A framework for the design of computer-assisted simulation training for complex police situations

Tor Söderström
Department of Education, Umeå University, Umeå, Sweden
Jan Åström
Police Education Unit, Umeå University, Umeå, Sweden, and
Greg Anderson and Ron Bowles
Justice Institute of British Columbia, New Westminster, Canada

Abstract
Purpose - The purpose of this paper is to report progress concerning the design of a computer-assisted simulation training (CAST) platform for developing decision-making skills in police students. The overarching aim is to outline a theoretical framework for the design of CAST to facilitate police students' development of search techniques in complex interactions within the built environment, learning to apply and perform the five "quick peek" techniques for information gathering, and subsequent risk evaluation.
Design/methodology/approach - The paper draws on Luckin's ecology of resources model of learner context informed with perspectives on reflective thinking from John Dewey and Donald Schön. The paper discusses design issues within the ecology of resources model applied on CAST for complex police situations.
Findings - It is suggested that Luckin's framework with its focus on the interaction between different elements and filters in the learner's context together with Schön's perspective on reflection challenge educational designers to look beyond the immediate development of specific tools (such as the CAST in this project) and examine how these tools will be effectively embedded in the overall learning experience.
Originality/value - This paper has presented two theoretical perspectives, Luckin's ecology of resources model and Schön's perspective on reflective practice as foundations for the educational design of CAST. Applying Luckin's framework as informed by Schön helps focus attention on issues that are important in the design process in order to facilitate educational transfer.
Keywords Skills, Transferable skills, Educational design, Education and training, Computer-based learning, Computer-based training, Reflective thinking, Vocational training, Police education, Computer-assisted simulations.
Paper type Conceptual paper

Introduction

A major dilemma for police education is the gap between education and performance in the field. Police education, like vocational education in other disciplines, is based on the concept that the training students receive results in effective future performance as operational police officers. This rests on an assumption that the transfer of learning from the educational to the operational context is dependent on the quality of the educational environment. Mayer *et al.* (2011) point out that social constructivist methodology facilitates transfer to a higher degree than behaviorist methods. They also note that transfer is affected by the structure and time spent on training.

Transfer of learning may also depend on the type of skills and knowledge involved. Isolated, "closed" skills that are performed the same in training and the workforce may transfer more easily than "open" skills where actions vary depending on how the individual interprets a particular situation. In fact, the gap between training and field performance is most noticeable in the application of complex procedures within dynamic environments, where learning emerges as a result of multiple experiences in similar, but varied situations. This paper focusses on these types of complex skills and knowledge within the context of police education.

Police students must learn to function in complex situations within an ever changing environment. Students must master both specific practical techniques and the thinking and decision making required to use these techniques effectively. These outcomes are learned through a variety of practical exercises such as drill exercises and scenario training. However, practical learning training generally requires large investments in time and money, limiting the number of repetitions or opportunities that students have to practice, reflect upon and gain experience, and perfect their training. Computer-assisted simulation training (CAST) provides a training resource that may offer cost-effective alternatives to, or supplements for existing physical training. CAST has been used to varying degrees in a variety of education settings and disciplines. For example, the use of CAST as a viable option for training physical skills is growing within medical education (see, e.g. Issenberg *et al.*, 2005; Nehring and Lashley, 2009). In other disciplines, especially in the natural sciences, research has shown that simulation training contributes to the development of subject-specific knowledge to a greater extent than conventional training (e.g. Chang *et al.,* 2008; Huppert *et al.,* 2002). The positive impact of simulations on knowledge development is explained by their contribution to experiential learning where the learner works actively with the material to be learned during training (e.g. Dalgarno and Lee, 2010; Holzinger *et al.,* 2009; Rieber *et al*., 2004; Stainton *et al*., 2010).

