Studies in Technology Enhanced Learning

Educational theory in technology enhanced learning revisited: A model for simulation-based learning in higher education

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ABSTRACT

This study proposes a model that explicates how technological innovation reshapes educational theory rather than focusing on its novelty as a means to engage the learner in the process. The focus of interest is the learning process that essentially involves applying and refining professional knowledge and skills in problem context. As such, the shift goes beyond the deterministic view that emphasises on technological innovations which often arises at the expense of the theoretical underpinnings that guide their use in the learning process.

Within the broad range of available TEL innovations, this paper focuses on simulations because they offer unique approaches to learning due to their ability to allow training based on trial and error, repetition of planned activities and reflection upon action. The aims of the study are: a)to provide an innovative educational design model for teaching in higher education, drawing from a learning intervention on medical and health care professionals and b)to illuminate TEL activities organised as part of and in the context of simulations for effective learning.

Understandings gained from the study provide a roadmap on the design of TEL that includes the integration of simulation-based learning activities in knowledge and skills-based education. Theory entailed in our proposed model serves as a vehicle for reflection and critical thinking for the development of meaningful and practice oriented TEL activities in higher education settings.

Keywords: TEL; simulations; problem-based learning; collaboration; reflection; teaching model

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1. Introduction

Technology-enhanced learning initiatives have transformed the nature of teaching and learning in the last thirty years (Kirkwood & Price, 2013). Their impact on student learning in terms of the levels of engagement and their representations of knowledge has been researched extensively with critics (Hall, 2016) and supporters (Motschnig-Pitrik & Standl, 2013; Goh, 2016; Ustunel & Tokel, 2018) on both sides. Similarly, a strand of research on TEL has paid attention in its implementation within universities including acceptance factors and adoption by academics (Thanaraj & Williams, 2016; Kurilovas & Kubilinskiene, 2020).

Prompted by the unique opportunities and challenges of innovations emerging in the field of higher education, this paper takes closer look at TEL in the light of a rich learning and teaching agenda and from the perspective of educational design. Among the wide range of available innovations, attention is drawn to simulations. Simulation-based learning is an area of increasing theoretical and practical importance. It addresses technical, professional and ethical concerns of our time. It raises key issues about TEL processes, group reflection and theory-practice integration. It creates new opportunities for examining problematic cases and increasing performance levels through deliberate action. As such they enable learners to practise key decisions and actions in certain professional related contexts. For these reasons, the area of simulation-based learning offers a highly productive site for research.

The use of simulations is a promising field, yet their integration in existing curricula is challenging (Kirkpatrick & Mackinnon, 2012; McGaghie, Issenberg, Petrousa & Scalese, 2016). Their use of procedures and tools in repetition over time in order to help explain complex and high risk processes that imitate real life requires careful consideration in terms of educational design. A more specific theoretical framework for teaching with simulations with a provision of sets of explicit learning activities that maximize learning benefits is required.

This study assumes that theory equips educational researchers to take a more responsible and informed view on how to respond to and what how to act in relation to emerging technologies and their impact on learners. The value of theory as the vehicle to allow moving away from external pressures that may not necessarily serve the pedagogic needs interests of the learners has been well documented in academia (Ball, 1995; Selwyn, 2012; Sclater, 2016). Currently, there is an increasing awareness of the need to understand learning theory so that we may stand up for TEL and simulation-based learning, in particular (Bøjeet et al, 2017). Deliberate consideration of pedagogic theory in applied learning interventions is essential if we are to deliver technology-enhanced learning successfully.

A greater emphasis needs to be placed on clarifying learner activities whilst designing simulated initiatives. Learner activities should not happen by chance, they should be carefully orchestrated to align with the expected learning outcomes and with the assessment procedures of a course. Biggs (2003) in his model of constructive alignment has argued for careful design that matches learning outcomes, delivery and assessment. The concept of constructive alignment drives activities that students engage with and enables them to construct meanings from their actions. This is in line with our view that TEL should cater for interactions and connections between students, teachers and resources.

This paper provides a theoretical basis for designing a teaching agenda for TEL and professional skills development drawing from simulated medical education. A model has been developed based on observations of activities taking place in a simulation-based learning intervention within a UK teaching hospital. Such activities include interactions between students, tutors, facilitators, simulations, learning resources, medical documents and treatments (e.g. drugs). Effective TEL approaches heavily rely upon social elements and allow flow of information across. The existence of strong and weak ties that coexist among sets of relationships between participants has been acknowledged by earlier research on networked learning (Jones, Ferreday, & Hodgson, 2008).

Secondly, the proposed model provides a specific strategy that serves as a roadmap for educators as well as for professionals who employ simulations for developing skill-based knowledge. The proposed strategy is deployed in the form of designed TEL activities embedded and situated within the simulation-based context and environment. Pedagogically-informed use of simulations is very much likely to engage students in quality learning.

In the following sections, the paper sets up the theoretical framework for the study that includes a discussion of educational theory that favours context-based action-oriented learning approaches and updates from available literature in TEL simulation studies. Next, it describes the learning intervention which has provided the basis for the proposed model for a teaching agenda with simulations in higher and professional education, followed by an in-depth discussion of the model and the practical TEL activities that form the teaching strategy that is a core part of the model. The model is a useful vehicle to help us organize knowledge about how to teach with TEL simulations and use objectivity in our judgement for designing learning programmes in higher education.

