever more problematic for numerous reasons. Advances in clinical techniques and therapies have led to less invasive procedures, leading in turn to a significant reduction in the time spent by patients in the hospital. In addition, many countries are introducing directives limiting physicians' traditionally long working hours, and this—along with growing concerns over the liabilities associated with allowing unlicensed (and therefore less accountable) students in the clinical workplace—is exacerbating the problem further. Moreover, in light of widespread requirements for more assured core skills and experiences on the part of healthcare workers, even the traditional approach to internships can leave too many holes in an individual's education (General Medical Council 2003). These various factors result in a dichotomy whereby the healthcare practicum is increasingly problematic in real hospital settings even as greater numbers of fully qualified healthcare workers are needed.

As student access to real clinical experience becomes increasingly difficult, the use of virtual patients (VP) has been shown to provide a valid and effective alternative (Pickell et al. 1986; Ellaway 2004; Zary et al. 2006). A virtual patient is "an interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education, or assessment" (Ellaway et al. 2006, 2). While many traditional educational artifacts—paper cases, full or partial mannequin simulations, or even live actors simulating patient encounters—are similar to virtual patients in their basic function, the use of computer-simulated virtual patients has posed a challenge with regard to establishing effective standards for their scalable implementation across diverse learning environments (Ellaway 2004). In turn, this challenge becomes all the more pronounced insofar as the embodied experience of professional practice cannot be reproduced online in anything like its full sensorial richness.

The question, then, is how does a limited medium such as the personal computer adequately support valid and effective practice-based learning? In this article we outline and describe the approach to VP case authoring at the University of Edinburgh, and we submit that harnessing professional narratives with VP technology in game-informed activities (cf. Begg, Dewhurst, and MacLeod 2005) can address, to a significant extent, the otherwise limited ability to reproduce practice settings online.

Virtual Patients in the Medical Curriculum

In order to gain a fuller sense of both the challenges and opportunies afforded by computer-mediated VP systems, it would be useful to consider them in the context of Benjamin Bloom's taxonomy of learning activities (1984), which proposes that the human cognitive domain can be divided into six levels. The model begins with low-level thinking (knowledge—including activities such as defining, labelling, and memorizing), then moves through intermediate levels of thinking (comprehension, application, and analysis), and finally progresses to more abstract areas of high-level thinking (synthesis and evaluation—including activities such as managing, organizing, choosing, comparing, predicting, and evaluating). Ideally, a well-designed VP system would need to elicit and support as wide a range of cognitive activities as it can in order to be sufficiently effective as a learning tool in the healthcare practicum.

In light of this ideal standard, however, the evolution of VP technology still remains relatively modest in its scope. While the development and use of virtual patients is not in itself new (Gerritsma and Small 1988; Verbeek 1987), the narratives that accompany many current VP scenarios and computer-assisted learning (CAL) sequences remain simple and linear in comparison with the complexity of the everyday clinical environment; in some instances, the content of such narratives is limited solely to clinical data. This abstraction from real-world practice, while providing a degree of formality, tends to distance students from applying (and thereby synthesizing) the information they acquire within clinical practice. These heavily directed VPs offer the student little room for personal exploration, demanding only that correct choices be made and responses echo the model answers provided. In terms of Bloom's taxonomy, the competence being tested within VP structures is, typically, little higher than knowledge.

These limitations may be partially illustrated in the case of one system currently in use at our own institution. During the first few years of the new millennium we developed the Edinburgh Reusable Object Sequencer (EROS) at the University of Edinburgh as a way of providing (among other uses) Web-based authoring and delivery of the kind of linear cases outlined above (Begg, Dewhurst, and MacLeod 2005). Although EROS has proved very successful as a way of getting otherwise skeptical faculty to experiment with, and in many cases adopt, e-learning content generation as part of their approach to teaching, it has a number of fundamental limitations:

