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ANNA-SOFIA ALKLIND TAYLOR
Informatics

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In loving memory of Ingrid and Ulla-Greta

ABSTRACT

This thesis explores the use of serious games from an instructor perspective. More specifically, it aims to study the roles of instructors and how they can be facilitated within an instructor-led game-based training environment. Research within the field of serious games has mostly focused on the learners' perspective, but little attention has been paid to what the instructors do and what challenges that entails. In this thesis, I argue that serious games, as artefacts used for learning and training, cannot fully replace the instructors' tasks, but must rather be designed to facilitate the various activities of the instructors. Thus, instructors form an important target audience in serious game development – not just as subject matter experts, but also as users and players of the game – with a different set of needs than the learners. Moreover, serious gaming (the actualisation of a serious game) involves more than in-game activities, it also involves actions and events that occur off-game. These activities must also be considered when designing and utilising games for learning and training.

Using a qualitative approach, instructor-led serious gaming has been explored from a range of contexts, from rehabilitation to incident commander training and military training. Several different instructor roles have been identified and characterised, including in-game facilitator, puckster, debriefer, technical support and subject matter expert. Based on empirical and theoretical material, a framework for instructor-led serious gaming has been developed. It involves best practices in different phases of game-based training, such as scenario authoring, coaching-by-gaming, assessing in-game and off-game performance, giving feedback, and conducting a debriefing or after-action review. Furthermore, specific needs and challenges for instructors have been identified and reformulated into guidelines for instructor-led serious gaming. The guidelines highlight the importance of usability and visualisation, as well as the need for carefully designed support tools for instructors' situation awareness, assessment and debriefing. Lastly, a number of success factors pertaining to both the development and actualisation of serious games are presented. Since serious games aim to be both productive and engaging, it is advantageous to work with interdisciplinary teams when developing serious games. This includes subject matter experts well versed in serious gaming practices. Furthermore, a successful serious game should adhere to sound pedagogical theories, be easy to use and maintain, and include system support for instructors' tasks. Successful serious gaming practices also involve having an organisational culture that fosters knowledge sharing among practitioners.

SAMMANFATTNING

Denna avhandling undersöker användningen av serious games från ett instruktörsperspektiv. Mer specifikt är syftet att studera instruktörernas roller och hur de kan underlättas inom en lärarledd spelbaserad träningsmiljö. Forskning inom området serious games har mestadels fokuserat på elevernas perspektiv, medan ringa uppmärksamhet har ägnats åt vad instruktörerna gör och vilka utmaningar det innebär. I avhandlingen argumenterar jag att serious games, i egenskap av artefakter som används för lärande och utbildning, inte helt kan ersätta instruktörernas uppgifter, utan måste i stället utformas för att underlätta instruktörernas olika sysslor. Således utgör instruktörer en viktig målgrupp i utveckling av serious games – inte bara som ämnesexperter, utan även som användare och spelare – med en annan uppsättning av behov än eleverna. Dessutom innebär serious gaming (dvs. användandet av ett serious game) förutom de aktiviter som utförs i spelet, även handlingar och händelser som förekommer utanför spelet. Dessa aktiviteter måste också beaktas när man utformar och använder spel för lärande och träning.

Serious gaming har, utifrån en kvalitativ ansats, undersökts i en rad olika sammanhang, från rehabilitering till utbildning av räddningsledare och militär utbildning. Flera olika lärarroller har identifierats och karakteriserats, bland annat facilitator i spelet, puckster (skötare av AI-enheter), utvärderare, teknisk support och ämnesexpert. Ett ramverk för lärarledd serious gaming har utvecklats baserat på empiriskt och teoretiskt material. Det omfattar en beskrivning av bästa praxis i olika faser av spelbaserad träning, såsom scenarioskapande, coachning genom spelande, bedömning av prestation i och utanför spelet, återkoppling, samt sammanfattande utvärdering. Vidare har särskilda behov och utmaningar för instruktörer identifierats och omformulerats som riktlinjer för lärarledd serious gaming. Riktlinjerna belyser vikten av användbarhet och visualisering, liksom behovet av omsorgsfullt utformade stödverktyg för instruktörernas situationsmedvetenhet, utvärdering och avrapportering. Slutligen presenteras ett antal framgångsfaktorer avseende både utveckling och utförande av serious games. Eftersom serious games syftar till att vara både produktiva och engagerande, är det fördelaktigt att utveckling av dessa utförs av tvärdisciplinära team. Detta inkluderar ämnesexperter väl bevandrade i serious gaming. Vidare bör ett framgångsrikt serious game hålla sig till välgrundade pedagogiska teorier, vara lätt att använda och underhålla, samt innehålla systemstöd för instruktörernas uppgifter. Framgångsrik serious gaming-praxis innebär också att ha en organisationskultur som främjar kunskapsutbyte mellan instruktörer.

POPULAR SCIENTIFIC SUMMARY FOR PRACTITIONERS

Games are commonly thought of as recreational, fun and engaging. While many people see them as something on which you spend your leisure time, games have also gained a foothold in other application areas, such as learning, training, rehabilitation, marketing, crowdsourcing and social change. These are commonly known as serious games and the act of playing them is called serious gaming. Serious games have many things in common with simulators, but put less emphasis on realism and more on characteristics of play, such as make-believe and competition. They aim to harness the engaging nature of gameplay, while at the same time encourage a change in the player, the way he or she thinks and acts in particular situations or contexts. However, as is argued in this thesis, games in themselves do not create this change. A complex set of conditions have to be met in order for people to learn by serious gaming. The thesis focuses on one particular instance of serious gaming, in which learning is facilitated by one or several instructors. Instructor-led serious gaming has many advantages. For instance, instructors are more engaged in the learning experience and can ensure that the learners practice in deliberate and reflective ways. Moreover, the instructors can add complexity and dynamic challenges by small means (e.g. role-play), which means that the developmental costs of serious games can be reduced.

The thesis examines instructor-led serious gaming from an instructor perspective, what roles instructors take before, during and after gameplay, and what practices are endorsed by scholars and practitioners. It takes the stance that instructors are and should be active participants of the serious gaming experience and that serious games should be designed to support instructors' roles and activities. Today, the needs of instructors are often neglected when designing serious games. To address this issue, the thesis presents a framework that can facilitate discussions about how to design an instructor-led serious gaming environment. It also presents a set of guidelines for the design of support systems and features that can help instructors in their work. Lastly, it presents a number of success factors, which enable further discussions on how to improve instructor-led serious gaming and provide identification of areas in need of further study.

The first take-away for practitioners is to *reflect upon learning and envision how the game should be used to facilitate learning*. How does the game fit within the larger learning or training context? Does it supplement other activities or reinforce them? How are the players encouraged to use their knowledge from gameplay in real-world situations? How are adaptive and non-linear thinking stimulated, and routine or non-reflective behaviours dissuaded? The thesis presents a few examples on how these questions can be approached. For instance, instructors can devise open-ended scenarios where the learners can try out different choices and solutions and test their outcome. Furthermore, a fundamental part of serious gaming practices is debriefing, which, if done correctly, can facilitate reflection upon the gaming experience and how it relates to real-world tasks and situations.

The second take-away for practitioners is to *make sure to incorporate in-game functionality that facilitates instructors' tasks*, such as automatic assessment features, bookmarking options and tools to provide feedback. Facilitating a serious gaming environment is challenging and instructors need support to assess how the learners are progressing, what they are doing and the consequences of their actions. In addition, they need help to create or select appropriate scenarios and modify them before or during runtime, such as adding new entities or adapting the scoring system.

The third take-away for practitioners is to *provide inexperienced instructors with resources that help them develop skills in how to facilitate serious gaming environments*. Online resources, such as databases or user forums, help instructors to take advantage of the collective knowledge of a large user base of experienced instructors, by asking questions, share stories and gain access to user reviews of various games. A more direct and specialised help can be provided through annual workshops and step-by-step exercises geared towards novices and instructors with low technical skills. Furthermore, managers should take care to encourage instructors who are prominent in their interest and skills in instructor-led serious gaming, since they are a valuable resource in promoting good practices and providing peer-to-peer support within their own organisation. This includes incentives for knowledge sharing among facilitators and the creation and refinement of communities of practice.

The fourth and last take-away for practitioners is to *include experienced instructors as subject matter experts in the development process of serious games*. Experienced instructors can more easily identify and express their needs and requirements, which will improve the design process and general quality of the game. However, less experienced instructors should not be neglected, since the game and the associated support systems should be easy and efficient to use, even for novices. Thus, inexperienced instructors can be advantageously employed for user tests. Moreover, not all projects have access to experienced instructors. In these cases, developers should take great care to train the subject matter experts in serious gaming practices and clarify the difference between games and simulators, in order to avoid unnecessary misunderstandings and confusion.

ACKNOWLEDGEMENT

I played my first computer game when I was about ten years old. It was the mid-1980s and my dad let me play on his Ericsson Portable PC. I remember playing Othello against the computer and laughing when the computer proclaimed “I’m thinking...” before making a move. Of course, I had never heard of the concept of anthropomorphism at the time, but ten year old me still found it amusing. This experience led me to appreciate technology in general and computers and computer games in particular. Even today, my parents inspire me to think about technology and how it is used. For instance, my mother use the game Wordfeud to keep in touch with family; as long as we keep the game going, she knows that we are alive and well. I sincerely believe this is ingenious. So my first words of gratitude goes to *Annica* and *Lars Alklind*, my beloved parents who have always encouraged and supported me in my life and career choices.

Next, I would like to thank the people who contributed more directly to this work: my supervisors. First, I will always be grateful to my main supervisor *Per Backlund*, who has been there all the way with encouraging words, insightful comments and a keen sense of nuances in the world of research. Second, I would like to thank *Jana Rambusch*, co-supervisor and close friend, who I appreciate for her straightforwardness, wisdom and shared geekiness. In this context, it also makes sense to mention *Lars Niklasson*, who was my supervisor for all but the last year and a half of my studies and who taught me to be proud of my work and not to be afraid to ‘stick my neck out’.

I am also lucky to have lots of great colleagues at the University of Skövde, whose support over the years means the world to me. I am not able to mention you all in here, but if you ever gave me advice, a pep talk, feedback or otherwise aided me in my work, know that I very much appreciate your engagement and interest in my work. Some deserve special thanks: *Henrik Engström*, *Mikael Lebram* and *Mikael Johannesson*, who form the core research team in many of the studies presented in this thesis, and *Hanife Rexhepi* for her involvement in the *Elinor* project. Let’s hope there are more fun and challenging projects ahead of us! Thanks also to my fellow PhD student *Björn Berg Marklund*, whose work on educational games complements my own work and whose ‘PhD anxieties’ mirrors my own ones.

A heartfelt thanks to *Eva Söderström*, who is always easy to talk to and a great support for PhD students enrolled at University of Skövde. I am also grateful to those who took their time to review an early draft of the thesis, especially *Wolmet Barendregt*, whose comments led to substantial restructuring of several chapters, which, in my opinion, increased the thesis’ quality. Furthermore, I would like to thank *Thomas Fisher*, who has provided me with invaluable help on LaTeX (including the class files with which this thesis is typeset) and who, like me, enjoys talking about everything that has to do with science fiction.

Another influential group of people is the cognitive science and UXD educators at University of Skövde (you know who you are), who form the greatest team to teach alongside. Thanks for always having my back during the stressful periods that comes with the territory of combining teaching and PhD studies! Some former colleagues also deserves a mention: *Karin Dessne*, *Madeleine Canderudh*, *Jessica Määttä*, *Maria Nilsson* and *Charlott Sellberg*. I wish you all the best with your careers and hope our paths will cross again.

I would also like to express my appreciation towards the cadets and staff at the Swedish Land Warfare Centre. I especially want to thank *Johnny Gullstrand*, *Anders Jakobsson*, *Stefan Lindquist*, *Rikard Johansson* and *Mats Walldén*. Without your support and our open discussions about game-based training, this thesis would not look the same. Additionally, I would like to thank *Victoria Karlsson* and *Peter Rodhe*, at FMV, as well as *Mark* and *Gavin*, at Bohemia Interactive Simulations, for allowing me to participate in their user meetings.

A special thanks also goes to *Vera Lindroos*, whose language review really raised the quality of this thesis.

More family members have also stood by me and I treasure their emotional support; my sister *Marie-Louise Alklind*, who grew up to become a really cool and fun geek to hang out with, and my brother *Kenneth Alklind*, whose friendship I cherish. I am also grateful to my mother-in-law, *Gunnel Hansson*, to whom I feel very close and who always puts my well-being first, and to my father-in-law, *Bernard Taylor*, who always shows interest in my work. Last, but definitely not least, I would like to thank my husband, *Mario Taylor*, who has been there for me through thick and thin. No words can express the gratitude and love I feel for you, so I will spend the rest of our lives showing it instead.

PUBLICATIONS

Publications written as part of this thesis project are listed below and include short summaries of their contents.

PUBLICATIONS WITH HIGH RELEVANCE

1. Alklind Taylor, A.-S., Backlund, P., Engström, H., Johannesson, M., Krasniqi, H., & Lebram, M. (2009). Acceptance of entertainment systems in stroke rehabilitation. In *Proceedings of IADIS Game and Entertainment Technologies (GET 2009)*, June 17–23, 2009 (pp. 75–83). Algarve, Portugal. Retrieved from http://www.iadisportal.org/digital-library/acceptance-of-entertainment-systems-in-stroke-rehabilitation

    I am the main author of this paper. It describes the *Elinor* project (Chapter 9) from a user acceptance point of view. It argues that models of user acceptance of productivity or utilitarian systems are not sufficient to fully explain acceptance of serious games (SGs).

2. Alklind Taylor, A.-S., Backlund, P., Engström, H., Johannesson, M., & Lebram, M. (2009a). Gamers against all odds. In M. Chang, R. Kuo, Kinshuk, G.-D. Chen, & M. Hirose (Eds.), *Learning by playing. Game-based education system design and development. Proceedings of the 4th International Conference on E-Learning and Games, Edutainment 2009* (5670, pp. 1–12). Lecture Notes in Computer Science. Banff: Springer. doi:10.1007/978-3-642-03364-3_1

    I am an important contributor to this paper. It describes the *Elinor* project (Chapter 9) and the challenges of using serious gaming with users who are typically not gamers, and who also suffer from disabilities that make commercial off-the shelf (COTS) game consoles inconvenient.

3. Alklind Taylor, A.-S. (2010, Sept. 6–10). Facilitating coaching during game-based vocational training. Paper presented at the doctoral consortium at the 24th BCS International Conference on Human-Computer Interaction (HCI2010). Dundee, UK

    I am the sole author of this doctoral consortium paper, which outlines the research area and research approach suggested for this PhD project.

4. Alklind Taylor, A.-S. & Backlund, P. (2011). Letting the students create and the teacher play: Expanding the roles in serious gaming. In *Proceedings of Academic Mind Trek conference (MindTrek'11)*, Sept. 28–30, 2011 (pp. 63–70). Tampere, Finland: ACM. doi:10.1145/2181037.2181049

   I am the main author of this paper. It combines ideas from the *Tactical Incident Commander* and SLWC projects (Chapters 10 and 11, respectively). It suggests that we should broaden our view of learners and instructors and see them as creators and players.

5. Backlund, P., Alklind Taylor, A.-S., Carlén, U., Engström, H., Johannesson, M., Lebram, M., & Toftedahl, M. (2011). Tactical incident commander – An online training game for incident commander training. In D. Gouscos & M. Meimaris (Eds.), *Proceedings of the 5th European Conference on Games-Based Learning (ECGBL'11)*, Oct. 20–21, 2011 (pp. 9–17). Athens, Greece: Academic Publishing Limited

   I am an important contributor to this paper. It outlines the *Tactical Incident Commander* game developed during the SCCA project (Chapter 10) and the pedagogical concepts driving the instructional design.

6. Alklind Taylor, A.-S. (2011, Dec. 9). *Coaching by gaming: An instructor perspective of game-based vocational training* (Licentiate thesis, University of Örebro, Örebro). Retrieved from http://oru.diva-portal.org/smash/record.jsf?pid=diva2:474545

   My licentiate thesis presents the state of this PhD work as it was halfway through.