The effective use of simulation and technology for developing skills and decision making requires a structured, planned, and reflexive approach to learning design (Goodyear, 2005; Mor and Craft, 2012). Computer-assisted simulations must facilitate the

intended educational purpose and support learners' interpretation of the learning experience (Mor and Craft, 2012). The outcome of students' learning is influenced by the design, revision, and additions to the simulation tool (Chang *et al.,* 2008; Windschitl and Andre, 1998), but also by the context in which the simulation is designed and employed. For example, Ha¨ll *et al.* (2011) added peer student exercises to simulation training and concluded that the support of a peer group was positively related to the students' task performance. Thus, the ability of CAST to improve knowledge and skills is affected by contextual and educational conditions which influence how the simulation is used. The challenge, then, for police educators is how to best design complex scenarios using CAST that help students better prepare for and effectively learn from subsequent physical scenario training.

This paper presents an approach toward the design of CAST that facilitates police students' learning of basic methods of local entry searches based on tactics used by the Swedish National Police Services. The overarching aim of this discussion is to outline a theoretical framework that can inform the design of CAST environments that foster the development of competence in complex training scenarios. This design process draws on Luckin's (2008, 2010) ecology of resources model of learner context and is informed by perspectives on reflective thinking (Dewey, 1910, 1938; Schön, 1983, 1987). This theoretical framework is introduced and then applied to describe the selection and use of different resources within the learners' context. Finally, various issues concerning the CAST and its future implementation in police education are discussed.

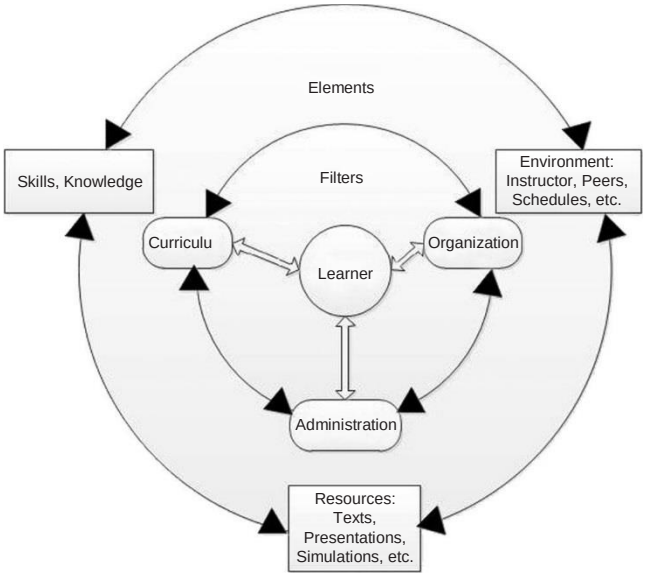
Theoretical framework

Educational design may be conceived of as the arrangement of a learning environment or context to support desired learning outcomes. Dewey (1910) claimed that if the subject matter of learning is not arranged in a meaningful way "the effect upon habits of thought is detrimental" (p. 10). Thus, the educational design process, from Dewey's point of view, must foster an interest in what is to be done and an incentive for doing it. This focus on the learner's context emphasizes the importance of learners' experiences and the need to create meaningful problems that engage the learner in a process of reflection.

Luckin (2008, 2010) calls upon Vygotsky's concept of the zone of proximal development (ZPD) to explore how educational technology can support effective learning. Luckin (2008) notes that the key to ZPD is the use of scaffolding, or the provision of feedback and support to challenge, but not overwhelm the learner. Thus, effective learning occurs where problems and feedback are slightly above the current level of the learner's performance. Luckin poses the zone of available assistance (ZAA) as the range of resources available to support the learner and the zone of proximal adjustment (ZPA) as those elements of the ZAA which are most appropriate for supporting the learner in relationship to a particular learning goal. In Vygotsky's model, a more capable partner or teacher selects and structures appropriate experiences (creates the ZPA) for the learner. Luckin's model extends these concepts and notes that simply providing a rich set of resources (ZAA) does not necessarily foster learning; either someone (e.g. peers or instructors) or something in the technology (e.g. programming) must monitor the student and adapt the learning experience to maintain the student in the ZPD. This point warrants re-emphasis: simply creating multiple experiences with rich resources does not ensure effective learning; these resources must be chosen, sequenced, and structured in an ongoing manner to meet the emergent needs of the learner.