- EROS activities are essentially linear with no branching or variation in how they are presented. Although a form of branching can be created by manually linking a number of EROS activities, there is no tracking or association between them. Thus there is no consequence associated with actions or explorability afforded to the student.
- To support its relatively inexperienced user community, EROS employs tightly defined page templates that give little control over how content is organized. Consequently, there is little flexibility in designing the student experience, and all EROS activities are rather similar.
- EROS has only one state marker (a "score" counter) that increments up from zero depending on how well the student answers particular questions. There is no relationship between this marker and how the activity proceeds. Multiple state markers (such as "health," "wealth," or "time") cannot be employed, and more importantly there is no consequence of state markers reaching certain critical values ("health" reaching zero, for instance).
- A final point, although of less immediate relevance to developing and delivering virtual patients, is that EROS has low system abstraction, which means that it cannot easily be delivered in different modes (Web, paper, mobile device) and it cannot easily be webserviced (for instance to allow for remote client connections).

Some of these limitations may be illustrated in selected portions of the EROS interface, which display the linear structure of its activities, the lack of continuity between its activities, and the further constraints of the system with regard to its fixed templates and its scoring function (Exhibit 1). Despite such constraints, the EROS delivery model continues to prove popular with students, whose requests for more CAL sequences persistently feature highly in course evaluation responses. Over time, however, we would expect (and encourage) students to develop and apply a higher degree of cognitive abstraction in their learning. This is the direction that the student needs to go to develop appropriate professionalism to be fit for practice.

The Labyrinth System

The Labyrinth system was developed by the University of Edinburgh's Learning Technology Section as a means of shifting the emphasis of case-based VP scenarios towards allowing the learner to steer the case—thereby moving the learner up through Bloom's taxonomy towards a more self-directed approach. The system was designed to allow greater agency to users, who would consequently become more reflective, confident, and able to move into real-world practice.

To achieve this goal the Labyrinth environment essentially allows Web-based authoring and delivery of branching case scenarios. Each step within a Labyrinth case provides a series of choices, and rather than just being told that the option selected is right or wrong, learners are presented with new choices reflecting the possible consequences of what they have decided to do. In addition to the core navigational structure, a series of supporting feedback mechanisms such as path tracking, session recording, dynamic information hints, multiple scoring paradigms, and countdown timers have also been developed (Exhibit 2).

Labyrinth allows for branching, decision-dependent emergent narratives to be designed and implemented. For example, in a module concerned with clinical admissions, students may enter into a scenario in which they are given the role of head of a hospital admissions unit at the start of a weekend shift (Exhibit 3). Students read a basic introduction text to orient them within the scenario, and then they are asked to make a decision as to what to do next: consult with the registrar, establish what resources are available, approach a patient, or make a cup of tea. Clearly, some choices from this array would be more appropriate than others. The critical point is that no matter what choice the student makes, the narrative continues unbroken. Electing "to make a cup of tea" will result in a text message indicating that this attitude may appear questionable and results in the registrar looking disapproving. At that point the student will then be provided further choices; the system asks whether the student would now like to consult with the registrar, approach a patient, or establish what resources are available. Similarly, in another scenario in which the student performs as a community general practitioner (GP) on call, a situation is presented in which the GP receives a telephone call at 8:30 in the evening from the mother of a baby, concerned that her child is not settling and has a persistent cough (Exhibit 4). The GP is asked to decide whether to go and see the child immediately, call an ambulance, ask the mother to bring in the child for surgery, ask the mother to phone back in the morning, or review the case again in the morning. Again, each choice comes with its own consequences, and these consequences inform the subsequent narrative chain of events.

Through these and other components of its design, Labyrinth integrates several key principles in terms of game-informed learning:

