The role of high-fidelity clinical simulation in teaching and learning in the health professions

Claire Bradley
School of Medicine, King’s College London
Submitted April 2011

Abstract
This essay reviews some of the literature about development of expert practice in medicine and related health professions. It uses adult education theory, Vygotsky’s notion of learning in the ‘zone of proximal development’ and some of the more general higher education literature in order to produce a critical analysis of the benefits of high fidelity simulation experiences. Conclusions point towards the validity of constructivist educational theories and their specific relevance in a medical educational context. The work constitutes critical advocacy for use of simulation training methods in Nursing and Allied Health Professions with the argument resting on the ways that these professional identities are constituted in the interplay of theoretical knowledge and practice application.

Introduction
Traditionally pre-registration medicine and healthcare education involves the acquisition and learning of classroom-based facts and theories interspersed with discrete periods of clinical practice which supposedly serve to consolidate students’ knowledge and prepare them for work once qualified. Due to the legal requirements for supervision, patient safety and the increasing frequency of litigation against the healthcare sector there is often limited opportunity for students to meaningfully explore and develop their newly acquired knowledge in the clinical setting which often involves dealing with unexpected situations and medical emergencies (Murray, 2006). It is my experience as both a teacher in higher education and a clinical practice educator that the link between theory and practice is not always easily elicited by students: classroom-based teaching often involves information transmitted to students as discrete topics in lectures or seminars which often fail to highlight the interrelation of one topic to another. This makes clinical reasoning and the management of ‘real life’ patients difficult as the relationships between these discrete facts is not always immediately obvious to the student in the clinical situation. In addition to this difficulty in transferring and transforming knowledge, students studying for a degree in medicine or healthcare-related professions are often rewarded in assessment for the memorisation and regurgitation of theories and knowledge through essays, multiple choice questions (MCQ’s) or in a six minute objective structured clinical exam (OSCE). These current assessment methods reward rote learning (Gibbs and Simpson, 2005), placing little emphasis for students on safe and effective patient management, teamwork and reflective practice, all of which are considered core attributes and skills of the modern healthcare professional. This poses the question; do current UK undergraduate training and assessment methods meet the needs of the health professional once qualified? This paper aims to explore the role of high-fidelity clinical simulation as an approach to overcoming some of these challenges and problems, potentially enhancing the teaching and learning strategies currently used in the education of medics, nurses and allied health professionals (AHP’s).

High-fidelity Clinical Simulation
It has previously been proven that technical faults are to blame for only 30 per cent of all clinical complications; the remaining 70 per cent are due to mistakes made by health professionals (Paver-Erzen
In response to this, increasing attention has been paid to the development of high-fidelity clinical simulation and the role this may play in postgraduate education and learning (Shapiro et al., 2004; Gordon and Buckle, 2009). Simulator-based training is well established in aviation and other high risk industries where it is used for skills training and enhancing inter-staff communication (Paver-Erzen and Cimerman, 2007). Healthcare is one of the few high-risk industries that has not yet fully embraced the incorporation of simulation into the primary and continuing education of healthcare professionals (Shapiro et al., 2004). Patient simulators were first used medically in anaesthesia crisis resource management and due to their benefits are now being increasingly used in the education of qualified physicians, nurses and other AHP’s (Good, 2003).

High-fidelity clinical simulation involves treating a lifelike mannequin that produces realistic physiological responses to interventions in a ‘real-time’ ‘real-life’ situation. The experience is viewed by peers and faculty and the participants able to view a recording of their simulated scenario. Post simulation, participants all engage in a debrief session, discussing reasoning and theories behind actions and reflecting on performance. The simulation and debrief process permits a sequential increase in task complexity, unlimited repetition, immediate feedback on action and enables learners to progress at their own pace (Good, 2003).

When combined with existing traditional training methods, simulation training for emergency department staff and graduate nurses has been found to improve both technical and non-technical patient management skills, enhancing learning and developing clinical proficiency (Gordon and Buckle, 2009). This leads us to consider whether high-fidelity clinical simulation facilitates the transition between theory and practice, facilitating deep learning and understanding at undergraduate level and assists in preparing students for the reality of clinical practice?

**Constructivist Learning Theories**

To quote Henri Poincare, mathematician and physicist (1854-1912):

‘Science is facts; just as houses are made of stones, so science is made of facts. But a pile of stones is not a house and a collection of facts is not necessarily science’.

Medicine and healthcare are sciences; however it is acknowledged that those students and clinicians who can instantaneously recall the facts and theories do not necessarily make the best healthcare professionals. Healthcare education has moved away from the traditional medical model, considering purely anatomy, physiology and diagnosis of the problem to the bio-psychosocial approach, recognising not only the underlying knowledge of the condition but also the impact emotional, behavioural and social factors have on the context of the disease (Santrock, 2007).