7. Alklind Taylor, A.-S., Backlund, P., & Niklasson, L. (2012). The coaching cycle: A coaching-by-gaming approach in serious games. *Simulation & Gaming*, *43*(5), 648–672. doi:10.1177/1046878112439442

   I am the main author of this journal article. It outlines the coaching cycle framework (Chapter 14) and argues (primarily) for it from a theoretical viewpoint.

8. Alklind Taylor, A.-S. & Backlund, P. (2012). Making the implicit explicit: Game-based training practices from an instructor perspective. In P. Felicia (Ed.), *Proceedings of the 6th European Conference on Games Based Learning (ECGBL'12)*, Oct. 4–5, 2012 (pp. 1–10). Cork, Ireland: Academic Conferences International (aci)

   I am the main author of this paper. It presents some of the empirical results from the case study at the Swedish Land Warfare Centre (SLWC) (Chapter 11).

9. Backlund, P., Alklind Taylor, A.-S., Engström, H., Johannesson, M., Lebram, M., Slijper, A., Svensson, K., Poucette, J., & Stibrant Sunnerhagen, K. (2013). Games on prescription! Evaluation of the Elinor console for home-based stroke rehabilitation. In Z. Pan, A. D. Cheok, W. Müller, & F. Liarokapis (Eds.), *Transactions on Edutainment IX* (Chap. 3, 7544, pp. 49–64). Lecture Notes in Computer Science. London: Springer Berlin Heidelberg. doi:10.1007/978-3-642-37042-7_3

   I am an important contributor to this paper. It is a comprehensive presentation of the results from the *Elinor* project (Chapter 9).

10. Alklind Taylor, A.-S. & Backlund, P. (submitted). Identifying success factors for game-based training

    I am the main author of this article. It outlines seven success factors for serious gaming that originate from three projects on SGs for adult training and rehabilitation (Chapter 16). It has been submitted to the *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS).*

PUBLICATIONS WITH LOWER RELEVANCE

1. Alklind Taylor, A.-S., Backlund, P., Engström, H., Johannesson, M., & Lebram, M. (2009b). The birth of Elinor – A collaborative development of a game based system for stroke rehabilitation. In *Proceedings of International Conference Visualisation (Viz09, CGa)*, July 14–17, 2009. Barcelona, Spain. doi:10.1109/VIZ.2009.19

   I am an important contributor to this paper. It outlines the development process of the *Elinor* console (Chapter 9).

2. Alklind Taylor, A.-S., Backlund, P., Bergman, M. E., Carlén, U., Engström, H., Johannesson, M., Lebram, M., & Toftedahl, M. (2012, Jan.). *Spelbaserad simulering för insatsutbildning (Slutrapport)* [Game-based simulation for incident training](Teknisk rapport No. HS-IKI-TR-12-001). Högskolan i Skövde. Skövde

   This is the final report (in Swedish) from the *Tactical Incident Commander* project (Chapter 10), to which I am an important contributor.

3. Backlund, P., Alklind Taylor, A.-S., Engström, H., Johannesson, M., Lebram, M., Poucette, J., Slijper, A., Svensson, K., & Stibrant Sunnerhagen, K. (2011). Evaluation of usefulness of the Elinor console for home-based stroke rehabilitation. In *Proceedings of the 3rd International Conference in Games and Virtual Worlds for Serious Applications (VS-Games 2011)*, May 4–6, 2011. Athens, Greece. doi:10.1109/VS-GAMES.2011.20

   This paper reports on the initial findings concerning the rehabilitation effect of *Elinor* (Chapter 9). I contributed significantly to the research project that developed and tested *Elinor*.

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PART I
THESIS OVERVIEW

CHAPTER 1

INTRODUCTION

Picture a group of cadets, each seated in front of a computer and deeply immersed in gameplay. They are playing a first-person shooter game designed to help them understand the workings of warfare through first-hand experience. Their instructor has given them an objective, to protect a village from hostile terrorists, and their task is to devise a strategy which will achieve that objective with a minimal loss of resources and human lives. The cadets who have been assigned platoon commanders pore over their maps, talking in hushed voices to their second-in-command. After a while, each of them calls for their squad commanders, who leave their computers to huddle together while receiving their orders. Some ask questions, others take notes. Then everyone returns to their computer. Tension rises as soon as one of the groups encounters its first enemy. One cadet's avatar is killed and has to wait in silence (dead soldiers cannot tell others that they are dead) for one of the other cadets to notice so that it can be dragged to the nearest shelter and 'revived' (or 'respawned', to use a gamer term). A bit further away, all of the soldiers in one of the squads are taken out by a mine. The cadets quickly huddle together to think of another strategy before their avatars are respawned outside the village.

The first-person shooter (FPS) game that the cadets are playing is a serious game (SG) and the above scenario is an example of serious gaming. SGs can be thought of as games *designed for and used in a non-entertainment context in order to engage the users, contribute to the achievement of a defined purpose, and assess the players' progress towards a goal related to said purpose*. A key question one might ask is: What does the instructor do during serious gaming? Monitoring the cadets' progress on a separate screen? Walking around in the room, peering over the cadets' shoulders and taking notes? Acting as a company commander, giving further instructions as the game progresses? Playing alongside the cadets, with their own avatar? Playing the enemy, controlling the enemy avatars? The truth is that the instructor, or rather instructors (because they seldom work alone), do all of these things, to a certain degree. What they do *not* do is sit back and passively watch the game unfold. This might seem like a mistake; will the cadets' flow and immersion in the game not be broken, giving the exercise a tint of falseness and, in effect, have a negative effect on learning? I would argue no, and this thesis gives you my arguments for that conclusion. Furthermore, it shows examples of how instructor-led game-based training (GBT) is and can be carried out, as well as suggests good practices based on empirical observations and sound pedagogical theories. Last but not least, it discusses and gives examples of how to facilitate the instructors' tasks in a serious gaming context.

1.1 INSTRUCTOR ROLES AND GAME-BASED TRAINING PRACTICES

What constitutes 'good' practice in GBT? As the field is moving towards maturity, this is a good time to study current practices, since more and more practitioners are starting to develop procedures for using games for various purposes. Using games efficiently for training requires a well thought out pedagogical model grounded in both theory and hands-on experiences by practitioners. However, few research-oriented publications describe serious gaming practices in terms of instructional strategies and the role(s) of the instructor or facilitator (Axe & Routledge, 2011). Instead, most descriptions of game-based learning (GBL) and GBT are presented from a learner's point of view, and few have ventured to describe them from an instructor's perspective. The issue is well articulated by Bauman and Wolfenstein (2013, p. 115):

> In order to use simulation and game-based technology to prepare students for actual clinical environments, it is important to consider who the end user actually is. The easy answer is that the end user is the student. The complex and comprehensive answer also considers other stakeholders. To a large extent the end user question should first consider the instructors and faculty that are going to facilitate the educational process. Educators will not adopt technology if it is too complicated or time consuming for faculty to use.

Although Bauman and Wolfenstein (2013) wrote this in the context of GBT in nursing and healthcare, their assertion is no less true for other domains. It is about time that we direct our attention to other factors than the here-and-now gameplay and issues only pertaining to the learner; we must incorporate other stakeholders into the mix. So far, much of what has been done in this area has focused on younger generations (i.e. traditional school settings), with little attention paid to adult and elderly learners (Frank, 2007; Ke, 2009). The study of educational games in schools has, however, yielded some interesting insights into the importance of teachers to supplement the gameplay (see e.g. Axe & Routledge, 2011; Egenfeldt-Nielsen, 2006, 2007a, 2008, 2010; Kirriemuir & Mcfarlane, 2004; Lawry, 1994). For instance, Egenfeldt-Nielsen (2007a) found that there is some resistance to changing teaching practices to accompany the use of games, despite the need for "a changed teaching practice that engages more closely with students' interpretations and assertions from their learning experiences" (p. 167). Furthermore, he considers teachers' knowledge and skill in using a specific game to be an important factor for the successful integration of games into the schools' curricula (Egenfeldt-Nielsen, 2008). As a consequence, he takes a clear stance against instructor-less educational games.

However, research on serious gaming with adult learners often lacks this practical perspective of the instructor's role(s). When I first became interested in this particular issue (in 2009), there was a distinct lack of such studies. Some might mention instructors, but do not delve into an examination of the instructional practices surrounding GBL and GBT. The role(s) of the instructor seem to be implicitly assumed to be known; they are either based on traditional teaching practices, or expected to fall into place by themselves as serious gaming becomes more ubiquitous in educational settings. Over the years, this has changed somewhat, although there is still a need for more understanding of the issues of instructor-led GBT.

One of my first inspirations for this work was Angela Brennecke's doctoral dissertation (Brennecke, 2009), in which she introduces the concept of a 'teacher player' and suggests a technical solution for such a role. However, while she has an engineering background, my perspective is more related to socio-technical issues, including cognitive science, human-computer interaction and educational sciences. This means that I approach the issue from a systemic or holistic perspective, where technology is one component alongside players and their meaning-making activities in a physical, social and organisational context (Egenfeldt-Nielsen, 2007a; Jenkins et al., 2009). By players, I here mean everyone who participates in that activity, including students, instructors, administrators, designers, and so on. Thus, I see serious gaming as more than just the activity of playing SGs.

Another early inspiration is the works of Elaine Raybourn (2007, 2008, 2009). She has developed the simulation experience design method in which different roles (for both instructor and trainee) are integrated. In the model, the instructor is described as someone who, among other things, provides the game-based simulation with dynamic content, either "in real-time or a priori through a scenario authoring interface" (Raybourn, 2007, p. 208). Additionally, she has also developed a game in which peer-assessment is a fundamental feature; students learn by reflecting upon and evaluating other students' performance in the game (Raybourn, 2009).

1.2 USAGE CONTEXT OF SERIOUS GAMING

SGs and simulations have been employed by the military for a long time, first to represent and visualise a battlefield and later to train abilities such as strategic thinking, leadership, combat tactics, and so on (Smith, 2009). Now games are even used to learn how to approach people from different cultures during peace-keeping missions (see e.g. Raybourn, 2009). The practice of using digital games for purposes other than entertainment can be traced back to the 1950s, although it took a few decades before their use in learning and training outside the military domain was popularised (Djaouti, Alvarez, Jessel, & Rampnoux, 2011). At first, it was thought that computer games could replace instructors as coaches (see e.g. Goldstein & Carr, 1977). As the field matured, it became clear that games cannot replace teachers, but that they change the way teaching is carried out (Egenfeldt-Nielsen, 2007b). Most importantly, using SGs without the guidance of an instructor puts a lot of pressure on the learner's meta-cognitive skills, that is, their ability to reflect upon their actions within the game and how the in-game activities relate to activities in the real world (e.g. work tasks) (Moreno & Mayer, 2005).

Serious gaming has had an upswing over the past ten to twenty years, along with the increasing sophistication of game technology (for a lower price) and the increase in popularity of games and gameplay (Bryant & Fondren, 2009; Michael & Chen, 2006). Now games are used in a multitude of application areas, from learning and training to policy making and advertising, just to mention a few. As a highly multi-disciplinary field, the research projects are very dispersed in terms of, for example, focus, methodology, and theoretical foundations. The growing body of research is moving towards consensus over the conclusion that the context and manner in which SGs are used will influence their effectiveness as learning and training tools (e.g. Squire, 2006; Tobias, Fletcher, Dai, & Wind, 2011; Wagner & Wernbacher, 2013). For instance, Whitney, Temby, and Stephens (2013) voice a concern that the wrong application of SGs will lead to no or negative learning effects.

Apart from different physical settings (e.g. at home or in a classroom), a game can be played in different social and organisational contexts. For example, a SG like *Virtual Battlespace 2 (VBS2)* (Bohemia Interactive, n.d.) can be played as a single-player or multiplayer game. In multiplayer mode, players can be physically located in the same space, such as a classroom, or distributed over different places, where communication is mediated through the computer and not face-to-face. *VBS2* also offers the players (most often the instructors, but possibly also the learners) the possibility of creating new scenarios from scratch or adapting old ones. Last but not least, it can be played with or without an instructor present. Of course, within the different combinations of these alternatives there are countless numbers of choices to be made concerning the detailed practices of serious gaming. My point is that each player will have a different learning experience depending on how a game is utilised.

This has two implications. First, games cannot be treated as a panacea for learning and training (Corti, 2006; Tang & Hanneghan, 2010). They need to be adapted to the specific needs and goals of an educational institution, including the needs and goals of its learners (Frank, 2007; Schrader & McCreery, 2012). Egenfeldt-Nielsen (2010) makes a distinction between (i) learning through games, (ii) learning with games, and (iii) learning by making games. He claims that the last two kinds of use "tend to be more driven by teacher adaption but also require more of an effort from future teachers that want to adapt it" (p. 64). This perspective of different usage with the respective conditions and challenges is interesting and needs further investigation. It also leads to the second implication; we need to look closer at how games are used in specific contexts. For instance, Frank (2013) studied the effect on game mechanics, such as victory points on learning, and concluded that reward structures can distract learners from playing the game as intended, that is, they play exclusively to win the game and lose sight of the learning goals. He suggests that instructors need to be present "to monitor the gaming process and steer players' reasoning into the right directions as it happens" (p. 8). Furthermore, in an updated review of GBL research, Tobias et al. (2011) conclude that instructional support, such as explanations, feedback and scaffolding, is imperative to learning from games.

1.3 DEVELOPING SERIOUS GAMES WITH AND FOR INSTRUCTORS

The development of SGs differs from entertainment game development, in that the latter is mainly concerned with creating an engaging experience and not with meeting specific learning goals (Chatham, 2009; Wagner & Wernbacher, 2013). Just as the development of information systems underwent a transition from programmers developing systems for themselves to developing systems for distinctively different users (Petter, DeLone, & McLean, 2012), so is the development of SGs in the process of undergoing a similar progression. A key component, relevant for the aim of this thesis, is the realisation that successful SGs have to be developed in collaboration with instructors.

There are two reasons for this. First, SG developers should, ideally, find a balance between game content and learning content, so that neither one becomes too dominant (Harteveld, Guimarães, Mayer, & Bidarra, 2010; Ibrahim, Gutiérrez Vela, Paderewski Rodríguez, González Sánchez, & Padilla Zea, 2012; Kiili, 2005). To accomplish this, a successful SG must be developed in close cooperation between people from a range of expert competencies, from game designers to instructional designers and subject matter experts (Appelman & Wilson, 2006; Hubal & Pina, 2012). Second, when developing SGs for formal educational settings, not enough emphasis is put on the utility of the game for the different user groups (learners, instructors and administrators) (Berg Marklund, 2013; Loh, 2012). To remedy this, SG development should utilise a "systemic approach that is effective and efficient for teachers while being appealing to learners" (Bauman, 2013, p. 89). One such approach is the user-centred design process, which emphasises usability issues and user involvement throughout the entire design process (Gulliksen et al., 2003; Whitton, 2010). As subject matter experts, instructors cannot only ensure that the game facilitates learning for the learners, but that it is also designed with instructors' tasks in mind.

1.4 RESEARCH QUESTION

The research in this thesis is based on three premises or key issues. First, I claim that *instructors take an active role in GBT*. They do this in mainly two ways: by designing learning and playing experiences and by guiding and coaching learners during and after gameplay. Additionally, they might have to deal with technical problems that occur during the preparation or execution of training sessions. None of these tasks are trivial and can be overwhelming for instructors.

Second, *GBT is an activity situated within a socio-cultural context* and, thus, incorporates more than the here-and-now gameplay and game artefact. This implies that research in this area should be conducted from a socio-technical perspective, that is, to consider practices from a work system perspective rather than a tool perspective and, thus, includes both human and technical issues (Alter, 2010). Moreover, GBT practices for adult learning are developed within specific communities of practice (CoP) that foster certain ways of conducting serious gaming, often without formal structures to guide instructors in their pedagogical and didactic tasks (Bickley et al., 2010; Dessne, 2012; Frank, 2012). This means that knowledge of GBT practices is by and large tacit and not readily available for direct observation and experimentation.

Third, *information technology (IT) can facilitate several of the instructors' tasks, but not act as a substitute*. The use of instructional aids, such as authoring functionality, automatic assessment and summary functions, can alleviate some of the strain put on instructors (Brennecke & Schumann, 2009; Raybourn, 2007; Salas, Rosen, Held, & Weissmuller, 2009), and help them focus on key roles and tasks that they, with their expertise in the subject matter and professional vision (Goodwin, 1994), do best. The design and implementation of these systems constitute new challenges for SG developers and other stakeholders. For instance, usability issues must take priority, as well as formal and informal structures for knowledge sharing among practitioners, in order to spread exemplary solutions.