- *Character role*: The player-as-protagonist component is one of the fundamental foundations of effective game design (Ryan 1997). In Labyrinth, the cases present narrative scenarios in which the learner is required to perform the role of a protagonist—typically a healthcare professional.
- *Scoring*: In turn, effective game design also requires a consistent means for particpants to assess their progress and strive for greater levels of achievement (Malone 1981). In Labyrinth, both immediate and summative feedback mechanisms can be included in the form of point scores, money credits, competence and confidence ratings, or other measurements.
- *Emergent narrative*: Murray's (1997) description of emergent narrative suggests that it is a form defined by interaction. The progress of the story in Labyrinth is, as much as possible, defined by the choices that the learner makes.
- *The responsive environment*: In a well-designed game the learner will reasonably expect the environment to respond to his or her input (Murray 1997). These expectations should not necessarily be limited to one right path and a few alternatives that lead quickly to a dead end. The features of Labyrinth have been created to support such an approach to game design. If a learner can take an individual path through a case, which allows for reasonable deviations and that does not result in a termination point, the environment will likely prove to be more engaging, more responsive, and may even allow for further knowledge assimilation through information picked up on the individual's choice of path.
- *The psychosocial moratorium*: Gee (2003) has illustrated how games allow for the making of poor choices without any detrimental effect upon the richness of engagement. The player, and for our purposes the learner, having failed to meet a core objective, can return to try again. It is not unusual in gaming contexts for a player to return to a successfully completed segment in order to improve performance and increase the score for that portion of the game. In Labyrinth, successive attempts can be made to attain the core objective; each attempt is increasingly informed by knowledge that has been successfully acquired through previous attempts.

Furthermore, the development and use of branching case scenarios afforded by Labyrinth provide a learning environment that is much more suited to accommodating a full range of cognitive activities on the part of students. Returning to Bloom's taxonomy, we can, for example, observe that within the context of a Labyrinth case, learners may be required to relate knowledge from several areas, predict outcomes, and draw conclusions (synthesis); they may also have to assess the value of theories and presentations and make choices based on reasoned argument (evaluation). In this manner, a game-informed approach to design in computer-mediated VP environments can provide better opportunities for richer, more engaged learning experiences for healthcare students and interns.

Initial Evaluation and Issues for Future Development

Much of the initial evaluation of Labyrinth has focused on the educator rather than the learner. Before the impact upon students and student learning can be addressed, we need to understand how educators will actually use the tool, what it is that they will seek to impart via the new tool, and how they would anticipate measuring its success.

Initially, we anticipated that the biggest challenge would be guiding educators towards rethinking their teaching in the new ways that game-informed approaches require. Basically, we wondered whether teachers would be good storytellers, or whether they would understand the underlying principles of game-informed learning well enough to be able to generate game-informed scenarios, structures, and interventions. What has emerged, however, is that educators, certainly those with experience in delivering case-based teaching scenarios, are already well primed to engage with this game-informed approach. They present cases as highly complex, multi-branched narratives and invite interaction and intervention from learners (Exhibit 5). Such interactions are often the stimuli leading to rich discussion and embedding of the learning objectives. Our work with around 50 clinical educators over a period of a year or so has shown that these case-oriented educators typically move from their initial introduction to the concept into direct engagement in game-informed activity in about an hour.

In turn, if educators already have the narrative skills to create authentic and compelling game-informed scenarios, one of the subsequent and ongoing challenges in the design of Labryinth has been to ensure that the system can support diverse forms of information provided by these educators. In supporting this kind of educational model, the authoring process for Labrynth has emerged as one in which hitherto peripheral input—such as clinical war stories, personal experience, and professional anecdotes (Greenhalgh and Hurwitz 1996)—have been transformed into effective educational activities. A number of educators have commented on the value of having to represent their experience in such a way that their otherwise tacit or subconscious professional knowledge can be made explicit and transferable to students.

Finally, one of the primary concerns for furthering our work will include the codification of such professional knowledge in such a way that the system would be scalable for more extensive use. By adopting a common vocabulary through which case-based learning can be described and incorporated within game-informed learning scenarios, we hope to provide a clearer foundation for future educators to be well positioned as authors of Labyrinth structures. We have already made significant progress in this direction by adopting the standards and specifications of the MedBiquitous Virtual Patient Learning Group for guiding authors in the creation of VP data for Labyrinth scenarios. Yet progress in this area also requires further research into how the narrative concept of genre may be applied to such forms of educational investigation. For example, a patient consultation could be considered as a form of mystery investigation. The term "mystery" commonly infers an enigma, an investigative agent, and a resolution to the enigma. This same model would hold potential relevance in a field such as law, where the enigma is the crime and the investigative agent is the detective. By establishing links and analogies between narrative genres and the storylines of medical case studies, we may gain valuable knowledge for authors as they design new VP scenarios.