It should be remembered at this stage that healthcare students are not just studying for a degree; they are learning to do an important and responsible job (Ward, 2011). Various professional bodies emphasise the importance of continuing professional development (CPD) throughout clinicians’ careers (General Medical Council, 2006; Nursing and Midwifery Council, 2008; Chartered Society of Physiotherapy, 2005). At an undergraduate or pre-registration level we therefore need to ensure students are provided with the opportunities to develop the skills to become competent and reflective practitioners of the future, recognising that qualification is not the end of the learning process but merely the beginning, with their degree providing the foundations to build knowledge and experience upon in their future clinical roles.

Constructivism involves the learner engaging in a joint experience with the teacher to construct and create their own understanding of the experience. Constructivist learning theories extend from Vgotsky’s notion of the ‘zone of proximal development’ (ZPD), that being the difference between the learners current ability to solve problems independently and that which they can achieve with guidance and collaboration (Figure 1). Problem-based learning (PBL) is a constructivist approach frequently taken in the education
undergraduate healthcare professionals. Students are presented with a problem, usually a clinical scenario, and are required to work in small groups to identify the issues emerging, draw upon the knowledge they already have to address the problem and highlight further knowledge they need to acquire in order to adequately solve the task (Khan and O'Rourke, 2004). PBL promotes a shift from didactive teaching methods which involve transmission of knowledge to the students towards more engaging activities which encourage students to construct their own knowledge and understanding (Khan and O'Rourke, 2004), developing skills that will assist them with CPD and reflective practice throughout their training and professional careers.

Figure 1: Zone of Proximal Development (taken from http://bucs.wikispaces.com/vygotsky)

Another benefit of PBL is the opportunity for students to incorporate and link information they have previously learnt, integrating basic science into the clinical scenario or problem to be addressed (Norman, 2005). Previous literature on mapping of knowledge structures suggest students enter into a situation with a set of pre-learnt facts or 'spokes of knowledge'. As learning takes place, these facts are built upon and linked together forming ‘chains of knowledge’ which enable the student to reach their goal and successfully understand the theoretical concept behind the problem (Kinchin et al., 2008). Clinical scenarios however are seldom that straightforward. The human factors involved when treating a patient mean previously learnt facts and chains of knowledge are not always relevant or prove untrue when dealing with ‘real-life’ scenarios. This is coupled by working in a team with individuals with differing backgrounds, knowledge and understanding. Students then need to ‘grapple’ with these competing spokes and chains of knowledge, which, as they develop meaning and situation specific context begin to form more complex ‘networks of understanding’, enabling them to successfully select a solution to the given problem. (Kinchin and Cabot, 2010; Bradley et al., 2006; Kinchin et al., 2008).

Despite these benefits, PBL still does this in the context of small groups, discussing and theorising actions and knowledge. Whilst this facilitates active engagement from students and clarifies understanding it does not necessarily translate to improved patient care and outcomes which is considered a primary aim in current healthcare. Activity theory on the other hand analyses and develops knowledge in relation to the tools used, the rules of the community and the social and contextual factors in which the activity occurs.
Jonassen and Ruhrer-Murphy (1999) conclude the more embedded the conscious thought processes are, the more meaning the learner attaches to the activity, deepening their learning and developing understanding.

High-fidelity clinical simulation provides an ideal activity to construct learning from, providing students with a ‘risk free’ environment (Good, 2003) to practice, explore and develop the theories and solutions they have constructed during the PBL activity (Gordon and Buckley, 2009). It also considers the non-technical skills such as team working and communication that are inexplicably linked to solving the problem if we adopt an activity theory view. By participating in clinical simulation and acting out a scenario students gain knowledge, which effects understanding, shapes future actions and creates the transformational processes central to activity theory and a constructivist approach to learning (Jonassen and Ruhrer-Murphy, 1999), thereby extending the learners ZPD.

Gordon and Buckley (2009) examined the effects of simulation on graduate nurse’s perceived ability and confidence in responding to patient clinical emergencies. Fifty nurses participated in the study and were filmed responding to simulated emergency situations. Results demonstrated significant improvements in both practical skills such as managing breathing difficulties and performing defibrillation and non-technical skills such as communication and resource utilisation. These are skills that it is undoubtedly difficult and unethical to practice in ‘real life’ scenarios. Perhaps most interestingly 94 per cent of the participants reported the post scenario debrief was the most useful aspect of the experience suggesting it is perhaps the opportunity to review, pause, discuss and reflect on practice that is important to enhance learning and development for future situations. Similarly, Shapiro et al. (2004) found a period of simulation training in addition to a traditional didactic teaching programme resulted in a positive but non-significant impact on team working amongst emergency department staff. These improvements occurred despite individuals being familiar with problem-solving skills and working in high pressure environments, suggesting the opportunity to practice in a low risk environment improves overall performance.