Ecology of resources model

Luckin's (2008, 2010) ecology of resources model offers a method for choosing and using resources within a social learning environment to foster complex learning outcomes. Luckin's model explores the interaction of learners with the skills and knowledge they wish to develop, the resources that are available to support that learning, and the environment in which these elements interact. She presents these facets - skills and knowledge, resources, and environment - as elements of an ecology or system that may be purposefully arranged to foster effective learning. Learners encounter each of these elements through "filters." Thus, the desired skills and knowledge are organized into curricular structures, such as simple-to-complex or abstract-to-concrete frameworks. Similarly, the range of resources that learners engage with, such as texts, learning presentations, or simulations, forms a ZAA, which require administrative structures to form an effective ZPA that fosters learning. Administrative filters may include adaptive strategies such as providing feedback based on learner responses or the selection and sequencing of further resources. Finally, the interaction of content and resources with environmental elements, including instructors and peers, are organized through structures such as formal schedules and activities (Figure 1).



Source: Adapted from Luckin (2008, p. 453)

This ecology of resources is useful in examining the role of CAST in addressing the gap between police education and practice at two levels: first, exploring how CAST may be an effective resource for meeting specific learning outcomes and second, in identifying ways in which CAST may interact with other elements of the learning environment to foster effective learning.

Dewey's (1938) views on experience and education suggest that effective police simulations must create an experience that prepares students for later experiences of a deeper and richer quality. As noted in the introduction to this paper, police students must master both specific processes and the decision making required to effective use those processes. Luckin's (2008, 2010) model notes that learning of specific skills or knowledge is dependent on the effective selection and use of educational resources. Practice activities, such as simulations, are critical steps in developing experiential knowledge required for application of procedures in the field. These activities provide scaffolding that enables students to improve their understanding and function at a higher level (Vygotsky, 1978). As noted in the introduction to this paper, practical training is expensive and time intensive. The ecology of resource model provides a way to address this gap by considering how other resources might be employed within the learning environment to develop these specific skills. Resources such as CAST are available and can be used to provide opportunities for police students to practice complex procedures.

But learners do not experience content and resources directly; rather their experiences are always filtered by the educational tasks to be undertaken, the underlying pedagogy of instruction, and the use and usability of the technology. Effective educational use of CAST requires consideration of where and when it is used, but also additional attention to its interaction with other environmental factors such as instructors and peers.

CAST in reflective thinking

CAST may serve a number of pedagogic functions including development of experience and fostering of reflective thinking. Perspectives on reflective thinking inform the use of CAST to foster decision-making skills required by police students. Action, or experience, is central to the development of knowledge, but does not generate knowledge automatically (see, e.g. Crookall and Thorngate, 2009). Mayer *et al.* (2011) showed that performance in a business simulation does not necessarily say anything about how much the students learned. Learning to deal with complex situations requires both training on specific practical techniques and the thinking that guides their use. Using Donald Schön's (1983, 1987) concepts, CAST must create opportunities for students' reflection-in-action to support thinking about their ongoing actions in-the-moment, but also for reflection-on-action to support thinking upon their past performances. Schön (1983) claims that feelings of uncertainty, uniqueness, and value conflict in a situation can provide an opportunity for learners to expand their understanding of a specific issue through reflection. Reflection creates a situation that requires one to go beyond knowing-in-action which is tacit and used as long as the situation falls within the boundaries of what we have learned to treat it as normal (Schön, 1987). However, the use of police procedures in the field is complex; many police encounters involve unique situations in which there is no pre-determined correct approach. In such situations, a police offer's tacit knowing-in-action is always under pressure. When one's knowing-in-action cannot handle a situation, Schön suggests that one may respond by reflection-in-action. Reflection-in-action occurs within the present action and involves thinking what one is doing while doing it (Schön, 1983, 1987), i.e. thinking critically about events that led to the situation where knowing-in-action could not be applied. This creates on-the-spot experimentation – responses taken when action cannot be based on one's prior professional repertoire of techniques, knowledge, and understanding. In this situation, people try out new actions in relation to practice. From Luckin's (2008, 2010) perspective, this reflective process can be supported by various resources and environmental elements. Schön emphasizes the importance of coaching and mentoring support so that students are given the opportunity to discover new dimensions of action (Schön, 1987). Vygotsky (1978) describes the role of the more able partner in