2. Theoretical Background

This section presents the conceptual background which discusses TEL through computer-based simulations examined under situated learning theory. The latter, explicates on the notion of communities of practice in TEL developments which is a central concept in situated learning (lave & Wenger, 1991). The concept of experiential learning which had a strong influence on situated approaches is also discussed along with problem-based learning (PBL) which has a central place in medical education in which our learning intervention is based. This section concludes by summarising research on simulation based-learning approaches.

2.1 Situated Learning

There is a strong link between situated learning theory and TEL (Zenios, 2011; Thumlert, de Castell & Jenson 2015; Sclater, 2016). The situated theory of learning is inherently social and it starts with the assumption that engagement with the practices of a community develops learning. In that sense, learning depends on the experience of participation in the various events and activities happening in the context of the community. The relations between the members of the community are shaped by the shared practices that take place. The construction of identities can possibly be an output of this process (Wenger, 1998). Lave & Wenger (1991), explicate on the nature and the function of learners' participation and they argue that it increases gradually in engagement and complexity. More specifically, it is suggested that newcomers in these communities are gaining access to information and knowledge through their involvement in activities within the community of practice. Learning in TEL environments that follow practice in-situ, is not achieved by acquiring knowledge transmitted through instruction, but rather it occurs through engagement and active participation within a community of practice. The latter implies active involvement and engagement with situated, meaningful and purposeful activities organised and structured around the life the community (Zenios, 2008).

The structured activities often rely on the presence of ‘masters’, being experts in the field to guide the newcomers towards achieving understandings within a community of practice. Simulations can provide opportunities for group work as part of a community of practice. In the case of simulated medical education, Kneebone (2003) argues upon the contribution of an expert clinician who can facilitate the sessions and give feedback on novice learners’ performances, therefore acting as the master in this community of practice. Feedback can be a powerful for learning if considered as a step towards improvement. The following part on experiential learning approaches argues on the value of reflecting upon experience.

2.2 Experiential Learning

Experiential learning enables the transformation of experience into knowledge, skills, values and emotions based on a cyclical process that involves reflection (Kolb, 1984). The steps involve: a) experiencing and/or practising, b) reflecting on the practice, c) formulating understanding which includes forming abstract concepts and finally d) planning a new experiment or intervention which leads to a new cycle. As such, the experiential learning cycle resembles an action-research based approach that encourages practice oriented approaches. Experiential learning is a pre-requirement of meaning making processes as meaning is rooted in and indexed by experience (Brown, Collins, & Duguid, 1989). The application of the experiential learning theory to simulation based learning in health care related settings can be seen within debriefing practices. Debriefing is a core component of patient simulation and involves feedback and reflection on performance over managing cases (O’Loughlin, Thomas & Runnacles, 2016). The management of real life problems in health care as part of learning with simulations is organised around problem-based learning (Nash, Paladugu, Crowther, Dickinson, Pimblett & Lees, 2015) which is discussed in the next part.

2.3 Problem-based Learning (PBL)

PBL is becoming increasingly popular in various disciplines (i.e. business, engineering, teacher education, mathematics, architecture) and it is amenable to different kinds of contextual problems that can be applied across professional schools (Jonassen & Hung, 2008; Takahashi & Saito, 2013). The use of PBL in medical education in particular, goes back to the 1950s (Hung et al, 2008) and it has been introduced in the UK medical education during the last twenty years. PBL innovations contributed to the emergence of leading teaching and medical research institutions. PBL emerges from discussions on the centrality of problem-solving in all aspects of everyday life and the need for education to go beyond transmission of knowledge which often graduates find difficult to apply to new contexts and at the workplace. In PBL contexts, learners solve problems in collaboration with peers as part of a self-directed learning approach. In that respect, responsibility for learning shifts toward the learner and/or the group of learners. In PBL, knowledge and skills are organised around authentic problems which are often ill-structured rather than being organised around hierarchical list of topics. As such, knowledge building in PBL approaches is stimulated by the problem, applied back to it and structured around it (Hung et al., 2008). The implementation of PBL implies restructuring the whole curriculum to be methodically arranged around and focus at ill-defined problems (Brush & Saye, 2017). Tutors act as facilitators rather than being at the centre of the learning process. Self-assessment and peer assessment is quite often part of PBL (Jonassen & Hung, 2008; Rooks & Dorsey Holliman, 2018). A participant in PBL needs to explore their decisions, think carefully before, during and after their actions. Therefore, reflection is a key part of the process and often this happens collectively in the form of group reflection (Rooks & Dorsey Holliman, 2018).

As a result of PBL there is interplay between theory and practice and the process is clearly student centred. The following section explores simulation based learning and its potential to enhance professional development such as student centred approaches and reflective practices.

2.4 Simulation-based learning

Simulations used in the context of a training programme, aim to enable users, i.e. practising students or professionals to be able to control or engage with complex and high risk processes. Historically, simulations have been compared to chess, jousting, and Kriegspeil which are thought to be ancestors of the modern war games in military education (Bradley, 2006). An example of a primitive simulation used in medical education back in the 18th century is the birthing simulator invented by Angélique Marguerite Le Boursier for teaching complex birthing techniques to French peasant women (Maran, 2010).