Given these premises, the overall research question of this thesis is:

How can instructor role(s) be facilitated within an instructor-led game-based training environment?

To limit the scope, the question mainly focuses on settings that involve adult learners. As a consequence, literature that investigates GBL and GBT with children is excluded unless the results can easily be generalisable to older learners. To answer the research question, several objectives have been established:

Objective 1: Conduct a literature survey on the roles of instructors in serious gaming and issues surrounding serious gaming, such as player experience (PX) design, learning and guidance, and SG development.

The result of the literature survey is presented in Part II, *Serious games and game-based training*.

Objective 2: Identify and describe instructor roles during different phases in current practices of GBT.

The empirical work and its results are presented in Part III, *Case studies*.

Objective 3: Create a framework for instructor-led serious gaming based on theoretical and empirical data.

Objective 4: Identify and describe challenges for instructor-led GBT and, from these, synthesise guidelines for instructor-led serious gaming.

Objective 5: Synthesise success factors for instructor-led serious gaming.

The result of this work is presented in Part IV, *Results and knowledge contributions*.

All five objectives have been met.

1.5 SUMMARY OF KNOWLEDGE CONTRIBUTIONS

The research presented in this thesis is multidisciplinary. It brings together knowledge from game studies, user experience design (UXD), cognitive science, pedagogy, knowledge management, and informatics. The result is a framework for GBT in which the instructors are central to the training cycle, from planning and preparing the training scenarios, carrying out the actual simulation or gameplay, to assessment and debriefing afterwards. While members from all these research fields might be interested in and can utilise some of the results, the main knowledge contributions are within the SG field.

The knowledge contributions of this thesis are presented in Table 1.1.

TABLE 1.1: Summary of the research contributions of this thesis.

CONTRIBUTION	TYPE OF WORK	OBJECTIVE	CHAPTER
A thorough review of the state-of-the-art of serious gaming theory, particularly pertaining to user and player experience design, user acceptance, learning theories and their relation to GBL practices.	Theoretical	1	4–7
A thorough review of instructor roles as described in SG literature, as well as the benefits and barriers to instructor-led serious gaming.	Theoretical	1	8
Characterisation of serious gaming practices from a range of training domains, including rehabilitation of motor function disabilities, training of incident commanders, and military training.	Empirical	2	9–13
Documentation and characterisation of current work practices pertaining to GBT at the SLWC.	Empirical	2	11
Documentation and characterisation of instructor support in SGs, including support for instructors' situation awareness and challenges related to capturing instructor needs.	Empirical	4	12 & 13

TABLE 1.1: (continued)

CONTRIBUTION	TYPE OF WORK	OBJECTIVE	CHAPTER
Development and presentation of the coaching cycle framework, in which instructors are the focal point of inquiry. The main contributions of the framework are those related to (i) learning by scenario authoring, (ii) the coaching-by-gaming concept, and (iii) the concept of instructors' situation awareness.	Theoretical	3	14
Identification of four player roles (learner player, learner author, instructor player and instructor author), which emphasise the interdependence of authorship and gameplay.	Theoretical	3	10 & 14
Development and presentation of guidelines for system support in SGs used for instructor-led GBT.	Theoretical	4	15
A review of success factors for (instructor-led) serious gaming.	Theoretical	5	16

CHAPTER 2
THESIS OUTLINE

This chapter provides a brief presentation of the outline of the thesis.

2.1 THESIS MAP

The thesis map in Figure 2.1 visualises the thesis structure. As illustrated, the thesis is composed of five parts. First, Part I, *Thesis Overview*, introduces the research problem and presents the research question and objectives (Chapter 1). It should give the reader a brief overview of the problem as well as the main arguments used throughout the thesis. Next, I discuss the overall research approach chosen and provide arguments for why this road was taken (Chapter 3). I also outline the different case studies included and how they contribute to answering the research question. At this point, the reader should have a good idea of how the research presented in this thesis has been carried out.

Part II, *Serious games and game-based training*, represents the background and also constitutes some of the theoretical work carried out (Objective 1). Since this is a highly interdisciplinary area, many aspects of serious gaming have to be accounted for. Chapter 4 presents an overview of what SGs are, how they relate to simulations, and my view of serious gaming. In Chapter 5, I outline issues pertaining to user and player experience design, which also form an important theoretical basis for my work. Apart from a closer look at player experience, I also outline the issue of user acceptance of SGs. Next, I narrow the scope of serious gaming to settings involving learning and training. Issues discussed in Chapter 6 are learning theories, expertise, transfer and motivation, and their relation to gaming and instructor roles. The chapter concludes with some common critiques of SGs and serious gaming, both from a learning and research perspective. In Chapter 7, I outline current theories related to scaffolding, guidance and debriefing, and how these can be realised in a serious gaming setting. Part II concludes with a chapter outlining arguments for and against instructor-led serious gaming (Chapter 8). After Part II, the reader should be well informed regarding the issues of instructor-led GBT and also have a fair notion of my position within the SG field. A reader who is already familiar with all or some of the above mentioned areas can peruse these chapters and focus on specific areas of interest.

Part III, *Case studies*, represents the empirical work carried out in order to reach Objective 2, that is, to identify and describe instructor roles during different phases in current

GBT practices. Chapters 9 and 10 present some early work in which the research problem (presented in Chapter 1.4) is not fully formed. The focus of these chapters is to give the reader some examples of serious gaming and to outline some lessons learned from those projects that led to the theories presented in this thesis. Chapter 9 provides a brief account of a study of serious gaming for persons recovering from a stroke, which was carried out with a different agenda than the one presented in Chapter 1. Thus, the material has been re-examined from a new perspective, namely that of the instructor role(s). Chapter 10 presents a project in which the aim of this thesis was partly included. It involves the development of a GBT system for fire-fighters who are training to become incident commanders. The core chapters of Part III, however, are composed of Chapters 11, 12 and 13, which present three interrelated studies carried out taking the research question presented in Chapter 1.4 into account. Chapter 11 presents GBT practices at the SLWC, and Chapters 12 and 13 delve deeper into some specific issues of instructor-led serious gaming. After all six chapters, the reader should have a fair understanding of the empirical research carried out, and the conclusions drawn from them.

Part IV, *Results and knowledge contributions*, presents the results of Objectives 3, 4 and 5, respectively. Chapter 14 presents a framework for instructor-led serious gaming (Objective 3) and compares it to other, similar frameworks presented by other researchers. Chapter 15 includes guidelines for instructor-led serious gaming that have been derived and synthesised from knowledge gained in the case studies (Objective 4). Lastly, Chapter 16 describes a number of success factors for instructor-led serious gaming. After Part IV, the reader should be familiar with the coaching gaming framework and how it fits into a broader perspective of serious gaming practices.

Part V, *Conclusions*, ties it all together by summarising the major findings and implications of the research presented in this thesis. It also reviews the research from a critical perspective and presents suggestions for future work.

For the readers who prefer to peruse one or several of the chapters, I have added summaries at the conclusion of each chapter that highlight the main points made and concepts introduced in the chapter.

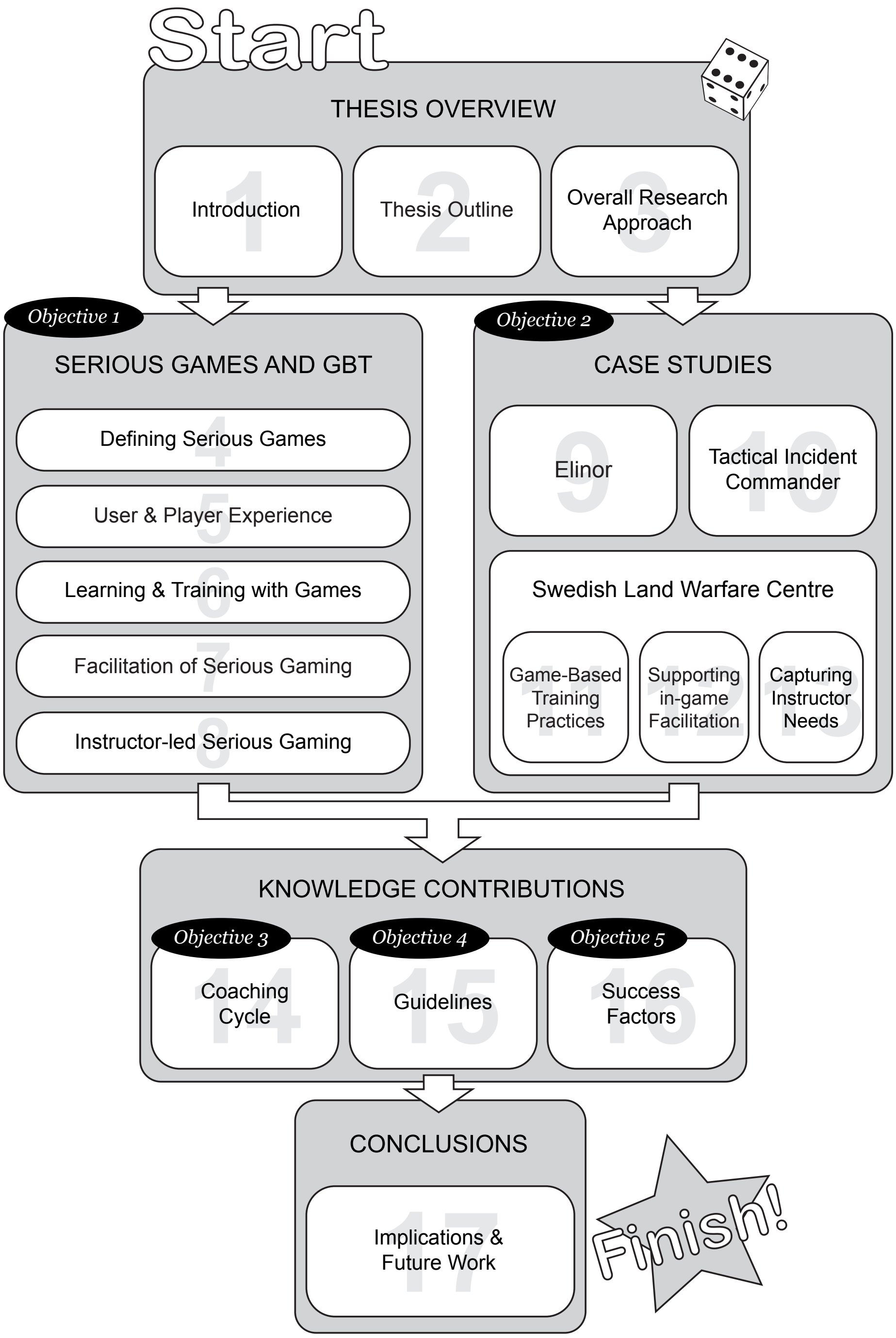


FIGURE 2.1: Thesis map with objectives (see Chapter 1.4).

CHAPTER 3
OVERALL RESEARCH APPROACH

This chapter outlines the overall strategy and approach applied for the research presented in this thesis. Since this research is based on a number of complementing case studies, the detailed research process and methods for each case are not described here, but in connection to each case study (presented in Part III).

3.1 RESEARCH STRATEGY

As stated in the introduction, this thesis aims to answer the question: *How can instructor role(s) be facilitated within an instructor-led game-based training environment?* As this question is multifaceted, the road to answering it has been equally complex. My research strategy has mainly been to (i) use a systemic approach to achieve a holistic understanding of serious gaming, (ii) maintain theoretical grounding by continuous literature surveys, and (iii) gain insights into serious gaming practices and challenges through empirical studies. This can of course be done in several ways.

For instance, using a systemic approach means different things depending on who you ask (Cabrera, Colosi, & Lobdell, 2008). I use the term loosely, meaning that I do not refer to it as a specific methodology, but more as a general way of thinking about and approaching the research question and the data generated throughout the process. Thus, my research is informed by a systems thinking approach. By system, I mean "an assembly or set of related elements" (Van Gigch, 1991, p. 30). In practice, a systems thinking approach means taking a holistic perspective in exploring and analysing a system; looking at the whole and the interdependencies between its parts (Kriz, 2010). This seems reasonable, since the practice of serious gaming is highly contextual and includes many stakeholders from a myriad of disciplines (e.g. game studies, cognition, pedagogy, design and technology). Honing in on a single aspect without accounting for how it affects and is affected by other aspects of the same system will inevitably lead to theories that are only useful during very specific conditions. This does not mean that studying a phenomenon in isolation is always a bad approach, only that it is inappropriate for the study of complex systems such as SGs and serious gaming (Dede, 2011).

The system relevant for the above mentioned research question can be studied at different granularity levels. As Figure 3.1 illustrates, instructor-led GBT is part of larger system of GBT in general, which also includes instructor-less GBT. In turn, GBT is part

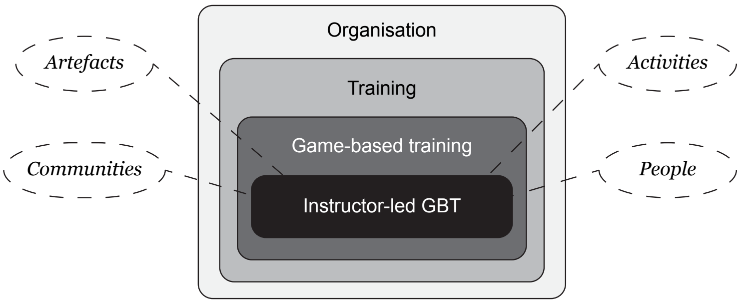


FIGURE 3.1: The system studied in this thesis is instructor-led GBT, a subset of (game-based) training practices within an organisation.

of a system of training practices, both game-based and otherwise (e.g. field and classroom training). Broadening the scope even more, training is conducted within an organisational context, which has formal and informal structures that affect how training is carried out and assessed. The organisation also comprises activities not related to training. It is impossible for a sole researcher in an outsider role to capture a complete picture of an organisation (Walsham, 1995). Therefore, the research was delimited to training situations involving SGs or simulations containing gaming characteristics, while other types of training carried out by the organisation were excluded. For the same reason, it was also necessary to exclude in-depth studies of the participating organisations. In addition, it is important to keep the focus on the core issues (the instructors in GBT and how they can be facilitated) and not become overwhelmed with factual details that only have minor relevance to the research question. For instance, studying instructor-less GBT would be unsuitable, since the thesis question refers to how instructor role(s) can be facilitated, which is a non-issue in instructor-less systems. Similarly, although studying other types of training practices could be interesting from a general GBT perspective, the focus has been on the specific roles that instructors take on in the context of GBT. While some of these roles also occur in other contexts, data from GBT contexts should be enough to answer the research question.

A closer look at the system under scrutiny, reveals that it consists of several parts related to GBT practices, such as:

- activities (e.g. assessment, design, evaluation, planning, teaching and training),
- artefacts (e.g. documents, games and simulators),
- communities (e.g. organisational culture and training practices), and
- people (e.g. administrators, instructors, learners and managers).

Three common research paradigms are deductive, inductive and abductive reasoning. *Deductive reasoning* is taking a top-down approach to theory building, that is, it involves constructing hypotheses based on theoretical propositions and then testing them empirically (Agar, 2008; Robson, 2002). Such a theory-derived approach usually involves quantitative data and an experimental method strategy (Patton, 2002), although qualitative studies can also be applied (Robson, 2002). *Inductive reasoning* takes a different, bottom-up route by collecting empirical data and then generating theories based on the patterns suggested by the observations (Patton, 2002). In its purest form, it requires the researcher to analyse the data without any advance presumptions so that patterns are allowed to emerge without bias towards a specific theory (Lincoln & Guba, 1985). This should not be confused with researcher objectivity, since the inductive process relies on interpretations, which will inevitably be influenced by the researcher's background and interests. Instead, Lincoln and Guba (1985) use the term fairness to denote the researcher's intention to be open to different interpretations and perspectives. To guide the researcher, particularly during initial observations, sensitising concepts can be used to illuminate certain elements of interest in the setting or organisation (Patton, 2002). Thus, even within an inductive paradigm, a researcher is never seen or assumed as having a 'blank slate' (Patton, 2002). In *abductive reasoning*, the researcher constantly goes back and forth between empirical observations and theory (Dubois & Gadde, 2002). It has gained popularity in diverse fields such as artificial intelligence, anthropology and design science (Agar, 2008; Dubois & Gadde, 2002; Gregory & Muntermann, 2011). Agar (2008) describes abduction as "a research logic that features the development of *new* theoretical propositions to account for material that the old material didn't map into" (p. 35). Thus, it can be described as a combination of both deductive and inductive reasoning (Patton, 2002).