guiding learners' learning. Practical learning and simulation activities that call upon reflective practice emphasize the importance of both instructor-led and peer feedback. CAST may support reflection-in-action through built-in programming and feedback; however, effectively fostering reflection-on-action may require support
by more knowledgeable instructors or peers.

The design process – resource considerations

The previous section outlined a theoretical framework that could inform the design of CAST activities to support the development of complex learning outcomes. In this section, we apply these concepts to describe the development of computer-based simulations within the context of police education. The following description follows Luckin in describing the simulations in terms of skills and knowledge, resources, and environment.

Knowledge and skills: basic training police tactics

Strategies for peaceful resolution of conflict during local entry clearance searches provide the basic premise for police tactics and conflict resolution. During basic police training the non-confrontational strategy for local entry clearance searches endorses three fundamental tactical approaches (Swedish National Police Services basic tactical instruction material):

(1) tactical risk and threat assessment (identifying risks and problem areas such as risk areas from which a possible attack can occur);
(2) control of the situation (concerning time and ability to adequately react during an active threat); and
(3) the thought process (creating time for oneself, i.e. preparing, locating the perpetrator); defining the situation (e.g. can the perpetrator locate me, prepare himself, can he start an attack at me?) and finally acting.

Conducting a search involves moving from areas under the control of the police into adjacent areas. Officers must assess the possibility of risk and ask whether or not they will have control before moving into subsequent areas. If the answer is "yes," then the search can continue. If the answer is "no," then the officers must choose one of several potential strategies in order to continue safely. Police students must learn how to search risk areas in a way that minimizes the possibility of a successful attack by a perpetrator. A key strategy involves reducing the time where full control is not achieved by moving forward quickly and "peeking" into risk areas while maintaining a position of control from which information can be processed safely.

The aim of training in local entry clearance searches is to develop skilled search tactics that utilize several basic principles: first, to ensure that a secure retreat path is present (meaning that a risk area that is not scanned should not be passed); second, to use defensive tactics, and, if possible, avoid direct confrontation in a risk area in which officers do not have control; and finally, to control the stress by limiting the number of potential problems and risk areas that must be dealt with at one time. The specific knowledge and skills that students must learn includes five ways to perform a "quick peek" to receive information for judging risks which guide their actions: a three-meter peek, a one-meter peek, center peek, own corner peek, and cross-corner peek. The three-meter-peek is done to assure that a person can move forward and perform the other peeks. The one-meter peak is used to obtain a more reliable view of the area to be searched. The center peek is used to give a broad perception of the room. The two corner peeks (own corner peek and opposite corner peek) reveal potential threats and potential points of cover. These peeks should be performed in silence and should be performed with tempo changes to minimize the time a person is in the risk zone.

Luckin (2008) notes that the types of knowledge and skill to be learned is filtered through the use of curriculum. The basic tactical approach ultimately controls the whole scenario. Thus, CAST scenarios that focus on these skills must allow the use and practice of these various search tactics. Further, the design of the scenarios must incorporate legislation connected to police practice as well as the police basic tactical approach. The scenarios must allow students the opportunity to succeed if the search is performed according to the desired approach.

Similarly, the curricular filter must ensure that the scenarios are relevant and engage the learner (Dewey, 1938). Three sets of questions related to the design of the scenario must be addressed in order to make it relevant (see Dieckmann, 2009 for the importance of relevance instead of realism):

(1) Which environment will the scenarios be set in? The design included several authentic locations such as an apartment/residential setting, warehouse/public building, and indoor office space.
(2) What are the possible scenarios and how might they unfold? What should be scanned? What types of characters will be in the scenarios (e.g. confused people, unarmed perpetrators, armed perpetrators)? What are the possible actions (up to and including lethal use of force) that students might be expected to use?
(3) Should all possible hiding spaces be searched? How detailed must the scenarios be?