Simulation-based learning can be termed as learning which is performed in a computer environment, where the learners gradually infer features of the concept model as they go through the simulation, which often results in modifying their original conceptions (De Jong & Van Joolingen, 1998). Simulation based learning and training has been originally employed in high-risk professional industries such as aviation and military for decades since it helps to avoid the cost and danger involved in training in real life contexts. The unique opportunities it provides, train users as to react rapidly and efficiently in real-life events that appear to be rare and therefore entail limited opportunities for practice.

It has been argued that simulations provide trainees with opportunities to practise skills repeatedly in a safe environment and receive immediate feedback about their actions (Issenburg & Scales, 2008). Such processes imply deliberate effort and action and increase performance. Deliberate activities are termed as those having been specially designed to improve current levels of performance (Ericsson et al, 1993). Simulation-based learning nowadays occurs in computer-assisted learning environments, in which users gradually enter through a concept model as they proceed through the simulation. This process is very much likely to allow changes in their original concept (De Jong & Van Joolingen, 1998). Simulation based learning is not limited to areas that require deliberate action in high risk contexts. Recently, it has been applied in fields where active learning methods in the service of meeting professional needs are on demand, such as management education (Lu, Hallinger, & Showanasai, 2014).

2.4.1 Simulations in medical education

The use of simulations in the training of medical students and staff is linked to the need for patient health safety and risk management standards within modern hospitals (O'Loughlin et al, 2016). The UK National Health Services (NHS) Trusts acknowledge that innovative methods of training using modern technology have a key role to play in reaching these standards known as the Litigation Authority's Risk Management Standards (NESC, 2008). Lessons for the use of simulations in medical education are taken from the aviation industry where they are used as a means to prevent and eliminate errors. The risk of dying or being seriously harmed by human error in a hospital is one in 300 and this is often compared to the risk in dying in an air crash which is one in 10 million (Department of Health, 2009). These statistics point to the need for training to limit the possibility of human error. Research by Maran & Glavin (2003) indicate that simulations can offer interactive and often immersive learning opportunities without exposing patients to the associated risks by recreating clinical experiences. Gaba (2004) argue that simulation-based learning gives medical students real-life opportunities to develop, practise, and improve their clinical skills. "Medical simulations, in general, aim to imitate real patients, anatomic regions, or clinical tasks, and/or to mirror the real life circumstances in which medical services are rendered" (Scalese, Obeso, & Issenburg, 2007, p.46). The emergence of scientific advancements in medical diagnosis and treatment along with the proliferation of new medical technology requires clinical staff to be up-to-date with new complex knowledge, skills and techniques (Issenburg, and Scales, 2008). More recent research has argued upon the value of simulation based learning on communication and clinical skills (Bertelsen, DallaPiazza, Hopkins & Ogedegbe, 2015).

Medical simulation models are ranging from low to high fidelity and have the potential to be used by both individual users and interactive groups of users depending on the goal of the training (Gaba, 2004). Examples of low fidelity simulations are anatomic models of human body (Bradley, 2006). Virtual reality simulations range from desktop computer-generated environments to highly immersive virtual spaces where the user wears goggles and sensor-containing gloves and sits within a specially designed display (Issenburg & Scales, 2008). The use of haptic systems such as touch and pressure feedback and audio-visual feedback in simulators make them more realistic and place them at the high end of fidelity spectrum.

The current study is based on the use of high fidelity simulations and sophisticated computer based technologies which simulate patient illnesses and behaviours. The major benefit of simulation based learning in medical and healthcare education is the improvement of patients' safety and the elimination of medical errors (Issenburg & Scales, 2008) As such, ethical issues around using patients for educational purposes are addressed appropriately. Further, simulation based learning addresses needs in medical training related to:

a) the reduced number of patients available for learning purposes in hospitals as a result of shorter hospital stays and clinic visits;

b) the reduction of working hours to 48 hour per week for clinical staff by introduction of the European Working Time Directive (EWTD);

c) regulations on revalidation of doctors every five years (GMC, 2010).

2.4.2 Limitations of simulations

Cost currently appears to be the key limitation of the use of sophisticated high-fidelity simulations in training. The creation of realistic settings, the development of audio-visual technologies required for running the scenarios and video recording can be expensive. Human resources i.e. well trained technicians and facilitators are an essential part of these developments. Further, scenario design and development of simulation-based training sessions can be very "time- and resource-intensive" (Issenburg & Scales, 2008, p.34). Established simulation centres which are fully equipped in human and technical resources are required for the use of holistic simulation based learning rather than isolated technologies. The set up and sustainability of simulation centres requires evaluation to ensure that effective learning takes place. As part of this, objective measures of performance should be refined and validated to ensure quality (Kneebone et al, 2002). A reliable and valid evaluation tool for simulation based initiatives in nursing education has been recently developed by (Hung, Liu, Lin, and Lee, 2016), yet more is needed to help lecturers design simulation augmented curricula in other domains. Finally, contrary to the field of aviation, simulation in medical education can be troublesome in terms of accuracy due to the level of human element involved. Patients are unpredictable i.e. they may have unexpected reactions both physically and emotionally to certain medical interventions. Accurate replication of infinite number of possible human reactions on the simulators, if at all possible, is extremely difficult to be achieved.