In my own research, all three paradigms are present, although the inductive and abductive approaches are more prominent. Abductive reasoning lends itself well to answering my research question, since it assumes a step-wise and iterative approach that makes use of a combination of empirical fieldwork, case analysis and established theoretical models. As put by Dubois and Gadde (2002), "the original framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process" (p. 559). In the context of my research question, this means that the framework of facilitation in instructor-led GBT presented in this thesis is the result of a refinement process guided by insights gained from empirical work and literature studies. On those occasions where inconsistencies occurred in the comparison of empirical and theoretical data, a process of careful interpretation took place, in order to adapt the framework.

Walsham (1995, 2006) emphasises that it is important for researchers who do interpretive research to be clear about the use of theory in their research. He states that there are three distinct uses of theory; (i) as an initial guide to design and data collection, (ii) as part of an iterative process of data collection and analysis, and (iii) as a final product of the research. How theory has been used in this thesis should be evident when looking at the objectives presented in Chapter 1.4. Objective 1 (conduct a literature survey on the roles of instructors in serious gaming and issues surrounding serious gaming, such as player experience design, learning and guidance, and SG development) maps to the first use of theory, that is, as an initial guide to design and data collection. Objective 2 (identify and describe instructor roles during different phases in current practices of GBT) and the first part of Objective 4 (identify and describe challenges for instructor-led GBT) are indicative of the second use of theory, that is, as part of an iterative process of data collection and analysis (i.e. abductive reasoning). Lastly, Objective 3 (create a framework for instructor-led GBT based on theoretical and empirical data), the last part of Objective 4 (synthesise guidelines for instructor-led GBT), and Objective 5 (synthesise success factors for instructor-led GBT) can be seen as theory generation and, thus, constitute the third use of theory (as a final product of the research).

In sum, my work falls into the tradition of interpretive rather than positivist research (Walsham, 1995, 2006). The goal is not to reach statistical generalisation or absolute truth, but to describe and evaluate a highly complex and dynamic system.

3.2 CASE STUDY RESEARCH

One of the most widely used qualitative methods in information system (IS) research is case study research (Darke, Shanks, & Broadbent, 1998). A case study is "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 18). Case studies are particularly useful in research fields in which knowledge is context-dependent (Flyvbjerg, 2011). Therefore, case study research is appropriate for the study of serious gaming practices and has been chosen as the primary method of gathering empirical data for this thesis.

Case study research can employ a single-case or multiple-case research strategy (Darke et al., 1998). Single-case studies allow for a more in-depth analysis of a phenomenon within a specific context, while multiple-case studies allow for cross-case analysis and the opportunity to study a phenomenon in diverse settings (Darke et al., 1998; Yin, 2009). Multiple-case studies can include a collection of independent case studies or a number of studies from the same overall study (Yin, 2009). Dede (2011) argues that collective studies with a broader scope are more useful in the study of SGs: "Fully understanding a complex educational intervention involving gaming and simulation that is effective across a wide range of contexts may require multiple studies along its various dimensions" (p. 235).

Five case studies of varying scope for the research question have been included in this thesis (see Figure 3.2). The cases are compatible because they all deal with GBT in one way or another. For more details, see Chapter 3.3.

A cross-case analysis looks for common patterns across studies and aspects in which they differ (Yin, 2009). Owing to the wide range of projects in this thesis, an understanding of serious gaming has begun to form and the thesis describes how these lessons learned have been elicited into a comprehensive framework.

3.2.1 TRUSTWORTHINESS OF RESULTS

To ensure trustworthiness of results from qualitative research, Lincoln and Guba (1985) suggest that four criteria should be met. These are credibility, transferability, dependability and confirmability. *Credibility* is accomplished by ensuring that the conclusions make sense to those who are affected by them (the consumers/practitioners) (Lincoln & Guba, 1985). For the results presented in the thesis, this was accomplished by presenting the results to the participants. For instance, in the SLWC study, the coaching cycle framework (see Chapter 14) was presented on several occasions to SLWC staff experienced in simulation and GBT.

The *transferability* criterion deals with the generalisability and validity of the results (Lincoln & Guba, 1985). Qualitative research deals with other types of threats to validity, compared to quantitative and experimental research (Seale, 2002). According to Maxwell (1992), validity in qualitative research "refers primarily to accounts, not to data or methods" (p. 283). Thus, two different accounts of the same phenomenon can be equally valid, because they are dependant on the understanding of the inquirer, who describes the phenomenon from a specific perspective (Maxwell, 1992). Viewing validity from a qualitative researcher's standpoint, Maxwell (1992) presents a topology of validity consisting of descriptive, interpretive, theoretical, and evaluative validity, as well as generalisability.

The most fundamental type of validity is *descriptive validity*, which refers to the accuracy with which an event or situation is described (Maxwell, 1992). Higher levels of accuracy can be achieved by recording events so they can be re-checked, which has been done to a large extent in the case studies included in this thesis. Furthermore, descriptive validity also means that observations and descriptions are in agreement with theory or common sense (Maxwell, 1992). *Interpretive validity* is central in most qualitative studies, since it refers to the parts of an account that is inherently conceptual or mental, that is, the meaning people attach to certain artefacts, events or behaviours (Maxwell, 1992). To achieve interpretive validity, the inquirer must seek agreement within the commu-

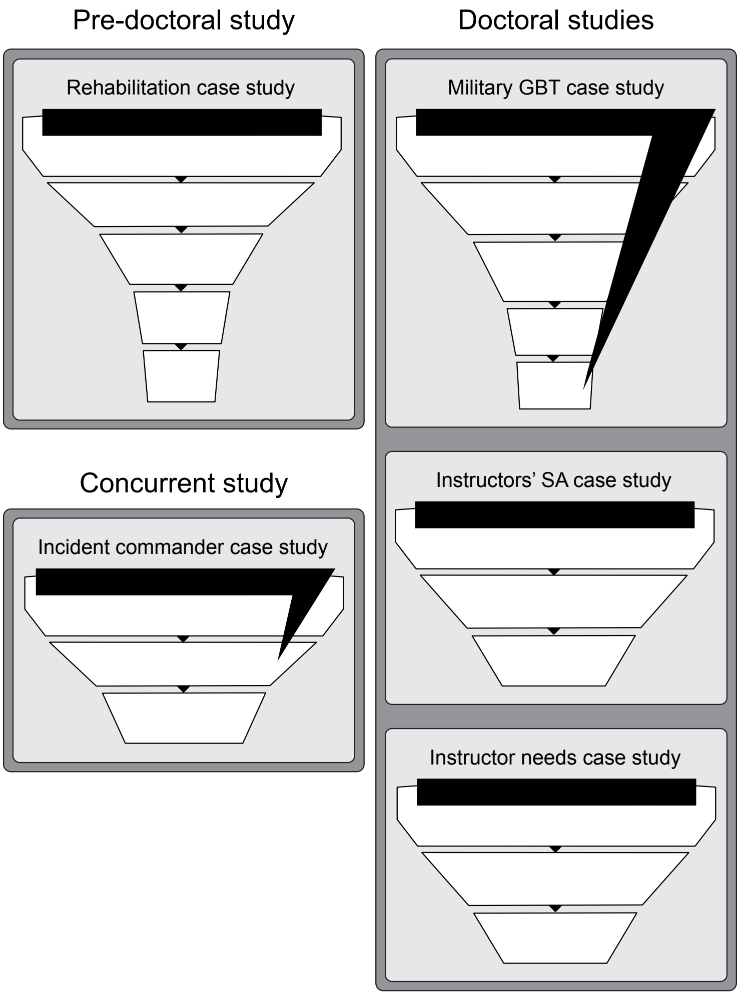


FIGURE 3.2: Overview of case studies included in the thesis. The first two are independent projects in which I participated, while the last three were all conducted at the SLWC and form the core cases of my PhD project. The funnel shapes represent scope or focus during each step as the research design emerged from a broad and open-ended focus at the beginning to a more specific focus towards the end.

nity studied. Thus, it is important to check assumptions and interpretations made with the people who are part of the phenomenon (Lincoln & Guba, 1985). This was also done in the case studies reported in this thesis. *Theoretical validity* refers to "the theoretical constructions that the researcher brings to, or develops during, the study" (Maxwell, 1992, p. 291), that is, the explanatory aspects of the account. As such, it includes both the concepts applied to the phenomenon as well as their proposed interrelationships. Here, the inquirer seeks consensus within the researcher community that is concerned with the phenomena in question (Maxwell, 1992). *Evaluative validity* refers to accounts that involve evaluations or assessments of the events beyond interpretations and explanations (e.g. a description of a behaviour as being 'right' or 'wrong') (Maxwell, 1992).

Generalisability refers to how much of the description of a specific situation can be extended and applied to other situations (Maxwell, 1992). This is a serious concern in SG research (Shapiro & Peña, 2009). The difference between the structure and use of two games (e.g. a simple puzzle game and a fully-fledged massively multiplayer online game (MMOG)) can be so large that generalisations drawn from comparing them would yield only superficial results. Shapiro and Peña (2009) also point out that generalisations of this kind are particularly difficult, due to the fact that the players approach games with different prior knowledge and attitudes, which also change as they come into contact with games. Capturing this change in a dynamic environment where contextual factors play a large role is a challenge, to say the least. Thus, we have to take a different approach to generalisability. As put by Shapiro and Peña (2009, p. 391):

> A case study that detects a phenomenon among game players can't be generalised in the statistical sense. From a case we don't know how widespread the phenomenon is. However, observing that phenomenon may contribute to generalisability in the long run by alerting us to something that current theory doesn't explain or to a possibility that hadn't previously occurred to us.

A useful viewpoint is offered by Walsham (1995), who distinguishes between four types of generalisations relevant for interpretive case studies: "the development of concepts, the generation of theory, the drawing of specific implications, and the contribution of rich insight" (p. 79). In my work, I have developed two concepts, 'coaching-by-gaming' and 'instructors' situation awareness', which are both part of the coaching cycle framework presented in Chapter 14. The construction of such a framework is a type of theory generation, since it can be used to guide further research into the area of instructor-led GBT. Furthermore, the framework can also be used to inform the design and use of SGs, which would constitute generalisation by "specific implications in particular domains of action" (Walsham, 1995, p. 80). Lastly, 'contribution of rich insight' is provided by an in-depth literature survey that complements and augments the conclusions drawn from the empirical data. Hence, this thesis covers all four types of generalisation.

Next, *dependability* can, in part, be shown by a demonstration of credibility. The studies should, additionally, be described in such detail that other researchers can duplicate the work, even if they cannot expect exactly the same results (Lincoln & Guba, 1985). Each case study described in this thesis has a method section in which detailed descriptions of the methods used for the respective study are given.

Lastly, *confirmability* relates to the issue of objectivity already discussed in Chapter 3.1. In order to achieve confirmability, the research must be shown to have rigour by documentation of the process and use of triangulation of findings (Patton, 2002). For instance, in order to obtain triangulation of results, the framework presented in this thesis (Chapter 14) has been confirmed both theoretically and empirically.

3.3 SUMMARY OF CASE STUDIES

As mentioned previously, five studies are included in this thesis (see Figure 3.2). One of the studies was conducted before I formally entered into my doctorate education in 2009, but I contributed as a participant researcher in both planning and carrying out the project. It coloured my perception of serious gaming, and must therefore be included, in order to clarify the source of my interpretations and results. In short, it deals with the (re-)training (i.e. rehabilitation) of motor skills lost as a result of a stroke, using a game console (Chapter 9). It contributed to the research question by its inclusion of healthcare professionals, that facilitate the rehabilitation, as an important target group, next to stroke patients. Thus, the healthcare professionals have a similar role to the instructor in an educational or training setting; they have to assess the patients' progress in the game(s) and give recommendations on how to proceed with the training. Furthermore, the study also provided some insights into the issues of user acceptance or buy-in of SGs, which are also relevant to the research question.

The next study was a project in which I was a participant researcher in parallel to my main PhD case study at the SLWC. It deals with the training of incident commanders using an online gaming system (Chapter 10). It contributes to the research question by exploring a pedagogical paradigm in which serious gaming is used to create a community of practice (CoP) through gaming and scenario authoring. The study also offers some important insights into the importance of guidance by instructors.

Finally, the three studies at the SLWC (Chapters 11, 12 and 13) deal with the military training of land warfare; tactical and communication skills that involve gaming characteristics. These last three cases make up the core source of empirical data to answer the research question, whereas the others act as contrasting studies that provide a rich data set from which to draw conclusions. The first of these three studies contributed to the research question by investigating serious gaming practices in a specific context and identifying instructor roles prevalent to these practices (Objective 2). The second study evaluated a status information panel (SIP) at the SLWC, from the perspective of instructors' situation awareness (SA). Thus, it contributed to the research question with further insights into the challenges of conducting instructor-led serious gaming. The last study contributed in a similar way by exploring the challenges of capturing instructor needs during SG development and refinement.

All five studies contributed to the coaching cycle framework (Objective 3), as well as the identification of challenges and success factors for instructor-led serious gaming (Objective 4 and Objective 5, respectively). Table 3.1 summarises the studies included, the methods used and how each case study has contributed to the results presented in this thesis. In the first two studies (*Elinor* and *Tactical Incident Commander*), I contributed by participating in planning, data collection and analysis. In the three studies conducted at the SLWC, I was the main researcher, which means that instead of working in a team of researchers, I conducted most of the data collection and analysis myself. These three studies were also guided by the research question presented in Chapter 1.4. As should be evident from the Table, including only the last three studies from this thesis would severely diminish the conclusions drawn, since all five studies contributed in some way to the development of the coaching cycle framework, which constitutes the core result of this thesis work.

A number of data collection methods have been employed in each study, as is common in case study research (Yin, 2009). The methods range from experimental evaluations and prototype development, to observations, interviews and questionnaires (see column labelled 'Methods' in Table 3.1). More detailed accounts for the choice and use of these methods can be found in the respective case study chapter.

TABLE 3.1: Case studies and their contributions.

CHAPTER	STUDY	YEAR	ORGANISATIONS/ COLLABORATORS	METHODS	MY ROLE	CONTRIBUTION TO THESIS
9	*Elinor*	2007 – 2008	Skaraborg Hospital, Skövde Sahlgrenska Academy, Göteborg	Prototype development Experimental evaluation Interviews	Participant researcher	*Off-game facilitation* *Stealth assessment* *User acceptance of SGs*
10	*Tactical Incident Commander*	2009 – 2011	Swedish Civil Contingencies Agency, Sandö	Prototype development Observational evaluation Interviews Case study evaluation	Participant researcher	*Creating a community of practice through serious gaming and scenario authoring* *Importance of scaffolding and guidance by instructors*
11	SLWC	2009 – 2013	Swedish Land Warfare Centre, Skövde/Kvarn	Participant and non-participant observations Informal interviews Validation questionnaire	Main researcher	*Phases of GBT* *Instructor roles* *Scenario authoring* *Coaching-by-gaming* *In-game assessment* *After-action review*
12	Status information panel (SIP)	2012 – 2013	Swedish Land Warfare Centre, Skövde Syntell, Stockholm Krauss-Maffei Wegmann, Munich	Prototype development Descriptive evaluation Usability testing	Main researcher	*Instructors' situation awareness* *In-game assessment* *Usability and visualisation in SGs*

TABLE 3.1: (continued)

CHAPTER	STUDY	DURATION	ORGANISATIONS/ COLLABORATORS	METHODS	ROLE	CONTRIBUTION TO THESIS
13	*VBS2* requirements	2013	Swedish Land Warfare Centre, Skövde/Kvarn Swedish Armed Forces International Centre, Kungsängen Swedish Defence Materiel Administration, Stockholm Bohemia Interactive Simulations, Prague	Participant observations Informal interviews	Main researcher	*Requirements for operator GUI, coaching-by-gaming and AAR interface* *Power-users* *Difficulty of balancing play and instructional content*

PART II

SERIOUS GAMES AND GAME-BASED TRAINING

CHAPTER 4
DEFINING SERIOUS GAMES

The design and use of serious games (SGs) is a complex matter for which researchers are trying to understand and create guidelines. This chapter provides an overview of the main concepts of SGs and serious gaming. It introduces and defines central concepts that are used throughout this thesis and, thus, represent a first step towards reaching Objective 1. The chapter also shows how my research is positioned within the SG field.