This may therefore highlight a role for high-fidelity clinical simulation in the training of undergraduate healthcare students, providing a controlled environment to reflect on knowledge and practice, engaging students in the discussion and exchange of knowledge with peers and experts, enhancing both learning and the scholarship of teaching (Trigwell and Shale, 2004).

Conditions for Adult Learning

Like constructivism and activity theory, Habermans (1971), describes three conditions that are required for adult learning to occur. These are context, meaning and reflection. As adults we have various levels of prior knowledge and accepted facts that we draw on when presented with new concepts, these can prove true or untrue depending on the context in which we use them. In order for adult learning to occur we need to add meaning to the situation, which often involves reflection and the notion of ‘perspective transformation’ (Mezirow, 1981). Perspective transformation involves recognising and reflecting on the impact past experiences have on the new experience and is a central function to adult education (Mezirow, 1981). The notion of reflection and perspective transformation is also evident in Kolb’s learning cycle (1984) which is frequently referred to as a framework for students to structure their reflection around in current healthcare teaching.

With consideration of the work by Habermans and Kolb it is clear to see how clinical simulation would provide the opportunity for adult learning to occur (Figure 2). The ‘concrete experience’ of the simulation task provides opportunity for the students to reflect on performance and outcome, drawing on prior knowledge and experiences when discussing their actions, adding conscious meaning to the experience. It also provides opportunity in the debriefing session to explore alternative theories or approaches to the situation, potentially transforming students understanding or ideas to approaching similar tasks in the future.
We often talk of a surface or deep approach to student learning. A surface approach involves rote learning of material, often driven by short-term external pressures such as passing an exam. In comparison, a deep approach to learning is established when students aim to find meaning and relations to similar domains or other knowledge (Fyrenius et al., 2007). Two main categories are considered in relation to achieving understanding; receiving and condensing information from available resources and sorting and sifting what is relevant to know. In a deep approach to learning, students relate new information to prior knowledge and experience, developing their own understanding of the material (Fyrenius et al., 2007). Students who choose to build and develop knowledge in this way ensure learning becomes a dynamic, evolving process where understanding is viewed as an opened ended event, constantly changing depending on the environment, situation and task (Fyrenius et al., 2007). This idea of moving understanding also reflects the perspective transformation described by Habermans and the reflection and abstract conceptualisation reported by Kolb.

As providers of higher education for healthcare students we should aim to engage students in a deep learning approach, enabling them to use their knowledge meaningfully in novel situations with patients (Fyrenius et al., 2007). Another central feature to adult education is enhancing students’ ability to function as independent learners (Mezirow, 1981). In their discussion of the scholarship of teaching, Trigwell and Shale (2004), suggest in order for students to learn and develop as independent thinkers they need to be viewed as equal partners in learning, involving collaboration and sharing of information between students and teachers in a two way interaction. Universities therefore need to provide students with the appropriate opportunities, activities and forums to develop critical thinking and reflection skills, enabling them to become independent learners both during and following their degree.
Clinical simulation affords this collaboration and interaction. Having drawn on their knowledge and prior understanding to address the problem the opportunity is then provided to interact with peers and teachers in the debrief session, exploring and developing the concepts covered in the simulated exercise. As well as promoting a deep approach to learning, reflection and perspective transformation, simulation may also offer the opportunity to develop knowledge structures, moving from the previously described spokes and chains of information to networks of understanding associated with advanced reasoning and expert status (Kinchin et al., 2008).

**Novice versus Expert Status**

Within the context of higher education students are often regarded as novices and academics as experts with superior knowledge and performance in their subject areas (Bradley et al., 2006). The role of the expert is to share with the novice their knowledge, enabling the novice to construct and develop their own understanding of the subject. When looking at the structure of individuals’ knowledge frameworks experts demonstrate networks of understanding incorporating various competing chains of knowledge, the most appropriate of which is selected depending on the task and desired outcome (Bradley et. al., 2006). The knowledge framework of novices on the other hand exists as spokes of previous information and facts that create a state of ‘learning readiness’ (Kinchin et al., 2008), upon which chains of knowledge devised from the experts teaching are constructed. In time the novice can begin to move and transform these chains of knowledge, developing their own network of understanding (Kinchin and Cabot, 2010).