2.4.3 Why we need TEL simulations in higher education?

This paper argues on the need to consider the processes of TEL that favour experiential forms of leaning in-situ, organised around authentic real-life problems, so that learners are faced with opportunities to relate theory with practice and become better equipped to enter their professional workplace after graduation. Simulations are used as tools in complex learning scenarios due to their ability to represent real-life situations and dynamic forms of representations instead of static ones such as images and diagrams (Van der Meig & De Jong, 2006). Workplace environments can be complex, since a professional needs to implement abstract knowledge whilst at the same time has to communicate with colleagues as part of team work and collaboration. Earlier research (Goodyear & Zenios, 2007) indicates that that the transfer of discipline-specific knowledge at the workplace should not be assumed to be straight forward. Professionals and students across domains experience a gap between theory and practice (Cavanaugh, 1993). Towards this end, institutions should seek to address employability. As part of this, they need to embed team work and knowledge creation practices in their programs of study in order to maximize graduates' potential and enable them to function as a driving force in their future professional roles. In the field of medical education, in particular, training scenarios should provide future medical professionals with accurate reflections of the real clinical environment along with its characteristics and challenges (Chen, Cheng, Weng, Chen & Lin, 2009).

Equally, reflective practices are of salient importance in the work of professionals as they allow integration of theory and practice (Wong, Kember, Chang, & Yan, 1995). Professionals often need to relate their own perceptions and personal experience to existing models and concepts provided by literature in their field in order to take decisions. Therefore students in higher education need to be encouraged to form representations of working knowledge that will make them more efficient at the workplace. Collaborative work around structured TEL activities among groups of students is thought to provoke certain forms of knowledge creation and learning (Zenios, 2011). As there are no pre-set solutions in the real world, a practitioner needs a repertoire of knowledge and skills ready to apply in conditions of uncertainty. Study programs based on problem-based learning approaches support authenticity by creating a need to solve a real problem. As part of this, students construct knowledge and develop skills while working toward a solution to the problem. Engagement with authentic learning elements such as collaboration, reflection, real-world relevance and critical reasoning through dialogue in TEL settings has gained value in higher education because it can help with dealing with professional challenges after graduation (Bozalek et al, 2013). The model proposed in this paper will identify opportunities for professional development in the form of reflective and autonomous practice developed as part of collaborative practices in simulation-based education.

3. The development of the Learning Intervention: Simulation-based learning for medical students

The understandings for the development of the proposed educational model for a teaching agenda with simulations have been possible due to a partnership between the NHS and Lancaster University, UK. The study involves research work and exploration upon the practices of a simulation training suite in the UK which has been developed as part of the Department of Health agenda for building a safer healthcare system and facilitating the use of simulation centres within teaching hospitals (UK Department of Health, 2009).

This section describes the learning intervention which frames the experiences and observations that helps develop the theoretical model proposed (see Figure 1: the learning intervention in three phases, below). A starting point for the development of the intervention is that pedagogy is not to be merely embedded into a new context enabled by TEL, it is redefined and reintroduced. The following discussion portrays the full picture and the details of the simulation-based learning experience of the students.

As part of the study, small groups of third year medical students consisting of six individuals have been asked to work with simulated patients under the guidance of a facilitator within the simulation suite of a teaching hospital. These scenarios are carefully designed as part of their placement in hospital wards where they were introduced to problem-based learning (PBL) activities. This initiative is envisaged as an exciting opportunity for medical students to work with real-life scenarios at minimal risk. As part of these activities they undertake different roles as part of a team, i.e. a) taking medical history, b) examining the patients and c) asking questions that lead into taking decisions as to what steps need to be taken towards taking care of the simulated patients including calling the appropriate specialist doctors and nurses on duty in each one of the cases.

The facilitators initiate the simulation by briefing the students before the simulation scenarios. The latter are prepared in advanced by a team of medical specialists including the facilitator. During the scenarios, the facilitators guide the students through the process which is recorded. An assessment tool is employed to record performance levels of the team at four key aspects: task management, situational awareness, team working and decision making.

Following the simulation scenario, a debriefing session is lead by the facilitator in which students have access to the assessment tool data and the video of the preceding simulation activity. The presentation and subsequent analysis of the assessment tool data in the debriefing sessions provide students with ample opportunities for group reflection.

3.1 Student group work with simulators on a given scenario

High fidelity, life-sized mannequins i.e. articulated models and artefacts connected to computers are used in the scenario. These reproduce the human anatomy and pathophysiologic function of a human patient. Manipulation by computers allowed mannequins to be interactive and respond to the actions of the trainees. For example, by administration of a drug, a mannequin’s heart rate and blood pressure would change. These reactions are automatically controlled by a model incorporated within specially designed computer software (see Figures 1 and 2: High fidelity mannequins)