4.1 WHAT ARE SERIOUS GAMES?

The term 'serious game' first appeared in Clark C. Abt's book *Serious Games* (1970). Although the practice of using games for various purposes is often thought of as being a new phenomenon, it has a long history, going back more than 4000 years when the Chinese board game *Go* was used to learn strategic thinking (Jin & Low, 2011). In fact, the first computer games can be considered SGs, since they were not used primarily for entertainment, but to showcase new discoveries within computer science. For example, to advertise the computer Nimrod, built in 1951, its developers created a math-based game called *Nim*, which visitors to festivals and industrial fairs could play (Djaouti et al., 2011).

The term serious game is often thought of as an oxymoron (Michael & Chen, 2006) and still causes some controversy, even within the field itself. For instance, a recurring discussion on Digital Games Research Association's 'Gamesnetwork' mailing list is the appropriateness of the label and suggestions for new names. SG developers find that using the term 'game' in the name is problematic, due to its association to fun and play, which are often perceived as the opposite to serious, effective, and work-related activities. Instead, they use terms such as 'simulation' when promoting their product (Wexler, 2008).

The other side of the coin is that some scholars who study games feel offended by the label, since it suggests that not all games are serious (see e.g. Klabbers, 2009). They have a point, considering the rapid growth of the game industry over the past decade, and that it now has an annual turnover equivalent to that of the film and TV industry (Berg Marklund, 2013). Gameplay is an important part of art and culture; playing games is now seen as something as ubiquitous to everyday life as watching TV, seeing a film, or going to the theatre (Murray, 2006). Murray (2006) also points out that play and games are inherent in our culture and cognitive development, as they help individuals learn social rules (e.g. turn-taking, conflict containment, coordination of actions, and practising reciprocity), train basic cognitive skills (e.g. hand-eye coordination, sorting, and interpreting symbols), and are works of art in and of themselves. Furthermore, the growing popularity of e-sports, where good players are able to make a living from playing competitive games (Rambusch, Jakobsson, & Pargman, 2007), is another example of how entertainment games are a serious business.

Bogost (2007, p. 57) has taken this even further as he coined the term ‘persuasive games’, which he believes should replace the term ‘serious games’:

> Serious games are videogames created to support the existing and established interests of political, corporate, and social institutions. [...] Such goals do not represent the full potential of persuasive games. If persuasive games are video-games that mount meaningful procedural rhetorics, and if procedural rhetorics facilitate dialectal interrogation of process-based claims about how real-world processes do, could, or should work, then persuasive games can also make claims that speak past or against the fixed worldviews of institutions like governments or corporations.

Although Bogost is not against SGs as a concept, he opposes the term itself. However, other scholars describe SGs differently. For instance, Raybourn (2007) argues that one “important aspect of social-process simulation design is to challenge existing beliefs” (p. 211), and Marsh (2011) writes that “characteristics such as being thought-provoking, informative, awareness-raising or stimulating are as important, if not more so, than fun or entertainment” (p. 62), meaning that being thought-provoking is one of the main traits of SGs. Thus, Bogost’s view of SGs as “created to support the existing and established interests of political, corporate, and social institutions” is not shared by the wider SG community. SGs may very well be used to “speak past or against the fixed worldviews of institutions” – it is all about how the game is used in a larger context.

Another solution to the name problem is offered by Klabbers (2009) who suggests that we call games by their function, e.g., games for educating, games for training, games for simulating, games for entertaining, and so on. This solution is problematic because it creates a subset of SGs and none of the terms can be used as a hypernym to denote the entire field. Klabbers (2009) suggests the term ‘games for simulating work conditions’ as a replacement for SGs, but it has not caught on (even Klabbers himself does not use it). Instead, ‘serious game’ has persisted as an umbrella term within the academic community. It is short, easy to abbreviate, and has been reinforced by continued use by scholars. Consequently, I have chosen to keep the term in this thesis, although I also use the term game-based training (GBT) when I specifically mean SGs for (vocational) training (i.e. a subset of serious gaming).

Appendix A provides a summary of subgroups and alternate terms for SGs and serious gaming. It is worth noting that some scholars prefer to use the term ‘computer game’ as an umbrella term instead, avoiding categorising altogether (Tobias et al., 2011). Of course, naming SGs computer games excludes table-top games and other non-digital games, which is another debate that I will not delve further into here (for one recent addition to the debate, see e.g. Linderoth, 2013).

4.1.1 DEFINITIONS

In order to define SGs, it is first valuable to look at the common definitions of play and games in general. One of the most widespread definitions of play is that of Caillois (1961). He defines play as an activity that consists of the following qualities: freedom, separateness, uncertainty, non-productivity, rules and make-believe. Using this definition as basis, Järvinen, Heliö, and Mäyrä (2002, pp. 13–14) define digital games as (i) “a sequence of actions within formal and predefined rules and goals", and (ii) having "definitions of winning or losing, or at least of gain and loss". The same theme is found in the definition by Salen and Zimmerman (2004), who state that games are systems "in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (p. 80). Sauvé, Renaud, Kaufman, and Marquis (2007) sum up the attributes of games as: player or players, conflict, rules, predetermined goal of the game, and its artificial nature. Furthermore, Garris, Ahlers, and Driskell (2002) claim that any game can be described in terms of six dimensions: fantasy, rules/goals, sensory stimuli, challenge, mystery and control. Note that the definitions of both 'play' and 'games' lack the element of fun and enjoyment, something that we normally associate with the activity of play. However, as Michael and Chen (2006) mention, fun is a result of play, not an ingredient. Some authors claim, however, that the definition of games should be decoupled from play. For instance, Malaby (2007) defines game as "a semibounded and socially legitimate domain of contrived contingency that generates interpretable outcomes" (p. 96). He especially points out that games should not be viewed as subsets of play, but social artefacts in their own right. In sum, games are artefacts with certain characteristics related, but not limited, to play.

Although SGs share most of these characteristics associated with games, they differ from entertainment games and play in that most usage situations are not voluntary, and, to some extent, aim to be productive (Garris et al., 2002). Thus, a SG can be said to be part game, part productivity system (or simulator). Definitions of SGs usually try to capture this double nature; Alvarez and Michaud (2008) define SGs as "IT applications that combine aspects of tutoring, teaching, training, communications and information, with an entertainment element derived from videogames. By offering this combination, the programs aim to make practical, utilitarian content (serious) enjoyable (game)" (p. 11). Another well-cited definition is that of Zyda (2005): "a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (p. 26).

Taking a different approach, Marsh (2011) defines SGs along a continuum (see Figure 4.1). The reasoning is that SGs have a varying degree of gaming characteristics and different purposes that makes it difficult to formulate an all-encompassing definition. Marsh's and other scholars' definitions can be found in Appendix B.

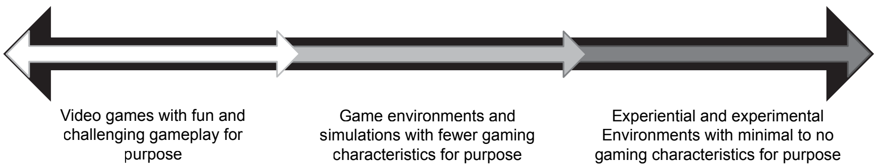


FIGURE 4.1: Continuum of serious games. Adapted from Marsh (2011, p. 63).

In most of my publications, I have used the definition by Susi, Johannesson, and Backlund (2007, p. 5):

> games that engage the user, and contribute to the achievement of a defined purpose other than pure entertainment (whether or not the user is consciously aware of it). A game's purpose may be formulated by the user her/himself or by the game's designer, which means that also a commercial off-the-shelf (COTS) game, used for non-entertainment purposes, may be considered a serious game. The advantage of this definition is that it is very inclusive.

In a sense, it captures what Ratan and Ritterfeld (2009, p. 11) say about defining SGs:

> While all edutainment games are certainly serious games, the body of serious games

> extends beyond edutainment, enveloping almost every digital game that has a purpose in addition to entertainment. Consistent with this notion, the Social Impact Games Web site defines serious games as "entertaining games with non-entertainment goals" (Social Impact Games, 2008). But a problem arises when attempting to identify such goals because the game producer's definition of its genre may not be consistent with the user's experience nor the psychological reality behind that experience. Hence, identifying an exact definition of serious games is neither a straightforward nor pragmatic endeavour. The simplest solution to this problem is to treat every game that has been called a serious game as a serious game.

However, inclusiveness is not unproblematic. Susi et al. (2007) claim that a player can achieve a game's purpose, without being made aware of its non-entertainment intent. This is known as 'stealth learning' and represents an approach to SGs where the content to be learned is embedded in the game in such a way that learners do not recognise it as 'serious' (Prensky, 2001). I would argue, however, that the goal of SGs is not to make learning 'stealthy', but more enjoyable and experiential. For instance, Tüzün (2006) showed that children playing the educational game *Quest Atlantis* did not separate playing and learning; they saw it as two aspects of the same activity. Furthermore, stealth learning can also be detrimental to learning; the players might start to 'game the game', take advantage of the fact that a game is not a perfect reconstruction of reality and take away skills that are only useful in the game, not beyond (Frank, 2012). Thus, at some point they must be made aware of the purpose of the game, even if the learning objectives are embedded in gameplay (Egenfeldt-Nielsen, 2006). A third argument is that stealth learning is not appropriate for all types of learning. While skills such as eye-hand coordination or pattern recognition are well suited for stealth learning (easily matched to concrete game elements), more complex skill sets, such as adaptive and soft skills, are difficult to fully embed within a game. As put by Whitton (2007, p. 1064):

> Even if it could be assumed that games are motivational, the belief that learning can be undertaken as an incidental additional effect of game play seems to be wholly inappropriate to adult learners, for whom an understanding of and engagement in the learning process is fundamental (Knowles, 1998).

Different authors use different definitions depending on preferences and how they want to use the term to prove a point or otherwise suit their overall intent. In my case, a more narrow definition seems appropriate, in order to distinguish SGs from entertainment games in general, and especially to fit the purpose of this thesis: to highlight the importance of contextual factors in serious gaming. Throughout this thesis, I argue that a game alone does not teach or facilitate learning, but it is the manner and setting in which it is used that matter.

The game is an ingredient or tool used to enhance a learning experience. The type of systems examined in this thesis all assume that the players are well aware of the game's purpose and that it is explicitly articulated within the gaming context. Another assumption is that the games are explicitly designed for a non-entertainment purpose, because they need to include features not normally found in entertainment games, such as assessment tools and after-action review (AAR). Entertainment game design includes assessment strategies to test a player's progress towards the game's goals, but it does this from a perspective of engaging the player and helping him/her interact with the game. In contrast, SGs should, optimally, include assessments tuned towards testing the player's knowledge or skills outside the game (Mislevy, Behrens, Dicerbo, Frezzo, & West, 2012). These assessments can be external or, preferably, embedded into the game (Hainey, Connolly, Baxter, Boyle, & Beeby, 2012).

Does this mean entertainment games should be excluded from being called SGs? Are Ratan and Ritterfeld (2009) wrong in asserting that any game that is ever called a SG should be treated as a SG? No, the works of scholars and educators such as Squire (2011) and de Freitas (2006) have shown that, in the hands of a skilled and ambitious instructor, working in a supportive community, a commercial off-the shelf (COTS) entertainment game can be successfully used as a learning tool. However, for the purpose of this thesis, SGs are thought of as games that are *designed for and used in a non-entertainment context* in order to engage the users, contribute to the achievement of a defined purpose, and assess the players' progress towards a goal related to said purpose. Again, this does not imply that I do not recognise the use of entertainment games for non-entertainment purposes, but signals that my work is centred around systems specifically designed (not just used) as SGs.

4.1.2 GAMES VERSUS SIMULATIONS

Another disambiguation that needs to be clarified is how games relate to simulations, virtual worlds, and role-playing. Several scholars have deliberated over this, with differing answers. An in-depth analysis of the relationship between games, simulations, and role-play is presented by Crookall, Oxford, and Saunders (1987). They specifically make a distinction between two different viewpoints: the 'representational' and the 'reality' perspective. Most descriptions of simulations are from the representational perspective, where simulations are described as something that represents or models something else; they have a referent (Narayanasamy, Wong, Fung, & Rai, 2006). Although a simulation can be used in place of the real thing (e.g. simulate the infrastructure of a city in order to predict the impact of a new road), it is an abstraction or simplification of the referent's features and characteristics (Crookall et al., 1987). Apart from being dynamic, simplified models of reality, simulations are commonly identified as being models that have fidelity, accuracy and validity (Sauvé et al., 2007).

A game, however, is another matter, according to Crookall et al. (1987, p. 161):

> A game (in the strict sense) does not purport to represent (abstract from, symbolize) any part of another system; it has no 'real-life' referent, and so is a 'real-world' system in its own right. CHESS was originally conceived as a simulation (though its inventors were probably not explicitly aware of this), but over the centuries it lost all quality or power of representivity. A game is formally constructed as a kind of mini-system, which takes place or 'happens' along with other social (sub-)systems whereas a simulation is a bracket, a hiatus, within the ongoing 'real-world' (sub-)systems. A game is a formalized system in its own right, while a simulation is a formalized representation of another system; a game is a 'real' system, a simulation a meta-system.

Sauvé et al. (2007) draw the same conclusion from their literature study: simulations and games have distinct differences in terms of their most fundamental attributes. Klabbers (2009) similarly claims that simulations are more rigid than games; that they contain 'closed models' (models that try to represent as much of the referent's characteristics and behaviour as possible), whereas games constitute partially or fully open models that can imitate less clear-cut rules, such as social ones.

This leads to the concept of *role-play*. According to Crookall et al. (1987), role-play is a necessary feature of simulations that involve human participation. The degree of role-playing that the participants carry out depends on the congruence between the roles taken on and the individuals themselves (Crookall et al., 1987). For instance, a pilot training in a flight simulator most likely takes on the role of him- or herself. Other simulations might require the players to take on a role that is completely different from themselves, as an exercise of perspective-taking and empathy (e.g. playing a victim of war) (Bogost, 2007). What about the situation of vocational training, in which a student takes on the role of a future self; are they simply being themselves or playing someone they will someday be? According to Crookall et al. (1987), the amount of role-playing depends on the participants' "knowledge and experience of the world as well as the characteristics of the role profile" (p. 159). Furthermore, Bogost (2007) also points out that there is a difference between playing a role within a game and validating that behaviour. People can carry out illegal or immoral acts within a game, without endorsing them outside of the game. Bogost (2007) calls this 'the simulation gap', that is, the separation between a game's representation of a topic and the player's interpretation of it.

It is this inclusion of social actors, outside of the simulator itself, that brings about a more complex view of simulations which Crookall et al. (1987) call 'the reality perspective'. They refer to reality as the intersubjective or phenomenological aspect of a simulation, that is, the experience of being a part of or running a simulation. A simulation viewed from the reality perspective is "the actualization of the simulator, the operation or experience of it, the on-going, 'live' performance. [...] Simulation thereby brings a simulator 'to life', and this can only be achieved by participants" (Crookall et al., 1987, p. 153). Viewed from this perspective, the line between simulations, games, and role-play starts to become fuzzy. Rather, Crookall et al. (1987) make a difference between a simulator (the object that contains models, fixed rules, and the ability to be 'brought to life') and the simulation, which can only be actualised by the addition of people and their actions. From this perspective, a game can apply simulation technology, but it is other factors that transform it into a game. Fictional elements, for example, can add to the gaming experience (Narayanasamy et al., 2006).

Begy (2013) also addresses this issue from a meaning-making viewpoint. He argues that some games are simulations and some are too abstract for the player to extract enough meaning from, to understand the system it simulates (if any) and compare the two. Thus, according to this reasoning, a game must convey to the player that it is based on another system in some way, in order for it to be identified as a simulation. Tobias and Fletcher (2011) take a different stance and argue that all games are simulations (even abstract games like *Tetris*), but they also differ from simulations in ways that make them separable. Table 4.1 summarises their view on how simulations differ from games. Among their arguments, simulations differ from games in terms of how they are used; simulations emphasise task completion and rule accuracy, whereas games focus on competition and rule clarity.