The computer simulation resource (tool)

Luckin (2008) notes that a variety of potential resources may exist to support learning (the ZAA), but that effective learning involves use of resources or tools designed to meet the desired knowledge and skills. The explicit learning goal for this computer simulation was to facilitate learning the knowledge and skills that are involved in the basic tactical approach for a local entry search, and in particular to allow students to practice in multiple situations (or scenarios). Although the actual technology used or financial

resources required are important, they are outside of the scope of this paper.
The project used the game engine "Unreal" which provides a 3D first person game user-interface (see Plate 1) to develop the scenarios.
To accomplish the desired learning experience, the tool created a ZPA (Luckin, 2010) through the use of scaffolding to support the negotiation of a ZPA for the learner. The scenarios were designed to prepare students to face unique and complex situations where "the case is not in the book" (Scho¨n, 1987, p. 5). Feedback on students' actions is essential for fostering both reflection-in-action and reflection-on-action (Schön, 1987). CAST developers considered what type of feedback should be given for each possible response and action, and how each response might enhance reflective thinking. For example, Dewey (1910) suggests that when one is doing something they are forced to use eyes, ears, and sense of touch as guides for action which, as much as possible, has to be addressed in the design process. Researchers have suggested that the simulator's ability to give feedback provides individualized perceptual and cognitive support for the student's learning of a new skill (Nilsson, 2007; Rieber et al., 2004; Sile´n et al., 2008). The actions and feedback given by the CAST scenarios provide, in effect, a scaffolding resource that serves as a "more able partner" in Luckin's terms, and

Plate 1.
The simulator user interface

provide for opportunities for improvization, discovery, and testing (Schön, 1983, 1987). Other research (Dalgarno and Lee, 2010; de Freitas and Oliver, 2006; Holzinger *et al.,* 2009; Rieber *et al.,* 2004) found that learners need the opportunity to ruminate, evaluate, reformulate, compare, and integrate the material to be learned during the CAST. So, students must also be able to reflect on their experiences in the scenarios. Overall, the computer simulation must respond to actions taken by the user (fostering reflection-in-action) while providing feedback based on the user's training. The CAST must give feedback that supports users' reflections on risks and risk evaluation during the local entry search and also allow an after-action debriefing on what users did during the search. Research from medical simulations indicates that this feedback should address the type of knowledge, skill, attitudes, or behavior desired of the learners (Gaba, 2004; Issenberg *et al.,* 2005).
Based on this analysis, the simulation must consider several issues:

(1) The police officers conducting search should have great freedom of movement (3D), being able to move in any direction.
(2) The police should be exposed to different types of attacks. Possible attacks and the scope of them should be tied into the police conduct. For example, if the search is performed incorrectly, then eventually an attack may occur. The police must also be able to switch between weapons, self-defense techniques, baton, pepper spray, and firearms. The scenarios must capture clinical variation similarly to Issenberg et al.'s (2005) view on healthcare simulations. In the healthcare domain Gaba (2004) points out that variations include conceptual understanding, technical skills, decision making, teamwork, and attitudes. In this project, the scenarios must focus on the conceptual understanding of how to conduct the base tactical approach and local entry search. The simulator's ability to produce random variations of specific tasks (e.g. possible attacks, new risk areas) must also allow repetition to support conceptual understanding.
(3) The police students should be able to get immediate feedback on their search. Students must be able to detect and identify risk areas during the search so they understand what areas are secure or need to be investigated. Both how fast the police will recognize the risky areas and in what order will depend upon the situation. Feedback on their positioning in a room, how long they are standing at the same spot, etc., in relation to an evaluation of the risks is required. Further, the users should be able to go back and search an area if they realize they missed a space (see Issenberg et al., 2005, regarding repetitive practice for healthcare simulations).
(4) The simulation must include different levels of difficulty (cf. Issenberg et al.'s, 2005, view on the importance of the range of difficulty level for clinical simulations in the healthcare domain).
(5) The search should be able to be performed with one and two police officers. The initial project was developed for a single patrol search; however, to be more effective in the future, the ability to easily implement double patrol searches (a

common work strategy in Sweden) needs to be considered.