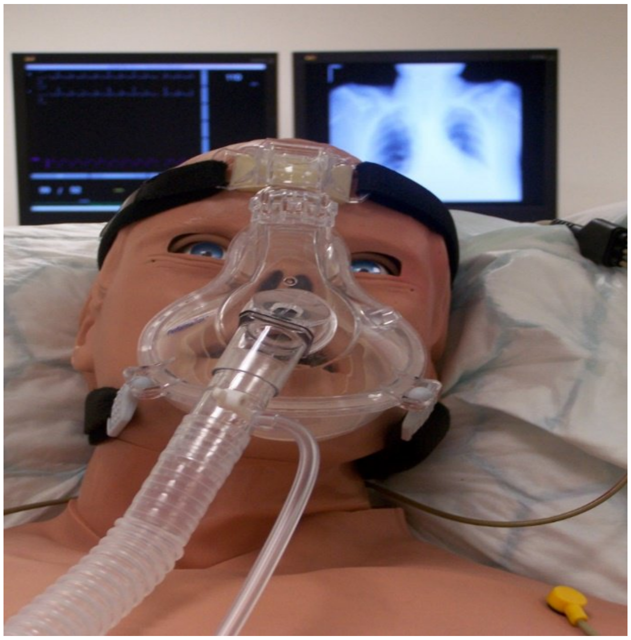

Figure 1: High fidelity mannequin (a)

Figure 2: High fidelity mannequin (b)

The prescribed scenario observed in the current study focuses on an A&E (Accident and Emergency) case where an aged female patient with multiple health problems including breathing difficulties is admitted to hospital without a clear indication as to what caused the illness. Students acting as a group of medical and health care professionals attempt to provide care for the simulated patient who has difficulties to communicate with them as the situation deteriorates. The scenario for the simulation is subject to modification following the intervention of instructor who acts in response to actions of learners. The simulated mannequins are adaptable to different scenarios in order to allow users to practise clinical skills and procedures. Finally, the whole experience is evaluated with specific focus on individuals' performance and team-working. Attention is drawn on the four key criteria for student assessment: task management, situational awareness, team working and decision making. These four themes structure the discussion initiated by the facilitator and lead towards group reflection activity that follows the simulated session.

All student group work is supported by the facilitator and enabled through the use of simulators. Activities as part of the learning intervention are structured around three phases (see Figure 3: the learning intervention in three phases).

Figure 3: The learning intervention in three phases

Each one of the phases includes a number of steps/ activities:

1. Phase 1: Introduction (prior to the simulated session)

> a. Participating in an introductory online teaching session that covered content subject knowledge relevant to the condition and disease(s) of the simulated patient.
>
> b. Asking queries for clarification on subject knowledge issues.
>
> c. Responding to questions posed by the facilitator.

2. Phase 2: The simulated session

> a. Working in teams to observe the simulated patient.
>
> b. Negotiating roles as part of team work in a swift manner in line to the demands of the environment.
>
> c. Listening to heart, breathing and abdominal sounds.
>
> d. Monitoring heart rate and blood pressure.
>
> e. Asking questions in order to get the diagnosis for the patient's condition using decision tree analysis procedures.
>
> f. Treating the patient (i.e. administrate correct drug dosage, call appropriate specialist for instructions or for referrals, order further examinations for vital clinical data such as blood tests and ex-rays, use appropriate medical technology for patient management).

3. Phase 3: Face-to-face debriefing (post simulated session)

> a. Watching a video recording of the simulation.
>
> b. Focusing on key moments and pause to reflect on key decisions on the management of the simulated patient.
>
> c. Identifying and self-assess individual/ group performance.
>
> d. Self-assessing individual/ group performances.
>
> e. Receiving feedback from the facilitator and/or from peers.
>
> f. Acknowledging and celebrate successes within the process.
>
> g. Reflecting upon errors made in the process.
>
> h. Discussing alternatives in the management of the simulated patient.

4 A teaching model for simulated-based learning in higher education

Theory is an essential vehicle in understanding learning phenomena and taking decisions over the future of learning and teaching in higher education. In developing and evaluating technological interventions, theory provides guiding frameworks and contexts for defining criteria for success. The proposed model draws on the theoretical account developed earlier and the examples of activities set out in the learning intervention which have been evaluated by medical student participants. It aims to provide a framework of ideas which may potentially enhance the sophistication of thinking and design of simulated based learning processes in higher education and professional development initiatives. This illustration acts as a guide to academics, course developers and health care professionals who use simulations in their teaching to develop communication and leadership skills. It provides a concrete example of effective simulation integration into higher education curricula that can be applied across disciplines because it uses a scenario that focuses more on professional development and employability skills rather than specific subject domain knowledge. The next parts describe all the elements of the proposed model (see Figure 4: Teaching model for simulated-based learning in higher education).

4.1 TEL activities

The learning activities enabled by the simulations lie at the heart if this model (See Figure 4). These are structured around a medical communication scenario and performed as part of a PBL agenda. The key task within the scenario explored in the learning intervention is to recognize and manage a seriously ill patient as a group while communicating effectively and taking leadership. The task is carried out across three phases including the introduction, the simulated session and finally the debriefing session which facilitates reflection. All three phases provide unique learning opportunities. Phase one which is conducted online provides students with an overview of the underlying subject and procedural knowledge in relation to the study. Phase two enables deliberate practice on the simulated patient including decision making as part of collaborative learning and team work. Finally, phase three stimulates individual and group reflection upon experience.