TABLE 4.1: Comparison of simulations and games, according to Tobias and Fletcher (2011, p. 7).

SIMULATIONS	GAMES
Will sacrifice entertainment in favour of reality	Will sacrifice reality in favour of entertainment
Scenario/Tasks	Storyline/quest
Emphasis on task completion	Emphasis on competition
Not necessarily interactive	Necessarily interactive
Focus on (rule) accuracy/detailed	Focus on (rule) clarity/stylised
Not all simulations are games	All games are simulations

On a similar note, Johnston and Whitehead (2009) differentiate between games and (training) simulations/SGs based on intent. According to them, games are used for fun, while SGs and training simulations are used with an academic intent. Hubal and Pina (2012) phrase it as: "Serious games are very different from simulation training. The point of simulation training is not for the user to have fun; the point is to engage the user in the learning situations. Consequently, users of training are not termed 'players'; they are 'students'" (p. 29). Further, Annetta (2010) claims that simulations have the same functions as SGs, but lack a score-keeping function and do not have in-game artefacts that can be bought or sold.

So, some scholars argue that all games are simulations, others that they are not. This disagreement affects how research into game-based learning (GBL) is conducted and interpreted (Sauvé et al., 2007). For instance, answering the questions: 'Are games good for learning?' and 'What is the active substance of SGs?' will inevitably lead to different answers, depending on how games and learning are conceptualised. Theories that are based on different conceptual frameworks might be incommensurable and, therefore, difficult to merge into a comprehensive and general theory of GBL. In my own work, the discussion is relevant because SGs used for (vocational) training are often termed simulations; calling them simulations rather than games is thought to give them legitimacy in the eyes of the more conservative users. More importantly, some of the SGs that I have studied are fully-fledged simulations and it is their actualisation that transforms them into SGs, such as the addition of a winning/losing condition.

4.1.3 FIDELITY

Simulation fidelity could be a property that can be used to distinguish games from simulators. Fidelity, in this context, can be defined as "the degree of similarity between the training situation and the operational situation which is simulated" (Hays & Singer, 1989, p. 50). It is sometimes used synonymously with 'realism' when simulations and games are described. According to Johnston and Whitehead (2009), a difference between training simulations and SGs is their distance to the user's reality; simulations have a sense of closeness to reality that SGs do not. As hinted in Table 4.1, games are usually thought of as having lower degrees of realism than simulations. Before delving deeper into this issue, I will first explain the concept of fidelity.

Fidelity can be viewed as *a continuum from low to high fidelity*. In this case, a system with low fidelity bears none or only little resemblance to the real world or situation. In a game like *Chess*, for instance, the rules of war have been formalised into a set of abstract game rules. Dormans (2011) calls this lexical or symbolic simulation, as opposed to iconic simulation, where game elements have an (iconic) resemblance to reality. According to Beaubien and Baker (2004), high fidelity has become synonymous with simulations, especially full-scale ones, such as flight simulators that realistically reproduce the motion cues of an aircraft, as well as realistic feedback to the pilot's senses, especially sight and hearing.

Since high fidelity is often equated with the notion of the user not being able to distinguish between the simulated world and the real world, it is also thought to be a prerequisite for the transfer of learning from the training situation to the actual work to be performed (Greitzer, Kuchar, & Huston, 2007; Liu, Macciarella, & Vincenzi, 2009). Although this seems like common sense, studies have shown a more complex picture. For instance, poor use of high fidelity can hinder learning for novices. Noble (2002, p. 44) writes:

> The implication here is that there is a point beyond which training devices fail to sufficiently motivate experts, even with high degrees of fidelity, if the design of the simulator and/or simulation device fail to sufficiently challenge the ability of the individual to handle novel tasks of increasing difficulty. On the other hand, novice pilots may be overburdened or confused by excess fidelity and/or a training task that is overly difficult for learning or assessment purposes.

Hubal and Pina (2012) also point out that too much realism can set up unrealistic expectations about what can actually be accomplished within the virtual environment. There is also some evidence that low degrees of fidelity can be successful for learning and training. Toups, Kerne, Hamilton, and Shahzad (2011) managed to create a game for team collaboration for fire emergency responders that did not resemble their work tasks or environment at all. This is equivalent to what Dormans (2011) calls non-iconic simulation. In their study, Toups et al. (2011) managed to show that the participants improved their cooperation and communication skills and that these skills transferred to other situations outside the game.

So far, I have discussed fidelity as a unidimensional concept, but it is evident from the broad range of simulations discussed here that it is more complex than that. Therefore, it is relevant to delve deeper into the issue. According to Liu, Macciarella, and Vincenzi (2009), fidelity is more easily understood in relation to a referent, that is, the thing or aspects that the simulation is trying to replicate. Broadly, fidelity can be categorised into physical, functional, task, and psychological fidelity. These categories are not mutually exclusive, but will inevitably overlap (Liu, Macciarella, & Vincenzi, 2009). Figure 4.2 summarises the categories found in the literature.

PHYSICAL FIDELITY

Physical fidelity is the degree to which the simulation looks and feels like the real world (Alexander, Brunyé, Sidman, & Weil, 2005). When people talk about fidelity in general, they usually mean physical fidelity. A simulation can replicate different aspects of the physical environment. For instance, equipment fidelity refers to the imitation of the user's equipment (hardware and software) (Liu, Macciarella, & Vincenzi, 2009), and environmental fidelity "relates to the physical surroundings, representation, and characteristics in which a simulation or game takes place" (Bauman & Wolfenstein, 2013, p. 104), such as motion cues and other sensory stimuli. Among these sub-categories, motion fidelity seems to be the least important for creating a sense of realism, with the exception of pilot training (Liu, Macciarella, & Vincenzi, 2009).

TASK FIDELITY

Task fidelity is the degree to which tasks and manoeuvres executed on the equipment are replicated (Liu, Macciarella, & Vincenzi, 2009). In a tank simulator, for example, the order in which something is performed must match the order in which the same task is accomplished in reality. Similarly, when communication skills are trained, the same rules and regulations of the real world must be applied in the simulation.

FUNCTIONAL FIDELITY

Functional fidelity is the degree to which interactions within the simulation resemble interactions in the real world (Alexander et al., 2005), that is, "how the simulator reacts to the tasks and commands being executed" (Liu, Macciarella, & Vincenzi, 2009, p. 67). Returning to the example of a tank simulator, the simulated vehicle reacts differently, depending on the surface (e.g. paved road or woodland) on which it is driven. The system also simulates how the barrel bends from the heat generated from firing, something that the trainee must bear in mind when aiming. Functional fidelity is closely related to but is not the same thing as physical fidelity and task fidelity, that is, in order to achieve functional fidelity, the simulation must have some degree of both physical and task fidelity.

PSYCHOLOGICAL-COGNITIVE FIDELITY

Psychological-cognitive fidelity is the degree to which emotional, psychological, and cognitive aspects are represented in the simulation (Alexander et al., 2005; Liu, Macciarella, & Vincenzi, 2009). Beaubien and Baker (2004) describe it as "the degree to which the trainee perceives the simulation to be a believable surrogate for the trained task" (p. i52). Examples of psychological-cognitive fidelity are stress, fear, engagement, believable non-playable characters (NPCs), communication, and cognitive workload. It has received great interest from the SG community, because it is seen as one of the most important prerequisites for the 'suspension of disbelief' and immersion (Bauman & Wolfenstein, 2013; Beaubien & Baker, 2004). A combination of sufficient psychological and environmental fidelity is postulated to produce this effect (Bauman & Wolfenstein, 2013), that is, although a game can include aspects of fantasy, a player can suspend disbelief as long as the game world behaves in a consistent way within its own rules and narrative (Sweetser & Johnson, 2004).

The simulation thus becomes believable, that is, the simulation gives an illusion of life, even if the player is fully aware that characters, objects, and settings are made-up (Umarov & Mozgovoy, 2012). By temporarily 'believing' the simulation, trainees are expected to behave as they would in the real world, which, in turn, would be an argument for the transfer of learning from the simulated world to the real one (Beaubien & Baker, 2004).

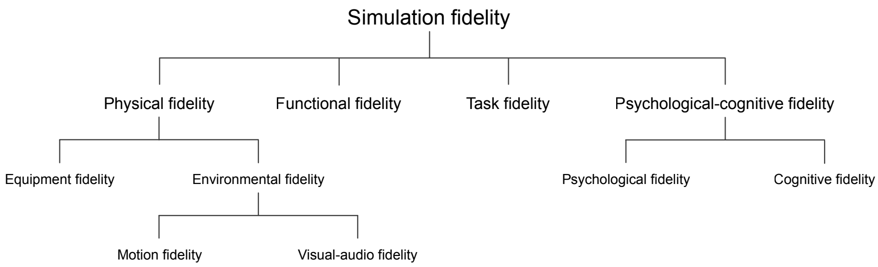


FIGURE 4.2: Sub-categories of simulation fidelity, aggregated from Alexander, Brunyé, Sidman, and Weil (2005), Bauman and Wolfenstein (2013), Beaubien and Baker (2004), and Liu, Macciarella, and Vincenzi (2009). The term psychological-cognitive fidelity comes from Liu, Macciarella, and Vincenzi (2009), whereas the other sources only mention psychological fidelity. Hence, psychological-cognitive fidelity has been divided into psychological and cognitive fidelity, respectively.

Figure 4.2 summarises the sub-categories of simulation fidelity mentioned above. Usually an increase in fidelity is thought to increase the transfer of training, but a game does not need high levels of fidelity in all dimensions, only the ones that correspond to the learning goals (Alexander et al., 2005). For example, a target practice game needs high physical fidelity in order to recreate visual cues (e.g. being able to discern friend from foe) and an accurate weapon operation (for fine-tuning motor skills). A game designed to practise reasoning skills, however, needs high functional fidelity in order to allow the player to test ideas and hypotheses through direct manipulation and experimentation. Furthermore, a game used to train stress management needs high psychological fidelity, to recreate situations that the player experiences to be just as stressful as the real-life ones. Since high fidelity at all levels is usually a costly endeavour (Bowers et al., 2013; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013), it is important for the instructor or the instructional designer to thoroughly explore which dimensions are necessary for learning and which can be prioritised lower (Beaubien & Baker, 2004).

Returning to the issue of games versus simulations, it is evident from the above discussion that explaining games in terms of having lower degrees of realism or fidelity is a gross oversimplification. Due to the high developmental costs involved in producing high physical fidelity, I would contend that most SGs put more effort into the other dimensions, especially psychological-cognitive fidelity. Physical fidelity also has lower priority because it has little impact on what is thought to make a game 'fun.' For instance, Joeckel and Bowman (2012) found that increasingly realistic graphics did not affect enjoyment (but different levels of usability had an effect). In fact, too much realism will make a game too challenging for the average player, and might even set up unrealistic expectations about what can actually be done within the game world (Hubal & Pina, 2012).

4.2 FROM SERIOUS GAMES TO SERIOUS GAMING

A SG relates to serious gaming in the same way as a simulator relates to simulation. Paraphrasing the definition of a simulation (from the reality perspective) given by Crookall et al. (1987) into gaming, it can be said to be *the actualisation of the game, the operation or experience of it, the on-going, 'live' performance*. Thus, serious gaming is the practice of using and playing an SG. Related terms to serious gaming are game-based learning (GBL) and game-based training (GBT), which refer to gaming within the context of learning and training, respectively.

Based on the dimension of technological proximity, I have divided serious gaming into three categories:

- Non-technological serious gaming (e.g. card games, table-top games, live role-play, and massive role-playing exercises)
- Technology-enhanced serious gaming (e.g. alternate reality games (ARGs), and mixed reality games)
- Technology-based serious gaming (e.g. simulators and digital games)

Although the interaction with the games differs across these categories, the differences between these categories can be argued to be merely superficial (see e.g. Linderoth, 2013). For instance, the rules and gameplay of *Chess* are, by and large, the same regardless of the medium in which it is played. From a practitioner's (e.g. a teacher's, trainer's or other type of facilitator's) point of view, however, they impose different constraints in terms of, for example, the physical environment (e.g. access to large and rearrangeable rooms), hardware and software needed (e.g. new computer technologies), the participants' role-playing skills, and their technical proficiency (including the facilitators'). For instance, to conduct emergency management training, it is important to have relevant, well-informed, and experienced actors present, who can reproduce a realistic response within an instant (van Laere, Lindblom, & Susi, 2007). Furthermore, from the player's perspective, a technology-enhanced or technology-based game can augment cognitive abilities or reduce cognitive load, such as calculating and keeping track of points or being able to see through walls (Linderoth, 2013).

My main point, however, is that gameplay is more than the here-and-now enactment of a game; it also constitutes cultural and social context outside the game, such as the involvement in virtual communities (Lastowka, 2009; Rambusch, 2010) and modding (Postigo, 2007). For instance, a player might contribute text to a game wiki, which helps other players overcome a difficult level or bug, or simply play the game more efficiently. In MMOGs, people meet online to create guilds, play cooperatively or competitively, chat, and so on, and gradually develop friendships that extend beyond gaming (Lastowka, 2009).

Jenkins et al. (2009, pp. 448–449) argue that it is important for SG research to move from a focus on content to a broader focus on the activities and experiences involved in the practices of using SGs, that is, they call for a shift of attention from SGs to serious gaming:

> We see games not so much as vehicles for delivering curricular content as spaces for exploration, experimentation, and problem solving. We do not simply want to tap games as a substitute for the textbook; we want to harness the meta-gaming, the active discus-

sion and speculation that take place around the game, to inform other learning activities.

It is from this position that I also take my stance; SGs must be studied from a broad, systemic perspective. Serious gaming is a complex set of activities that involves in-game tasks, as well as activities surrounding the game.

4.3 CHAPTER SUMMARY

This chapter has presented an overview of SGs. As such, it has been a first step in reaching Objective 1. It has provided a summary of the scholarly discussions on how to define SGs and how they relate to simulations, (entertainment) games and role-play. The conclusion is that there is no sharp division between these concepts, especially when viewed from a meaning-making and/or experiential perspective. A game can apply simulation technology, but other factors transform it into a game, such as fictional elements, scores or elements of competition. While most training simulations strive towards high realism in terms of physical fidelity, games (and role-play) give higher priority to psychological-cognitive fidelity, that is, while the game do not necessarily resemble the real world in a physical sense, it evokes a sense of believability on a psychological level, such as stress, engagement and communication.

Additionally, this chapter has also clarified how I position myself within the SG research field. For the purpose of this thesis, I have chosen to focus on a narrow definition of SGs that highlights not only the use of games for non-entertainment purposes, but also incorporates features specific to the assessment of (non-entertainment) goals. Thus, SGs are seen as games designed for and used in a non-entertainment context in order to engage the users, contribute to the achievement of a defined purpose, and assess the players' progress towards a goal related to said purpose. Furthermore, the chapter concludes that serious gaming is the actualisation of the SG, the operation or experience of it and includes other activities surrounding the practice of using SGs. Thus, when studying serious gaming from an instructor perspective, it is important to consider its socio-cultural context, meta-gaming, and off-game activities.

CHAPTER 5
USER AND PLAYER EXPERIENCE DESIGN

So far, I have delved into the workings of serious gaming. However, some of my work belongs to another field, namely, user experience design (UXD). Better-designed systems based on the users' needs (including the instructors') will make the experience of playing a SG, as well as facilitating the whole serious gaming experience, more efficient and enjoyable. Since this thesis is about how to facilitate instructors in their work, issues related to UXD and player experience (PX) is highly relevant. Thus, this chapter is a further step in reaching Objective 1. First, I outline the major components of UXD, the role of situated cognition for studying user experiences, and information visualisation (a specific sector of UXD that is relevant for this thesis). Then I also delve into the concept of PX and how it relates to user experience (UX). Lastly, I discuss the importance of user acceptance and buy-in when designing and using SGs.

5.1 USER EXPERIENCE

A central component of UXD is user experience (UX), which Garrett (2011, p. 6) explains as such:

> User experience is not about the inner workings of a product or service. User experience is about how it works on the outside, where a person comes into contact with it. When someone asks you what it's like to use a product or service, they're asking about the user experience. Is it hard to do simple things? Is it easy to figure out? How does it feel to interact with the product?

Thus, UX relates to aspects of context, interactions, and emotions, or, as expressed by Hassenzahl (2013), it "emerges from the integration of perception, action, motivation, and cognition into an inseparable, meaningful whole [...] An experience is subjective, holistic, situated, dynamic, and worthwhile."