As a practitioner learns a skill they pass through five stages of development. These range from novice, to advanced beginner, competent, proficient and finally expert (Dreyfus and Dreyfus, 1986). As they progress through the stages, the learner becomes more aware of the interaction and outcome of their activity in relation to the wider situation. There is a move away from a rigid adherence to the rules towards an intuitive grasp of the situation, based on a deep tacit understanding and analytical approach (Kinchin and Cabot, 2010). If the experts' tacit knowledge is not made available to the student during the learning experience they may struggle to grasp the topic and its relevance unless the expert spends time teaching and explaining what has become intuitive to them (Kinchin et al., 2008).

It is recognised experts view a situation more holistically than a novice. For example a student or newly qualified physiotherapist has a basic level of understanding and limited experience to aid in hypothesis generation. The novice therefore will adopt a more structured approach using little situational awareness whereas the expert will utilise more abstract concepts to solve a problem, demonstrating a holistic perception of the situation (Bradley et al., 2006).
Certainly during healthcare education I do not believe it is possible to create ‘expert’ graduates as the vast and rapidly changing domain of healthcare requires a commitment to lifelong learning and CPD. I do believe however that our role as higher education institutes is to produce graduates who are of a competent and proficient level, provided with the skills to cope with the crowdedness of information surrounding them and approach situations holistically rather than as separate discrete tasks.

Engaging students in clinical simulation exercises may serve as a safe and efficient way of facilitating development of these skills. Students are able to put theory into practice, exploring the links and conflicts of previously learnt knowledge and theories in a safe environment where reality can be suspended and no harm occurs to patients. Simulator-based learning enables the training agenda to be determined by the needs of the learner, not the patient (Good, 2003) and provides the learner with an insight into the experts network of understanding, tacit knowledge and holistic view of the situation during the post simulation debrief which involves two way sharing of information between students and teacher.

**Assessment**

It was mentioned in the introduction to this essay that current methods of assessing medical and healthcare students such as OSCE’s, MCQ’s and exams tend to promote surface learning approaches, assessing students knowledge rather than proficiency in both the basic and complex tasks required in practice (Murray, 2005). Whilst a comprehensive discussion on the role of high-fidelity clinical simulation in the assessment of students studying healthcare related courses is beyond the scope of this paper it has become apparent it may incur potential benefits.

If our overall objective is to produce healthcare professionals not only competent to practice at a basic level but to develop as expert practitioners of the future we need to equip students with these skills and assess them in these ways at university (Stefani, 2005). Clinical simulation as an assessment modality has the potential to assess and reward competent and proficient students who have demonstrated a deep approach to learning, using, transforming and re-presenting relevant university taught material in the clinical context they are about to enter into as a qualified medic, nurse or AHP. Assessing deeper learning and situation-specific use of knowledge promotes these actions amongst students during their studies. By
using clinical simulation in the assessment of the competent or proficient student we can align learning outcomes, teaching activities and assessment methods, developing a ‘web of consistency’ and enhance the constructive alignment of the curriculum (Biggs, 2003). This will hopefully improve teaching and learning experiences for healthcare students and produce competent, thoughtful, professional and forward-thinking healthcare professionals of the future (Ward, 2011) who are adequately equipped to take on the challenges of the modern health care system and lifelong learning.

Conclusions
This paper has presented evidence for the role of high-fidelity clinical simulation in the education of undergraduate and pre-registration medical and healthcare students based on constructivist theories of learning.

Clinical simulation can be used to create a clinically realistic environment in which learning takes precedence over patient care (Good, 2003). It uses activity theory to compliment and further develop the concepts of PBL, providing students with the opportunity to work together to use and acquire the knowledge necessary to solve a given task. The simulation experience and post session debrief provide an interactive forum for students to use and transform their chains of knowledge to the beginnings of networks associated with the expert status. It also provides a risk free learning environment which can progress at the rate and direction desired by the student, developing both technical and non-technical skills essential for effective patient care. Ultimately clinical simulation promotes learning that ‘is based on discovery guided by mentoring rather than on the transmission of information’ (Boyer Commission, 1998), providing ideal opportunities to promote and develop clinical reasoning and critical reflection skills necessary to become independent learners ready to take on the challenges of the health care system and notion of lifelong learning.

Clinical simulation is also likely to be beneficial in the assessment of competent and proficient healthcare graduates, enhancing the constructive alignment of the curriculum and promoting deep approaches to learning and studying.

It would be of interest to investigate the incorporation of high-fidelity clinical simulation into the undergraduate education of medical, nursing and AHP students to formally examine the impact on the quality of learning and the healthcare professional produced as a result.
References


Nursing and Midwifery Council (2008) *The code: Standards of conduct, performance and ethics for nurses and midwives*.