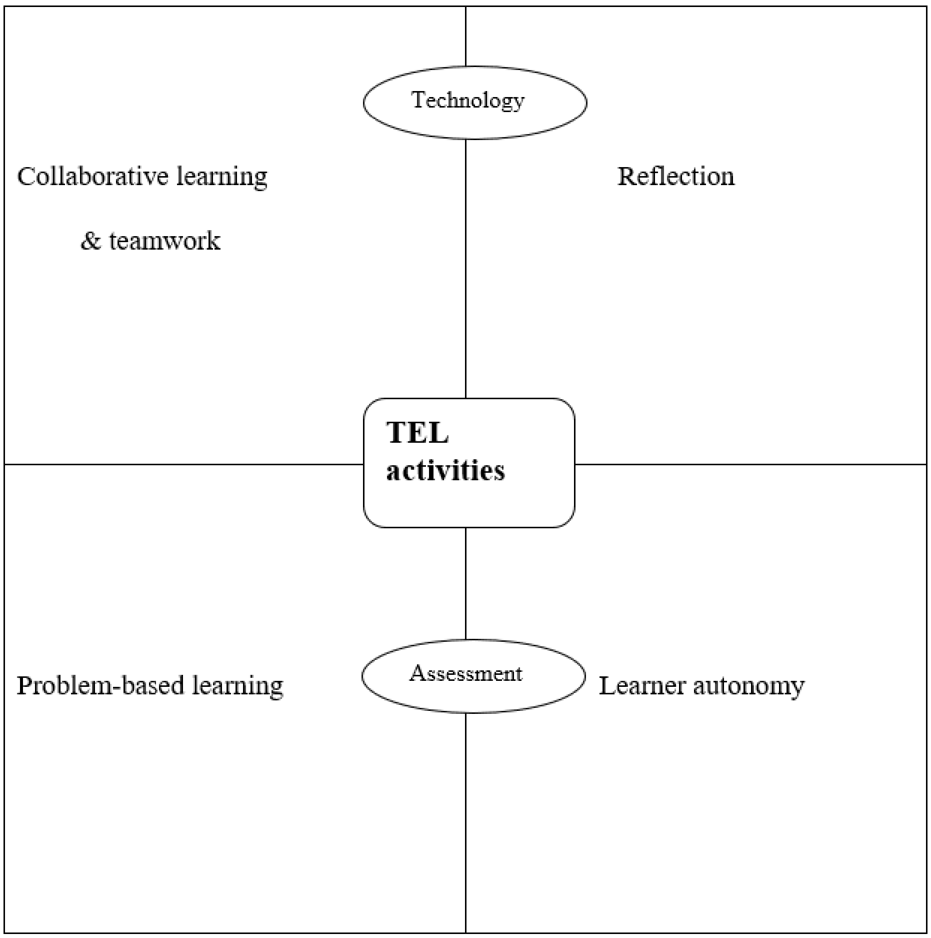

Figure 4: Teaching model for simulated-based learning in higher education

The medical scenarios examine student performance on clinical and human factors criteria. Clinical criteria include patient care, diagnosis and treatment. Human factors criteria include team leadership, communication, delegation, decision making, teamwork, situational awareness, and safety. Human factors training is a key element of training in medical education and it can alter the behaviour of the participants as to manage complex situations at the workplace (Bamford et al, 2016). The same factors are key skills for professional development and employability required across disciplines. The face-to-face debriefing activities following the simulation focus on reflection and explore each one of these criteria for individual students and group performance.

An assessment tool was developed that uses iPad tagging with annotated video for current and subsequent comparative video analysis of reflective learning based on progress and practice. The assessment tool employed the matrix marking system is developed at the Lancashire Simulation Centre and set up on iCoda software (Davis et al, 2014). The iPad tagging system is used to evaluate performance across the four human factors criteria: team working, task management, situational awareness and decision making (See Figure 5: the ipad tagging system).

Figure 5: The ipad tagging system

The moderator can easily keep an electronic version of the performance of each student participating in the simulation exercise and use these annotations for discussion based on feedback to improve future performance. Subsequently, further learning activities are developed in addressing each one of the communication-based criteria mentioned above during the debriefing session. For example, students are asked to repeat parts of the simulation process focusing on key moments in order to address the areas or the criteria in which they underperformed. In the same spirit, they are directed towards further study of the topics underlying the previous tasks and prompted to complete online activities.

4.2 Role of the facilitator in structuring the learning activities

In contrast to the PBL approach, here the facilitator's role remains central although he/she does not appear to be at the centre of attention. The facilitator uses computer technology to produce real time audio to mimic the simulated patient according to the scenario (see Figure 6: the facilitator's desk).

Figure 6: The facilitator's desk

He/she also leads the sessions prior and after the simulation. Their role is crucial, in particular for the set up and management of the learning activities following the simulation including time-stamping and redisplaying clinical data that illustrate the performance of the group. Careful handling is required as to focus on key events and decisions within the preceding simulated process for reflection and analysis and to engage students in consideration of critical moments including their errors and successes. Identifying the errors in the procedure and enabling students to make understandings out of these has been beneficial to the students' experience.

The process described above ensures than learners engage in processes and behaviours which are likely to promote quality in learning. The learning activities proposed as part of our model are authentic, realistic and relevant to the needs of the students and the profession they will be called to serve upon graduation. They are constructive as they lead towards developing skills and understanding. Their organisation as part of a clinical case study scenario allows them to be sequential, interlinked and aligned with each other as well as with the desired learning outcomes. Further, they require students to use higher order cognitive processes such as analysing, evaluating, synthesizing information, making judgements and problem solving. Most importantly they motivate and challenge them to get involved in action and engage with the group processes. As such, the learning activities described above seem to fit together with discussions for the need to align learning environments, assessment and students' approaches to thinking (Meyers & Nulty, 2009).