(6) The search should be recorded to enable reflection on the action a user performed in the simulation. This is important in order to enable for deep after- action debriefing (Crookall, 2010).

The environment resource

The third element in the ecology of resources is the environment in which students encounter the resources that support the learning of desired knowledge and skills. Luckin (2008) notes that, in the same way that different resources may be used to achieve specific results, the environment may also be effectively organized in various ways.

The students' use of CAST never occurs in isolation. All learning activities are embedded and interact within the students' overall experience of the curriculum. CAST may be employed in the curriculum in a number of ways to support different types of learning outcomes. For example, CAST scenarios may be completed by individual students in isolation from each other, or may be employed in collaborative training. Similarly, CAST may be run as a desktop application in the student's home or may be part of a scheduled lesson in a computer lab. The scenarios may be designed as extra-curricular activities or as scheduled activities within the curriculum. The scenarios may be used as an orientation activity, employed to demonstrate procedures (e.g. an instructor performs the simulation and the output is projected to the entire class), or used by individual students to practice in preparation for practical scenarios. Each of these uses fosters different outcomes. In each case, the purpose and use of CAST is based on an analysis of a specific learning task which is then integrated into the curriculum to support its learning objectives. Instructors adjust the environment and embed CAST in the curriculum in the most effective manner.

Within this project, the use of CAST was spurred by the need to create an environment and resource that allowed students to practice the use of local entry search tactics within a dynamic (changing) environment. However, a second element of the environment must also be considered. As noted above, reflective thinking is an essential element of effective practical learning environments. While the CAST has built-in support of reflection-in-action, in the form of feedback and adaptation based on student actions, reflection-on-action is best supported by a more able partner external to the simulation itself. In this case, structuring the environment to use CAST as an individual activity on personal computers may not be effective. Reflective thinking is better supported by the use of CAST in collaborative training sessions within the computer lab. Students work together and collaborate on the scenario. (Note that more advanced CAST applications may also allow multiple learners on different computers to work on the same scenario through a network connection.) Peers and/or the instructor are able to provide immediate feedback and support, as well as participate in post-scenario debriefing sessions to foster reflective thinking. Both individual and collaborative uses of CAST can be effective, but the specific relationship between the resource (CAST) and the environment (how its use is structured and embedded in the curriculum) must be based on the aim of simulation and the attainment of desired knowledge and skills.

Reflections on a design work in progress

Both Luckin's and Schön's theoretical frameworks have been useful in the design process. Luckin's (2008, 2010) framework focusses attention on the interaction between different elements and filters in the learner's context. Schön's perspective on reflective thinking focusses attention on reflective possibilities in the design process. Together these perspectives challenge educational designers to look beyond the immediate development of specific tools (such as the CAST in this project) and examine how these tools will be effectively embedded in the overall learning experience. The work performed in this project involved the design of CAST for learning local entry clearance search procedures in complex police situations. Based on this theoretical framework, the project developed a simulator prototype for single patrol searches where students can, preferably in groups, act and discuss action strategies to enable reflection-in-action (peers can enhance subject-specific reflections). Risk areas can be identified and marked and searches are recorded and can be used for reflection-on-action (after-action debriefing). Further work will allow for the creation of dynamic situations with the addition of levels, scenarios, and tailored feedback opportunities.

Other theories and models may further enrich the engagement of learners in the scenarios, such as the incorporation of learning engagement factors (game engagement) (Whitton, 2011) or incorporating a design dilemma perspective (Harteveld *et al.,* 2009). Further assessment of the scenarios by students and professional police officers may identify other improvements to engagement or performance (see Whitton, 2011). As well, the next stage of the design process should explore the use of action hooks, resource hooks, tactical and strategic hooks that afford actions and feedback to the players which Dickey suggests may work as "[y] a type of architectural model for promoting engaged learning" (Dickey, 2005, p. 80).