In terms of what feedback has actually come from learners, this is proving to be most significant where the students themselves are asked to author the Labyrinth cases rather than simply play them. In fact, aside from the utility of Labyrinth activities as educational content, what at least initially appears to be more valuable is requiring students to act as authors themselves. For example, in one situation a group of senior students (who need to have enough clinical practice to be able to evaluate what is credible in a real-world setting) are given a week to prepare a VP scenario for review in a case conference with senior colleagues; in the conference, the scenario is explored as if it were a real patient and the VP design is critiqued or validated by these more senior clinicians. In this activity senior students thus explore, record, and have to defend their knowledge and understanding at the same time that they generate content for junior students in the same program. In another example, groups of students taking an undergraduate elective in tropical animal health are asked to create a Labyrinth activity around a relevant clinical condition. The students in this course have reported back in the past two academic sessions that the process of developing Labyrinth scenarios has been one of the few areas of their course that has forced them to "think like professionals" rather than students and to situate their learning in plausible contexts.

The Future of VP Technology: Labyrinth and Beyond

As students move through their training and develop their professional practice, they traverse a series of continua—moving from knowledge to practice, from directed to autonomous learning, and from pedagogical models to andragogical ones (Knowles et al. 1998). Eraut, for instance, identifies the "distinction between propositional knowledge which underpins or enables professional action and practical know-how which is inherent in the action itself and cannot be separated from it" (1994, 15), and similar concepts have been observed elsewhere (Miller 1990). It is to be expected that formalized educational systems (typified by technology-mediated activities) will need to support these distinctive forms of learning in different ways depending on where they are applied in a given professional program. Thus in Edinburgh the EROS system has been designed around supporting knowledge acquisition and reinforcement in the earlier stages of the program, whereas Labyrinth focuses on supporting the acquisition of the praxis skills later in the program (Exhibit 6).

Meanwhile, in considering the long-term possibilities for implementing VP systems such as Labyrinth, it is necessary to recognize their inevitable limitations in comparison to non-virtual, "real-life" practice. Fitness for practice in healthcare professions is a composite of many things above and beyond the core knowledge imparted in the formal learning environment. The physicality of individuals and environments as well as the knowledge imparted through non-verbal, non-textual engagement play their part in the formation of professional development. The embodied reality of professional practice involves all the senses, attuned through familiarity, experience, and tacit understanding to enable fast, accurate, and informed decision making in critical situations—each of which may contain all manner of background sensory noise. For instance, a physician's nose may provide the first intimation of gangrene; it may be the sound of a patient's voice breaking frequently for breath in mid sentence that first suggests Chronic Obstructive Pulmonary Disease; the feel of a lump under the patient's skin may make all the difference between a diagnosis of subcutaneous fat or of something more sinister. More holistically, the physical appearance, smell, or gait of a patient can offer clues about his or her background, general well-being, and social status as much as any direct indicator of pathology or anomaly. This is part of the tacit knowledge of professionalism and is acquired as much through familiarity and experience as it is through formal knowledge of the process of history taking, differential diagnoses, and other procedures. Despite the many strengths of virtual patients, it seems highly unlikely that computer-mediated applications will be able to adequately represent the broad sensorium of situated and "real" professional practice.

However, some aspects of professionalism *are* informed by taking control of choices, anticipating the consequences of those choices, and remaining accountable for having made them. These aspects of professional practice can, we would suggest, be approached in a computer-mediated virtual learning environment such as Labyrinth. Further, Labyrinth, when situated within Bloom's taxonomy, suggests accommodation for learners who are ready to move towards more abstract or higher thinking than the knowledge-led linearity adequately accommodated by more familiar VP applications such as EROS. As such, the possibilities of Labyrinth accommodating summative assessment for advanced learners begin to present themselves.