4.3 Collaborative learning and teamwork

Collaborative learning is termed as a condition in which certain interactions likely to promote learning among participants may occur. It is useful to note that these interactions are not guaranteed to emerge among peers working together on an agreed task (Dillenbourg, 1999). Opportunities for critical discussion with tutors within small groups are highly respected in higher education contexts (Pilkington & Walker, 2004).

It is clear that within the case study scenario described above as part of the learning intervention some forms of collaboration have existed. The tasks were shared among the group and there was some discussion among individuals. The latter made the experiences students had as part of their management of the simulated patient explicit. Aspects of collaborative learning can be identified as part of the critical human factors criteria against which the simulated session was assessed. The criteria included leadership, communication, delegation, decision making and teamwork and the areas in which students should improve as individuals and as a group were made evident to them.

During the post simulation reflection section, issues posed by the moderator are integrated into the context of the group's shared experiences. As such, learning takes the form of a contextual and collaborative activity. As part of this, learners initiated the inquiry process and generated relationships between what had been done and said in the preceding simulated session and its immediate impact on the simulated patients' condition (see Figure 7: The simulation based experience recording used at the debriefing session).

Figure 7: The simulation based experience recording used at the debriefing session

4.4 Reflection

Earlier thinking on reflection, including its focus and its processes (Schön, 1983; Eraut, 1995), help illuminate relevant steps in our simulated-learning activities framework. Eraut (1995) elaborates on Schön's (1983) framework of reflection, by explaining the term reflection- in-action whilst at the same time pointing to the need to look at both the focus and context of reflection. It is often impossible to find time to reflect as a professional while acting towards dealing with a problematic and urgent situation at the workplace. Eraut (1995) suggests that the alternatives to reflection-in-action are reflection before action, reflection after action and reflection away from or out of the action. Our model places emphasis on reflection after the simulated session using video and tagging technologies along with the assistance of the facilitator. The focus of reflection in our model refers to the actions of the individuals and the group as part of the management of the simulated patient. In particular, the clinical and human factors criteria under which the group was assessed guided the reflective activities following the simulated session. The context of reflection refers to the medical scenario and the simulators including the patient and its conditions that guided the session. The process of reflection in phase three allows participants to link newly acquired knowledge to their prior knowledge and actively construct new internal representations of practice.

4.5 Problem-based learning

Our model caters for problem-based learning which often forms the basis for medical curricula given its success in helping students develop clinical and life-long learning skills as well as independent approaches to study. There is much innovation in PBL approaches and their value in medical education has been argued based on their effectiveness in facilitating student problem solving and self-directed learning skills (Hung, Jonassen, & Liu, 2008).

PBL in medical education requires exploration of a real problem as part of group work. PBL groups consist of five to eight students. The process involves normally a number of steps in which they attempt to define the problem, explore its parameters, set learning goals and provide solutions. Most importantly, they hypothesise on the case and/or problem and try to understand it by breaking it in tasks and delegating. As part of this, they decide what they need to learn, where they need to seek for resources and when they need to carry out tasks. Often tasks may include producing written assignments and reports which they share within their group.

In the medical scenario followed through the simulated sessions students relocate the initial question posed, i.e. "How do you treat an aged patient with breathing problems at A&E?" The carefully designed learning activities set out in three phases, being structured around a real-life scenario and supported by the tutor, being embedded within the simulation suite context provide students with a purposeful learning environment. The tutor acts mainly as a facilitator of the process rather than a disseminator of knowledge. The process enabled by the tutor and the simulation scenario modelled reasoning processes for the group and students as individuals. Direct answers were not provided to the students not until the third phase i.e. post simulation during which students were engaged in reflection. During the reflection time, the facilitator asked questions aiming to probe students and lead them into finding the correct answer themselves whenever that was possible, rather than providing them with ready-made solutions.

Whilst engaging in reflection, understandings can be made by the students individually and as a group based their actions during the simulation and their prior work as part of PBL. After simulation event participation, individual study as part of exam preparation or assignment completion potentially fosters these understandings. In completion, this process implies flexibility in learning that supports student-centred and self-initiated learning.

4.6 Learner autonomy

Learner autonomy can be promoted through personal reflection. The analysis and evaluation of one's practice enables taking control of their personal and professional development. According to Tait and Knight (1996), learner autonomy enhances development because it allows learners to define their needs and take their own decisions for learning. As such autonomy facilitates independent learning, which enables student personal growth. In that sense, learner autonomy can have long-term beneficial outcomes in developing self-confidence and self-esteem (Rogers, 1961).

Autonomous learning enabled through the simulation process allows the personal construct of the learners to emerge. This is very useful in the case of medical education as the training often involves skills such as situational awareness, communication, leadership, delegation and teamwork. Learner autonomy is thought to be conducive to professional development and it can be stimulated through reflection as part of a learning community (Zenios, 2004). Autonomy offers learners empowerment and helps them to obtain skills leading to life-long learning.

Previous research on learning argued that learner control and autonomy offers students the opportunity to commit themselves into the process of learning and it allows them to refine personal goals and to work towards achieving them based on their individual learning styles and time schedules (Claxton, 1996; Marland, 1997). In the current study, students could benefit from pausing, rewinding and forwarding the video recorded simulated session in order to receive feedback on critical issues, take notes and clarify certain points. Therefore, they were able to focus on problems relevant to their interests and needs and they were invited to develop an autonomous approach to learning.