McCarthy and Wright (2004) outline a 'technology as experience' framework, consisting of four interconnected threads of experience: compositional, sensual, emotional and spatio-temporal (see Figure 5.1). The *compositional* thread refers to what actions are possible or plausible, how the actions are explained and what consequences they have, as well as the overall narrative structure of the experience. The *sensual* thread refers to how the experience affects our senses; how it looks, sounds, feels, and perhaps even smells or tastes. The *emotional* thread has to do with value judgements and how it feels emotionally to interact with a system; is the user bored, frustrated, excited, or amused? Lastly, the *spatio-temporal* thread has to do with the effect of space and time on the experience; do things move too fast or too slow, is the space open or closed, and how does that affect the user's willingness to continue using the system?

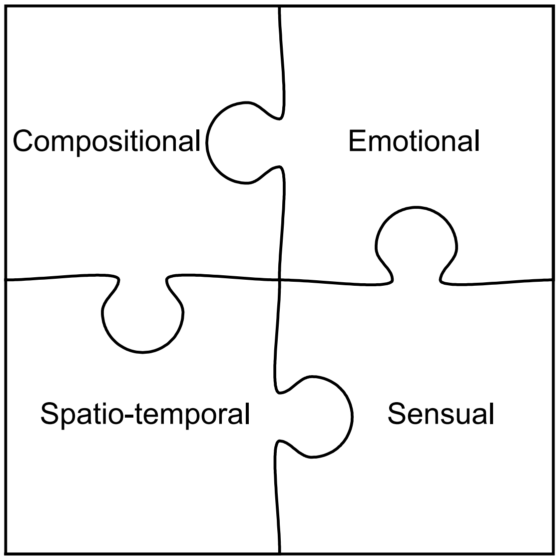


FIGURE 5.1: The four threads of experience. Adapted from McCarthy and Wright (2004, p. 42).

Moreover, the framework also consists of six processes aimed at explaining how people actively construct or make sense of experiences: anticipation (how previous experiences affect the user's expectations of the system), connection (the immediate reaction or judgement that the user makes when first coming into contact with the system), interpretation (how the user discerns what is happening and what is likely to happen in the near future), reflection (how the user, as the experience unfolds, examines and evaluates what is going on), appropriation (the process of the user making the experience his or her own), and recounting (the act of telling someone else of the experience, which in turn can change the meaning of it).

The technology as experience framework of McCarthy and Wright (2004) is interesting, because it puts technology as part of the experience and not something that creates an experience. Furthermore, it views experiences as a continuous narrative that starts before the use of a specific system and, similarly, does not end with its conclusion. In terms of serious gaming, this means that SGs do not create a (learning) experience, but are merely a part of that experience.

Hartson and Pyla (2012) define UX as "the totality of the effect or effects felt by a user as a result of interaction with, and the usage context of, a system, device, or product, including the influence of usability, usefulness, and emotional impact during interaction, and savoring the memory after interaction" (p. 5). This definition fits well with the technology as experience framework, because it manages to capture the broad scope of the issue, while at the same time positions itself to key concepts of interaction, usage context, usability, usefulness and affect.

Consequently, UXD is more than just designing a product; it involves considering factors beyond the mere functionality of the product, but also contextual and emotional aspects pertaining to its use (Hartson & Pyla, 2012). It looks at aesthetic and functional aspects of design elements and analyses them in the light of the usage context. Garrett (2011) divides the components of UXD into five planes representing different levels of granularity, from strategic level to surface level (see Figure 5.2). At the strategic level, there is a balancing act between user needs and product objectives. This activity leads to the creation of functional specifications and content requirements on the scope plane. At the next three levels, these requirements are realised through various design activities: interaction design, information architecture, information design (including interface and/or navigation design), and sensory design.

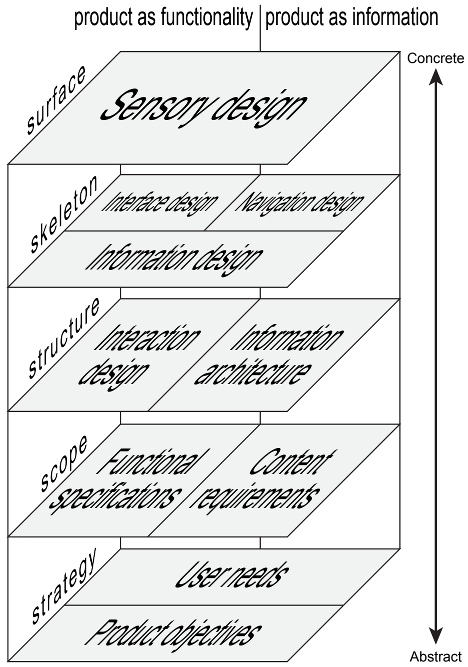


FIGURE 5.2: Elements of user experience design. Adapted from Garrett (2011, p. 29).

5.1.1 FROM HCI TO UXD

Most of the knowledge base of UXD stems from the field of human-computer interaction (HCI) (Hartson & Pyla, 2012). Historically, HCI grew from a need to study and improve human performance when interacting with computers, which led to a number of theories concerning, for instance, cognitive ergonomics and human factors (Dix, Finlay, Abowd, & Beale, 2004). A key concept in HCI is *interaction*. Interaction can be seen as a reciprocal action between the user(s) and a system, that is, a continuous exchange where user actions or input cause a change in the internal system state, which, in turn, influences further user actions (Hartson & Pyla, 2012).

The first computers were designed by the users themselves, and therefore also perfectly adapted to their needs and work practices. However, in the 1980s, when computers began to be ubiquitous in the workplace and subsequently in people's homes, the users were no longer a small, homogeneous and technically oriented group. Consequently, there was a need to overcome the barrier between the not-so-technical user and the technology itself. The solution was an iterative process that would increase a system's usability, consisting in broad terms of design, evaluation and implementation of interactive computing systems (Rogers, Sharp, & Preece, 2011). This approach was, at the beginning, quite influenced by engineering traditions (e.g. Fitts's Law, in Göktürk, 2013), but later evolved to include activities that allowed developers to work on creativity and aesthetics.

The International Organization for Standardization (2006) defines *usability* as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". It is commonly described as comprising a number of goals (Hartson & Pyla, 2012; Rogers et al., 2011), such as:

- *Effectiveness*, how well the system does what it is supposed to be doing;
- *Efficiency*, how well the system supports the users in carrying out their tasks;
- *Productivity*, such as the number of tasks the user can perform within a specific time frame;
- *Safety*, how well the system protects the users from dangerous or undesirable situations and how easy users can recover from errors;
- *Utility*, the extent to which the system provides the right kind of functionality so that users can do what they need or want to do;
- *Learnability*, how easy it is to learn how to use the system;
- *Memorability* or *retainability*, how easy it is to remember how to use the system, once learned;
- *User satisfaction*, how satisfied the user is with the system, and other subjective measures (e.g. the level of job satisfaction when using the system, how motivated the user feels about using it, how much fun and aesthetically pleasing it is considered to be).

Moreover, Hartson and Pyla (2012, p. 10) stress that usability is not equivalent to being 'user-friendly':

> This is a misdirected term; to say that it is about friendliness trivializes the scope of the interaction design process and discounts the importance of user performance in terms of user productivity, etc. As users, we are not looking for amiability; we need an efficient, effective, safe, and maybe aesthetic and fun tool that helps us reach our goals.

Usability is still a core component in UXD, but with the inclusion of factors pertaining to the experience of using a system (Hartson & Pyla, 2012). That is, if a system's usability is deficient, it will affect the overall UX, since it will leave the user confused, irritated and frustrated. For instance, the PC version of the entertainment game *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, n.d.) has been criticised for its bad user interface, which makes the player inefficient and error prone (see e.g. Schwarz, 2011). However, the game can be said to have good UX on other accounts; it offers the players something beyond the here-and-now player-game interaction. For example, PC players have the opportunity to create and download mods that fix some of the original game's shortcomings. Furthermore, a player can take snapshots mid-gameplay by pressing the 'print screen' button and the images are automatically saved onto the player's hard drive. This feature does not affect progress within the game, but enhances its UX, since the player can use the images as memorabilia or to share with friends. A more inefficient solution would be for the player to use a third-party software to take screen-shots, or having to exit the game after each 'print screen' button press in order to access the computer's clipboard and using an image software to save the image to a file. Thus, the game stretches beyond the immediate player-game interaction and situates it within a broader sociocultural context.

In conclusion, HCI with its focus on usability, GUI design, and interaction design, is still a core component of system development, but UXD is the 'icing on the cake' that in the end will determine how a system is received and perceived by the users (see Figure 5.3).

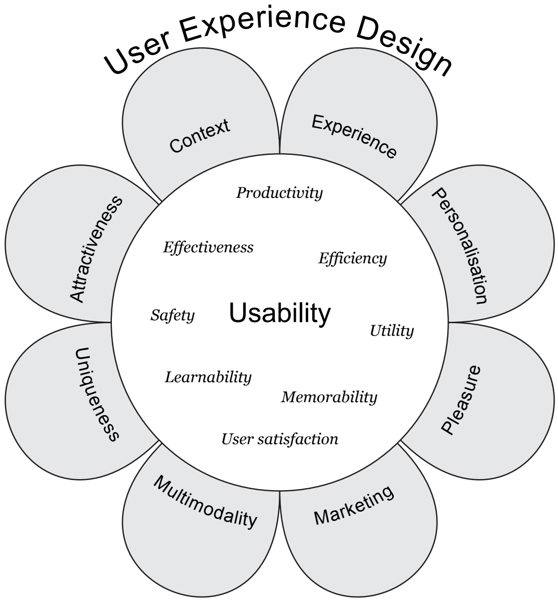


FIGURE 5.3: UXD as an extension of HCI, not a replacement.

5.1.2 INFORMATION VISUALISATION

In serious gaming, being able to perceive and interpret what is happening or has happened at any given moment of the (learning) experience is crucial when assessing players' performance. A strand of UXD that is relevant to mention in this context is information visualisation. Information visualisation seeks to augment human cognition in terms of perceiving patterns, trends and anomalies, and subsequently gain insight into a particular phenomenon or situation (Rogers et al., 2011). On the surface, this has to do with information display design, but requires an in-depth understanding of the human visual system and how to graphically represent complex data in a dynamic and interactive way. Furthermore, issues pertaining to the socio-cultural context affect are also of importance, since they affect how people attend to and interpret information (Goodwin, 1994).

One of the most widespread principles of information visualisation is Ben Shneiderman's visual-information-seeking mantra: "Overview first, zoom and filter, then details-on-demand" (Shneiderman, 1996, p. 337). Although this principle has been criticised for being too narrow (there might be situations where the user wants to see the details first and then zoom out for an overview) (Ware, 2013), it highlights the fact that users should be able to interact with information displays (if relevant for the task at hand) and that the organisation of information plays an important part in how information is interpreted and, hence, experienced. Research on information visualisation has been greatly influenced by the ecological approach to visual perception by James Gibson (1986). Gibson's approach focuses on the role of the visual system for obtaining properties of surfaces.

Consequently, the ecological approach enables the UX designer to manipulate what is presented to the user and how, such as through the use of shadows, angles, and movement.

Knowledge of information visualisation is required when designing for situation awareness (SA). Endsley and Jones (2012) define SA as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p. 13). SA is especially important for dynamic work tasks that require rapid decision-making and assessments of the situation. A well-designed display can help a user detect something in the periphery of the visual field or draw attention to a specific detail among the information, and, thus, increase the user's SA (Ware, 2013).

5.1.3 SITUATED COGNITION AND UXD

UXD has been greatly influenced by situated cognition, a theoretical framework that tries to explain cognition from a socio-cultural and embodied perspective. It explains learning, thinking, and knowing as something that emerges among people that share a social and culturally structured world (Lave & Wenger, 1991). Thus, according to this theory, thinking and experience cannot be understood or studied without also understanding the social and cultural context in which it takes place.

Being influenced from various schools of thought, such as activity theory (Kaptelinin & Nardi, 2006), ecological psychology (Gibson, 1986), and pragmatism (Dewey, 1958), situated cognition takes a stance against the view of cognition as merely internalised processes (Bredo, 1994; Clark, 1999). Instead, it views cognition as something that exists outside the brain; in the body (so-called embodied cognition), between people, and in artefacts (social and distributed cognition). Rambusch (2010) summarises this in an equilateral triangle consisting of three levels of situatedness: *high-level* cognition (the socio-cultural level; cultural and social norms and practices), *here-and-now* (the context in which a cognitive activity takes place; the setting and the tools and artefacts used to accomplish a task), and *low-level* cognition (activities pertaining to the body, especially our senses). Early HCI studies tended to be focused on the here-and-now level, but with the emergence of Computer-Supported Cooperative Work (CSCW) (which grew out of HCI, but eventually became a field of its own) there was a shift from single-user interfaces to multi-user ones that required insight into social and cultural issues (Gruding & Poltrock, 2013). There is still little emphasis on the role of the body in HCI, with a few exceptions (see e.g. Dourish, 2004), although recent advances into ubiquitous computing technologies (e.g. gestural interaction, biofeedback technology, brain-computer interfaces) have incited a new interest in this area (Schmidt, Pfleging, Alt, Sahami Shirazi, & Fitzpatrick, 2012).

Comparing the levels of situatedness to the technology as experience framework presented earlier, there is a distinguishable overlap (see Table 5.1), which makes it clear why situated cognition is an appropriate framework to use in UXD. For instance, the compositional thread is compatible with the socio-cultural level, since action possibility and explanations of actions are dependent on the socio-cultural structures in which the user takes part. A concrete example is the use of mobile phones during a dinner party. In some social settings it might be acceptable to answer a phone call while remaining seated at the table, whereas in others it is considered rude (the dinner guest should leave the table before answering), or completely unacceptable (the phone should be turned off during dinner).

Situated cognition has been scrutinised by a number of scholars (see e.g. Wilson, 2002), but has gained great acceptance from the HCI and UXD communities (e.g. Buxton, 2007; Dourish, 2004; Hassenzahl & Tractinsky, 2006; Suchman, 2007). Risku, Mayr, and

TABLE 5.1: Comparison between the three levels of situatedness in situated cognition (Rambusch, 2010) and the technology as experience framework (McCarthy & Wright, 2004).

SITUATED COGNITION	TECHNOLOGY AS EXPERIENCE	COMPARISON
High-level	Compositional	The narrative structure is dependent on the socio-cultural context in which an activity takes place
Here-and-now	Spatio-temporal	An experience and the level of engagement that the user expresses are dependent on where and when the activity takes place
Low-level	Emotional and Sensual	Aspects of embodiment affect how an activity is experienced

Smuc (2009) especially stress that the view of cognition as being situated and embodied can help usability research and practice to move forward in reinventing user-centred design practices. They suggest that the focus of attention in system development should be on action as a contextual activity, instead of usage and user. Similarly, Kaptelinin and Nardi (2006) argue that the shift from an information-processing view of users to higher-level interaction models changes the unit of analysis from user-system interaction (limited to system-specific tasks) to subject-object interaction (which includes all meaningful tasks that can be enabled by technology).

A core concept in situated cognition, which is also useful for UXD, is *participation* (Lave & Wenger, 1991, pp. 51–52):

> [G]iven a relational understanding of person, world, and activity, participation, at the core of our theory of learning, can be neither fully internalized as knowledge structures nor fully externalized as instrumental artifacts or overarching activity structures. Participation is always based on situated negotiation and renegotiation of meaning in the world. This implies that understanding and experience are in constant interaction – indeed, are mutually constitutive. The notion of participation thus dissolves dichotomies between cerebral and embodied activity, between contemplation and involvement, between abstraction and experience: persons, actions, and the world are implicated in all thought, speech, knowing, and learning.

Consequently, UX can be studied from a perspective of participation. From a practical perspective, using situated cognition as a framework in UXD involves studying users and their interactions with technology in the real environment (as opposed to artificial situations such as laboratory experiments). It gives the researcher or designer a lens from which to view experience. Thus, ethnographic approaches (e.g. contextual inquiry) and action research have gained popularity among UX researchers and practitioners (Kaptelinin & Nardi, 2006; Risku et al., 2009).