Additional study may also inform the integration of game-based CAST activities. The current prototype is based on a single person performing the searches. As noted above, the CAST is employed collaboratively by having groups of students work through the scenario together. However, a networked version of the CAST would allow students, each from a different computer, to work in teams which would more closely replicate actual practice. Within the ecology or resources framework, however, changing the resources (e.g. multiple students on different computers engaged in the same scenario) will require a different organization of the environment. In addition, students have different levels or backgrounds in using gaming environments, and a current study is exploring how much training students with different backgrounds need to use the CAST environment effectively.

Summary

This paper has presented two theoretical perspectives, Luckin's ecology of resources model and Schön's perspective on reflective practice as foundations for the educational design of CAST. Police students must master both specific procedures and the thinking and decision-making processes required to use them effectively. Ideally, these skills and knowledge are established through ongoing

practical training exercises and drills. However, practical training requires both time and financial resources that limit students' ability to develop skills, such as local entry clearance search procedures, to the extent required to adequately prepare them for professional practice. CAST scenarios provide a potential resource that allows students to repetitively practice these procedures within a dynamic environment. The use of feedback built into the scenarios facilitates reflection-in-action, and embedding CAST scenarios as collaborative activities within a computer lab allows for peer and instructor-based feedback to encourage reflection-on-action. Thus students are able to practice different scenarios and develop a larger repertoire of experience in dealing with cases or situations that they will encounter in real life situations (Johnson, 2010). Applying Luckin's framework as informed by Schön helps focus attention on issues that are important in the design process in order to facilitate educational transfer. However, there is a need for more research on different simulations and scenarios informed by theoretical perspectives to enhance the knowledge about design for learning and its relation to learning.

References

Chang, K.-E., Chen, Y.-L., Lin, H.-Y. and Sung, Y.-T. (2008), "Effects of learning support in simulation-based physics learning", *Computers & Education*, Vol. 51 No. 4, pp. 1486-1498.

Crookall, D. (2010), "Serious games, debriefing and simulation/gaming as a discipline", *Simulation & Gaming*, Vol. 41 No. 6, pp. 898-920.

Crookall, D. and Thorngate, W. (2009), "Editorial. Acting, knowing, learning, simulating, gaming", *Simulation & Gaming*, Vol. 40 No. 1, pp. 8-26.

Dalgarno, B. and Lee, M.J.W. (2010), "What are the learning affordances of 3-D virtual environments", *British Journal of Educational Technology*, Vol. 41 No. 1, pp. 10-32.

de Freitas, S. and Oliver, M. (2006), "How can exploratory learning with games and simulations within the curriculum be most effectively evaluated?", *Computers & Education*, Vol. 46 No. 3, pp. 249-264.

Dewey, J. (1910), *How We Think*, Dover Publications, New York, NY.

Dewey, J. (1938), *Experience & Education*, Touchstone, New York, NY.

Dickey, M.D. (2005), "Engaging by design: how engagement strategies in popular computer and videogames can inform instructional design", *Educational Technology Research and Development*, Vol. 53 No. 2, pp. 67-83.

Dieckmann, P. (Ed.) (2009), *Using Simulations for Education, Training and Research*, Pabst Science Publisher, Lengerich.

Gaba, D.M. (2004), "The future vision of simulation in health care", *Quality and Safety in Health Care*, Vol. 13 No. 1, pp. 2-10.

Goodyear, P. (2005), "Educational design and networked learning: patterns, pattern languages and design practice", *Australasian Journal of Educational Technology*, Vol. 21 No. 1, pp. 82-101.

Häll, L.-O., Söderström, T., Ahlqvist, J. and Nilsson, T. (2011), "Collaborative learning with screen- based simulation in health care education: an empirical study of collaborative patterns and proficiency development", *Journal of Computer Assisted Learning*, Vol. 27 No. 5, pp. 448-461.