4.7 Assessment and Technologies

Assessment seeks evidence of learning and allows teachers to check students' understanding and support future learning. The assessment process is not problem-free as it focuses on creating meanings through errors and therefore, often involves intellectual as well as emotional engagement.

The success of the learning activities is very much depended on available technologies including the simulated patients, the computer software and the iPad assessment tool used to mark the criteria for students' assessment, i.e. clinical criteria (patient care, diagnosis and treatment) and human factors criteria (team leadership, communication, delegation, decision making, teamwork, situational awareness, and safety). It is noted that assessment is seen as an integral part of the learning process that guided the design of the activities including reflection and it is not perceived as an extra element imposed at the end of the process.

Technology in our model is used with a purpose to improve learning and teaching rather than having limited impact in the name of innovation. Since the emergence and proliferation of technological advances in education, questions have been raised about their potential to make a difference and to engage students in meaningful learning activities that promote understanding and life-long learning. This learning intervention is an example of an innovation which makes a true difference to medical education.

4.8 Educational design for better links between theory and practice

Our study sees learning as a result of effective educational design that caters for establishing explicit links between theory and practice. In the simulated activity demonstrated above, teaching strategy is an essential part of educational design and guides the learning processes while it goes beyond the traditional boundaries of tutoring. The learning activities enabled prior to, during and after the simulated session, including the final group reflection lie at the heart of our proposed teaching strategy.

The TEL activities happen in situ and they are contextually bounded. The context in which they are placed is near authentic and encourages social interactions and collaborations. An authentic context requires presence of real patients upon which students can practise communication skills as part of a medical scenario, not merely simulated ones. However, that could be too risky for the human patients, therefore raising ethical concerns. Practising on human patients does not really allow for any mistakes upon which a novice doctor may reflect. The simulation-based learning environment replicated the real A&E ward context and reproduces the near authentic context which was required to set up learning activities which provided opportunities for reflection in situ. The value of the near authentic replicated simulation experience needs to be stressed here. Earlier psychological research suggests that deliberate practice can even be preferable to real setting work activities not just because it allows for attention to most critical situations, but also because it enables to improve performance in response to discussion upon results and/or tutor feedback (Eriksson, Krampe, & Tesch-Romer, 1993).

Higher education institutions are often being disapproved for highlighting on the transfer of declarative subject knowledge to the students at the expense of preparing them for practice at the workplace and meeting the needs of the employers. The simulation-based learning model is an example where opportunities for transferring skills into real work contexts are provided. Collaborative activities, including decision making and sharing of knowledge have been sought, developed and explained as part of our model.

During the final phase learning activities, aspects of knowledge applied in the simulation session are made evident and explicit through discussion and elaboration. This processes enables students to potentially improve their future performance in response to knowledge and feedback from their tutor. Such initiatives favour the creation of links between theory and practice and prepare students to function intelligently and confidently in conditions of complexity and uncertainty. In the case of medical education such approaches help to improve patient safety and well-being.

5. Conclusion

Simulations are vital in medical and health care education for practising clinical and non-clinical procedures and skills given that experimenting with patients can be high risk and prone to ethical concerns. Rare cases are even more difficult to teach in medical training especially if a hands-on approach is required. Constant reliance on availability of patients is less accepted as appropriate for the 21st century medical education. In the suggested model, the learning agenda is structured around the needs of the learners rather than the availability of human patients. The model employs a learner-centred approach in which learning activities are salient and favour deliberate practice. The simulated process allows repetition of certain complicated tasks to ensure they are mastered (Ericsson et al., 1993). The environment allows learners to make mistakes and learn from upon reflection on performance facilitated in phase three and beyond.

Although the model draws on a medical scenario, it focuses on communications skills that can be applied across programmes that aim to cater for developing employability skills. Useful lessons can be drawn for programmes across disciplines that include participation in TEL simulation events with structured learning activities organised as part of communities of practice. In incorporating new technologies in education we don't take existing pedagogy for granted. New experiences bring surprises and challenge for learners and tutors. Therefore there is a need to redefine pedagogy so that it serves the purpose of understanding TEL initiatives and enabling design for success.

This study provides a model for organizing simulated-based learning activities that can promote collaborative learning as part of a PBL approach that can be applied in teaching communication and employability skills across disciplines. The proposed model brings together perspectives from experiential and situated approaches to learning informed by the TEL approach. Within the proposed framework, the activities enabled by the simulations are key in the quality of the learning experience and they are situated and contextually bounded, i.e. the context in which these are embedded including the designed medical scenario are paramount. Reflective practices, collaborative learning activities and pedagogically informed tasks have a central role in this process.

Implications for practice can be drawn for teaching staff and practitioners in the medical profession as well as for other professionals who employ simulations in order to engage in learning activities that favour workplace practices such as communication and leadership. The paper contributes to a more complete understanding of the complexities of simulation-based learning processes in higher education and professional development. This paper has focused on developing theory on TEL not merely for legitimacy purposes but for practical reasons. Theory is a powerful guiding platform for shaping implementation and uptake of technology. Developing educational theory is an investment in developing the capability of TEL.

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