How educators might wish to assess learners using systems such as Labyrinth will perhaps be dependent upon how they actually approach the authoring possibilities afforded them within such systems. Anecdotal evidence suggests that approaches to authoring may be unduly governed by constraints of the tool being used in the authoring process. For this reason, establishing a standardized, scalable structure that still accommodates a full range of diverse scenarios is a crucial prerequisite for the design of any game-informed VP system. This key issue of design, as well as how educators utilize such environments to transform their personal experience into transferable knowledge, are vital areas for future exploration as such systems continue to evolve.

Conclusion

In our discussion of Labyrinth and educational virtual patient technology in general, we do not propose that virtual patients replace the embodied practice of the healthcare practicum. Rather, we maintain that they offer a formalized, effective thin-sliced way of experiencing, learning, and assessing practice for healthcare professionals at a time when both the quantity and quality of real patient encounters is under threat. We also suggest that by adopting a design modeled on the branching and narrative structure of gaming environments, the creators of such technological tools can ensure that they reach their fullest potential in supporting a full range of cognitive activities suited to the learning needs of students. While our work with Labyrinth offers only one emerging precedent in this context, the future development and implementation of similar systems holds much promise in addressing the limitations that currently face educators and students in the healthcare professions.

References

Begg, M., D. Dewhurst, and H. MacLeod. 2005. Game informed learning: Applying computer game processes to higher education. *Innovate* 1 (6). http://www.innovateonline.info/index.php?view=article&id=176 (accessed July 24, 2007).

Bloom, B. S. 1984. *Taxonomy of educational objectives*. Boston, MA: Allyn and Bacon.

Ellaway, R. 2004. Modeling virtual patients and virtual cases. *MELD*. Baltimore, MD: MedBiquitous. http://meld.medbiq.org/primers/virtual_patients_cases_ellaway.htm (accessed July 24, 2007).

Ellaway, R., C. Candler, P. Greene, and V. Smothers. 2006. An architectural model for MedBiquitous virtual patients. Baltimore, MD: MedBiquitous. http://www.medbiq.org/working_groups/virtual_patient/MVP_WhitePaper_11Sep2006.pdf (accessed July 24, 2007).

Gee, J. P. 2003. *What video games have to teach us about learning and literacy*. New York: Palgrave MacMillan.

General Medical Council. 2003. Tomorrow's doctors: Recommendations on undergraduate medical education. London: General Medical Council. http://www.gmc-uk.org/Education/Undergraduate/Tomdoc.Pdf (accessed July 24, 2007).

Gerritsma, J. G. M. and J. A. Small. 1988. An interactive patient simulation for the study of medical decision making. *Medical Education* 22 (2): 118-123.

Greenhalgh, T., and B. Hurtwitz, eds. 1998. *Narrative-based medicine: Dialogue and discourse in medical practice*. London: BMJ Books.

Knowles, M. S., E. F. Holton, and R. A. Swanson. 1998. *The adult learner: The definitive classic in adult education and human resource development*. Houston, TX: Gulf Publishing.

Malone, T. 1981. Toward a theory of intrinsically motivating instrution. *Cognitive Science* 5 (4): 333-369. http://www.leaonline.com/doi/pdf/10.1207/s15516709cog0504_2 (accessed July 24, 2007).

Miller, G. E. 1990. The assessment of clinical skills/competence/performance. Supplement, *Academic Medicine* 65: S63-7.

Murray, J. 1997. *Hamlet on the holodeck: The future of narrative in cyberspace*. Cambridge: MIT Press.

Pickell, G. C., D. Medal, W. S. Mann, R. J. Stabler. 1986. Computerizing clinical patient problems: An evolving tool for medical education. *Medical Education* 20 (3): 201-203.

Ryan, M.-L. 1997. Interactive drama: Narrativity in a highly interactive environment. *Modern Fiction Studies* 43 (3): 677-707.

Schön, D. A. 1987. *Educating the reflective practitioner*. USA, Jossey-Bass.

Verbeek, H. A. 1987. Self-instruction through patient simulation by computer. *Medical Education* 21 (1): 10-14.

Zary, N., G. Johnson, J. Boberg, and U. G. Fors. 2006. Development, implementation and pilot evaluation of a Web-based Virtual Patient Case Simulation environment—Web-SP. *BMC Medical Education* 6:10. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1397827 (accessed July 24, 2007).