Harteveld, C., Guimares, R., Mayer, I.S. and Bidarra, R. (2009), "Balancing play, meaning and reality: the design philosophy of Levee Patroler", *Simulation & Gaming*, Vol. 41 No. 3, pp. 316-340.

Holzinger, A., Kickmeier–Rust, M.D., Wassertheurer, S. and Hessinger, M. (2009), "Learning performance with interactive simulations in medical education: lessons learned from results of leaning complex physiological models with the HAEMOdynamics SIMulator", *Computers & Education*, Vol. 52 No. 2, pp. 292-301.

Huppert, J., Lomask, S.M. and Lazarowitz, R. (2002), "Computer simulations in the high school: students' cognitive stages, science process skill and academic achievement in microbiology", *International Journal of Science Education*, Vol. 24 No. 8, pp. 803-821.

Issenberg, S.B., McGaghie, W.C., Petrusa, E.R.I., Lee, G.D. and Scalese, R.J. (2005), "Features and uses of high fidelity medical simulations that lead to effective learning: a BEME systematic review", *Medical Teacher*, Vol. 27 No. 1, pp. 10-28.

Johnson, S. (2010), "Transferable skills", in Bailey, R., Carrow, R., Carr, D. and McCarthy, C. (Eds), *The Sage Handbook of Philosophy of Education*, Sage, London, pp. 353-368.

Luckin, R. (2008), "The learner centric ecology of resources: a framework for using technology to scaffold learning", *Computers & Education*, Vol. 50 No. 2, pp. 449-462.

Luckin, R. (2010), *Re-Designing Learning Contexts. Technology-Rich, Learner Centred Ecologies*, Routledge, London.

Mayer, B.W., Dale, K.M., Fraccastoro, K.A. and Moss, G. (2011), "Improving transfer of learning. Relationship to methods of using business simulation", *Simulation & Gaming*, Vol. 42 No. 1, pp. 64-84.

Mor, Y. and Craft, B. (2012), "Learning design: reflections on the current landscape", *ALT-C 2012 Conference Proceedings – A Confrontation with Reality*, pp. 85-93.

Nehring, W.M. and Lashley, F.R. (2009), "Nursing simulation: a review of the past 40 years", *Simulation & Gaming*, Vol. 40 No. 4, pp. 528-551.

Nilsson, T.A. (2007), *Simulation Supported Training in Oral Radiology. Methods and Impact in Interpretative Skill*, Doctoral dissertation, Umeå University, Umeå.

Rieber, L.P., Tzeng, S.-C. and Tribble, K. (2004), "Discovery learning, representation, and explanation within a computer-based simulation: finding the right mix", *Learning and Instruction*, Vol. 14 No. 3, pp. 307-323.

Schön, D.A. (1983), *The Reflective Practitioner. How Professionals Think in Action*, Basic Books, New York, NY.

Schön, D.A. (1987), *Educating the Reflective Practitioner*, Jossey-Bass, San Francisco, CA.

Silén, C., Wirell, S., Kvist, J., Nylander, E. and Smedby, Ö. (2008), "Advanced 3D visualization in student-centred medical education", *Medical Teacher*, Vol. 30 No. 5, pp. 115-124.

Stainton, A.J., Johnson, J.E. and Borodzocz, E.P. (2010), "Educational validity of business gaming simulation: a research methodology framework", *Simulation and Gaming*, Vol. 41 No. 5, pp. 705-723.

Whitton, N. (2011), "Game engagement theory and adult learning", *Simulation & Gaming*, Vol. 42 No. 5, pp. 596-609.

Windschitl, M. and Andre, T. (1998), "Using computer simulations to enhance conceptual change: the roles of constructivist instruction and student epistemological beliefs", *Journal of Research in Science Teaching*, Vol. 35 No. 2, pp. 145-160.

Vygotsky, L.S. (1978), *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, Cambridge, MA.

Corresponding author

Dr Tor Söderström can be contacted at: tor.soderstrom@pedag.umu.se