5.2 PLAYER EXPERIENCE

Historically, game design has not paid much attention to UX (Zaharias, Gatzoulis, & Chrysanthou, 2012). Formal user testing (tests on real and representative users/players) is rare, and game designers more often than not rely on tacit knowledge and informal, ad hoc UXD methods (Bellotti, Berta, & De Gloria, 2010; Mirza-Babaei, Nacke, Gregory, Collins, & Fitzpatrick, 2013). However, with the increase of competition between game producers, game developers have discovered the advantages of a more structured approach to increase a game's quality and sales (Bernhaupt, IJsselsteijn, Mueller, Tscheligi, & Wixon, 2008).

In gaming literature, UX is often renamed player experience (PX). Although these two terms are sometimes used interchangeably, PX is usually seen as something that goes beyond UX. For instance, Ibrahim et al. (2012) claim that "PX could be much more extensive than the UX; PX helps to improve the player interface design, the level of challenge, the pace, game mechanics and game story" (pp. 23–24). Mirza-Babaei et al. (2013) also conclude that "classic usability measures and scales do not provide enough information on player experience" (p. 1507). Similarly, the concept of 'playability' is often described in relation to usability, such as "Playability represents the degree to which specified users can achieve specified goals with effectiveness, efficiency and specially satisfaction and fun in a playable context of use" (González Sánchez, Padilla Zea, & Gutiérrez, 2009, p. 357).

Additionally, Desurvire, Caplan, and Toth (2004) suggest that the evaluation of playability must, apart from the usual usability metrics, also include measurements of gameplay, narrative, and game mechanics. The reasoning is that games are different from productivity systems, since their primary agenda is to create pleasurable experiences, not productivity (Ang, Avni, & Zaphiris, 2008; Cowley, Charles, Black, & Hickey, 2008; Nacke & Drachen, 2011). Of course, when talking about SGs, the issue becomes even more complex, since entertainment and fun are secondary priorities, so framing the design and use of SGs as *experiences* is even more relevant (Marsh, 2011). In sum, usability ensures that interaction with the game moves smoothly, but does not cover temporal aspects, that is, PX will differ depending on how events are perceived, recalled, and (re)acted upon (Zaharias et al., 2012).

Researchers from the HCI and the games research communities have approached the concept of UX/PX from many different perspectives. For instance, Takatalo, Häkkinen, Kaistinen, and Nyman (2011) compared how players experienced playing the game *Halo* (Bungie, n.d.) in a laboratory setting and in a natural environment (at home). They managed to show that the two settings differed significantly in terms of the gamers' involvement, presence, and cognitive evaluation of the playing session. This means that evaluating PX in game development and research has to consider what aspects of PX are of interest and how they might be affected by contextual factors. In some cases, laboratory studies could be sufficient, but to capture the full range of PX, gameplay has to be studied long-term (hours as opposed to minutes) in a natural environment (Takatalo et al., 2011).

In another study, Barendregt, Bekker, Bouwhuis, and Baauw (2006) performed a usability test on children that played a game. They expanded their range of possible usability problems to also incorporate a category of 'fun problems', that is, problems that affect motivation to play the game, such as when there are incongruencies between challenges in the game and the player's skill, or when the player is not in control of game content (e.g. unable to skip cut scenes). Interestingly, the authors also emphasise issues in interpreting the results from a social context viewpoint. For example, they mention that even if some children encounter problems so severe that they cannot proceed in the game, they will overcome these by receiving help from, for instance, a parent or sibling. Thus, less severe usability problems may be more problematic in the long run, since the children might not ask for help to overcome these (Barendregt et al., 2006). This conclusion affects the decision process involved in an iterative design process, that is, how results from user tests inform further improvements to the system.

Another application of UXD in game design is offered by Mirza-Babaei et al. (2013), who explored the use of Biometric Storyboards as a method to improve user testing during game design. The idea behind the method is to use biofeedback data (e.g. skin conductance and facial electromyography) from players as they play a game, in addition to self-report measures (e.g. think-aloud protocols) and observations, that are more commonly used in user testing. Biometrics is especially useful for analysing PX, since it is less disruptive to the gameplay, but at the same time can give a (somewhat) objective measure of engagement (Mirza-Babaei, Long, & Foley, 2011). Since biofeedback technology measures bodily responses and actions, it should also be useful for studying embodied cognition in gameplay (Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010). Furthermore, an interesting aspect of the Biometric Storyboards is that they visualise information from a play session in an effective way. Data plots show, on a timeline, aggregated data from biometric measures, player comments, and observational notes, which help interpret the data, and triangulate findings against the designer's intended PX (Mirza-Babaei et al., 2013).

These concrete examples show that there is a broad scope in applying UXD in games research, from traditional usability tests and extended PX evaluations, to the innovation of new methodologies for exploring and testing PX. They also show that situated cognition plays an important role in analysing PX. As Rambusch (2010) has shown, the three levels of situatedness can be used to explain and study gameplay. Unfortunately, many PX studies still mainly focus on the here-and-now level and the low-level of gameplay, that is, what is occurring in the moment of playing and around a player (e.g. interactions between individuals), as well as issues pertaining to the player's body (e.g. what input devices are used). For instance, Ali, Abdullah, Salim, and Lee (2013) limited their study of UX in *The Sims 3* (The Sims Studio, n.d.) to the interface (comprising controller buttons, mouse clicks, menus, status bars, and field of view), ignoring most of the sociocultural setting in which gameplay takes place.

5.2.1 ENGAGEMENT, IMMERSION, AND PRESENCE

A more detailed look at the concept of PX, reveals it is closely linked to the concepts of engagement, immersion, presence, and flow. The three concepts of engagement, immersion, and presence are often clumped together as a way of describing how involved the player is in the game. However, there is considerable confusion about how these concepts fit together, as is evident by the lack of consensus on how to define them (Brown & Cairns, 2004; Gajadhar, de Kort, & Ijsselsteijn, 2009; Gunter, Kenny, & Vick, 2008). Some describe engagement as consisting of, among other attributes, immersion (Benyon, 2010; Whitton, 2011). Others claim that engagement is a prerequisite for, or a sub-category of, immersion (Brown & Cairns, 2004; Gunter et al., 2008). This confusion makes it difficult to conclusively define each concept, but I will here try and recount some of the most comprehensive or prevalent definitions that are used in the context of virtual worlds, games, and SGs. As an overarching conceptualisation, I will use the hierarchical framework presented by Brown and Cairns (2004); that engagement is the first stage of immersion, and presence the last (i.e. total immersion).

Engagement is often described as the level of involvement or absorption in an activity (Brown & Cairns, 2004; Gajadhar et al., 2009). According to Gunter et al. (2008), engagement must involve active participation from the player and is reliant on interactivity, that is, the reciprocal action between the player and the game (or other players). They further divide engagement into emotional, intellectual, psychological, and physical engagement, which all has to do with the player's willingness to invest in or 'play along' with the gaming experience at different levels. Brown and Cairns (2004) also add the extra level of 'engrossment' to denote even further involvement in the game, but not full immersion. When engrossed, the player invests more time and emotional energy into the game. For this reason, engagement is seen as important for SG and simulation, as a characteristic that will increase learners' time on a task and, thus, enhance learning (Alexander et al., 2005).

According to Gajadhar et al. (2009), *immersion* is "a metaphorical term originating from the experience of being submerged in water. In digital gaming it connotes [...] the experience of being surrounded by the game resulting from the depth and breadth of the game's sensory stimulation and its narrative quality" (p. 16). A central theme in most definitions of immersion is a sensation of being "cut off and detached from reality such that the game is all that matters" (Ali et al., 2013, p. 7), losing track of time (Whitton, 2011), and at the same time have a heightened sense of presence in the virtual world (Annetta, 2010). What separates immersion from engagement is a willingness to suspend disbelief (a term introduced in Chapter 4.1.3), that is, immersion is the move from simply investing in the experience, to a belief in the game's fantasy context (Gunter et al., 2008). This does not mean, however, that the player is convinced the game world is real, only that he or she is willing, within the boundaries of the game, to act as if it is real. As put by Salen and Zimmerman (2004, pp. 450–451):

> The immersive fallacy is the idea that the pleasure of a media experience lies in its ability to sensually transport the participant into an illusory, simulated reality. According to the immersive fallacy, this reality is so complete that ideally the frame falls away so that the player truly believes that he or she is part of an imaginary world.

Recalling the description of a game as a system in its own right (Crookall et al., 1987), suspension of disbelief can be viewed as a players' acceptance of the attributes, rules, and roles within that system, without forgetting that they are actually playing a game, or mistaking the virtual world for the real world.

Moving along the immersion continuum, towards presence, it is relevant to mention that Alexander et al. (2005) differentiate between diegetic and situated immersion, where diegetic is the immersion in the act of playing the game, and situated is immersion to the degree that the players experience an illusion of existing within the game space (equivalent to presence). Diegetic immersion is perhaps related to the here-and-now level of situated cognition described earlier (section 5.1.3), whereas situated immersion relates to all three levels.

The most common definition of *presence* is a sense of 'being there', especially in contexts where 'there' connotes another environment than the one where the player is physically situated (Ali et al., 2013). Annetta (2010) describes presence as "the psychological perception of being in or existing in the game environment in which one is immersed" (p. 107); which clarifies the relationship between immersion and presence.

Furthermore, Alexander et al. (2005) differentiate between personal, environmental, and social presence, where personal presence is a more general term for an overall feeling of being within a virtual world. Environmental presence is closely related to environmental fidelity (see Chapter 4.1.3), but also encompasses reactions from the virtual environment on the player's actions. Social presence is the sense of being in the virtual world together with others, also known as co-presence (Gajadhar et al., 2009; Mennecke, Triplett, Hassall, & Conde, 2010).

One of the most comprehensive conceptualisations is offered by Lombard and Ditton (1997), who define presence as "a perceptual illusion of nonmediation in which the medium appears to become either invisible, or transformed into a social entity." This definition incorporates six interrelated conceptualisations (Lombard & Ditton, 1997):

- Presence as *social richness*: verbal and non-verbal social interaction is mediated in such a way that it is indistinguishable from face-to-face communication;
- Presence as *realism*: the medium has high fidelity;

- Presence as *transportation*: the border between the real world and the simulated world becomes blurred to a point where the player moves effortlessly between the two;
- Presence as *immersion*: the medium is perceptually and psychologically immersive;
- Presence as *social actor within medium*: other agents (people or avatars) provide enough social cues (e.g. eye contact) that the player is encouraged to interact with them (even if it is not possible);
- Presence as *medium as social actor*: the medium in itself mimics social behaviour that elicits social interaction from the player.

Schultze (2010) also adds embodiment as a central concept for presence; the experience of having and controlling a body. In gaming and virtual world, this is usually achieved through some kind of avatar. Lombard and Ditton (1997) summarises a number of factors that affect the level of presence, such as sensory stimuli, interactivity, social realism, willingness to suspend disbelief, and the player's personality traits/interests.

Additionally, Sweetser and Wyeth (2005) surmise that social interaction from other people can interrupt immersion and, thus, dissolve the sense of presence. However, others have found that social presence is an important ingredient in PX (Gajadhar et al., 2009), and that connecting with other people can increase the sense of presence (Lombard & Ditton, 1997). These insights into engagement, immersion and presence are useful when considering the possibilities and constraints of serious gaming, for example, the importance of avatars and other aspects of a gaming experience.

5.2.2 FLOW

Flow is another aspect of PX that has its roots in the study of enjoyment. The concept of flow was first introduced by Csíkszentmihályi (1990), as a way to describe and explain the state of deep concentration in which one loses the sense of time, and being fully immersed in the task at hand; the optimal experience. Flow is a state of mind present in all levels of engagement, immersion, and presence (Brown & Cairns, 2004). If flow is interrupted, so is also immersion (Gunter et al., 2008). However, while these concepts have proven elusive in terms of defining and operationalising, flow has been studied at great length, in a wide variety of contexts, and is described consistently in the literature.

There are several aspects of flow that make it an interesting and important concept in the study of gameplay and PX. First, since flow is linked to enjoyment, it has captured the interest of the UXD community, as well as scholars of games studies. In other words, if we want to make a system pleasurable to use, it should be designed in such a way that the user reaches a state of flow quickly and stays there as long as possible. Flow is sometimes also termed 'pleasurable frustration' (Annetta, 2010), to denote the distinction between pleasure and enjoyment. As put by Csíkszentmihályi (1990, p. 46):

> Enjoyment is characterized by this forward movement: by a sense of novelty, of accomplishment. Playing a close game of tennis that stretches one's ability is enjoyable, as is reading a book that reveals ideas we didn't know we had. Closing a contested business deal, or any piece of work well done, is enjoyable. None of these experiences may be particularly pleasurable at the time they are taking place, but afterward we think back on them and say, "that really was fun" and wish they would happen again. After an enjoyable event we know that we have changed, that our self has grown: in some respect, we have become more complex as a result of it.

According to Csíkszentmihályi (1990), there are seven elements of enjoyment that lead to flow: (i) a challenging activity that requires skills, (ii) the merging of action and awareness, (iii) clear goals and feedback, (iv) concentration on the task at hand, (v) the paradox of control, (vi) the loss of self-consciousness, and (vii) the transformation of time. Moreover, he proposes that some people are more autotelic than others, that is, they have personality traits that make them strive, almost obsessively, for the flow experience, and do certain activities for no other reason than the activity itself (hence the word autotelic, meaning self goal). Flow seems to be closely linked to an individual's ability to focus attention exclusively on one thing, and also to set goals with increasing complexity that consume cognitive resources. There are also cultural differences in terms of favouring flow or not, which would also explain some of the individual differences (Csíkszentmihályi, 1990).

The flow theory explains why some tasks are experienced as boring, some as stressful, and some as enjoyable (reaching a state of flow). To experience flow, the challenges that a game player encounters have to be matched to his or her skill level (as described by Figure 5.4). Although a simplified model, we can deduce that novice players must have easy to moderate challenges in order to be in flow, otherwise they will experience anxiety or apathy and probably not finish the game. Similarly, experienced players will become bored and stop playing, if the game is too easy. In sum, to experience a continued state of flow, a player must be pushed towards higher levels of performance, at the 'right' pace.

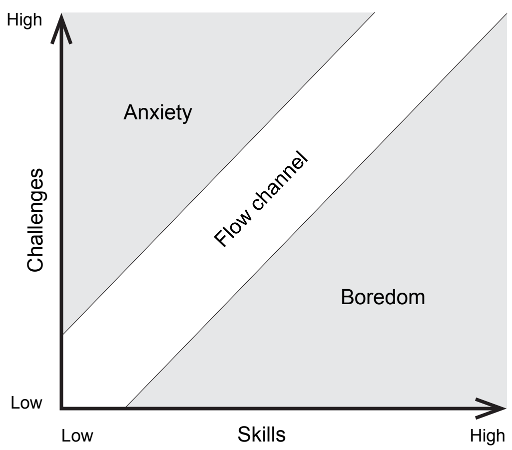


FIGURE 5.4: Flow in relation to skills and challenges. Adapted from Csíkszentmihályi (1990, p. 74).

A second reason why flow theory is interesting from a gaming perspective is that it has been used as a basis in a number of models and frameworks to explain, analyse, and evaluate media enjoyment, including PX (Sherry, 2004; Weber, Tamborini, Westcott-Baker, & Kantor, 2009). One such framework was developed by Cowley et al. (2008) in order to operationalise play experience. They base their reasoning on the user-system-experience (USE) model (Figure 5.5), which explains gameplay from an information system's perspective. The USE model is an information systems framework and consists of three interrelated parts: user, system, and experience. User refers to the human player, especially user profile data that can be used for player modelling in adaptive systems. In relation to flow, this means that the game will have to use data about the user (including play statistics), in order to adjust the game (e.g. challenges) to fit the individual player and, thus, avoid static difficulty levels (Cowley et al., 2008). System refers to the technological system, that is, the game itself and the possible actions that it affords the player. It should be able to detect player data and react accordingly. Lastly, experience refers to the player experience, especially aspects concerning flow. The framework is especially useful when dealing with adaptive games that can automatically "objectively (albeit approximately) evaluate cognitive and emotional states of gamers as they play, [...] which in turn is needed to affect the player's experience in real-time" (Cowley et al., 2008, p. 23). It is worth noting that the framework is merely conceptual and does not offer concrete solutions to how this would be realised, although psycho-physiological measurements come to mind (see e.g. Ekanayake, Backlund, Ziemke, Ramberg, & Hewagamage, 2011).

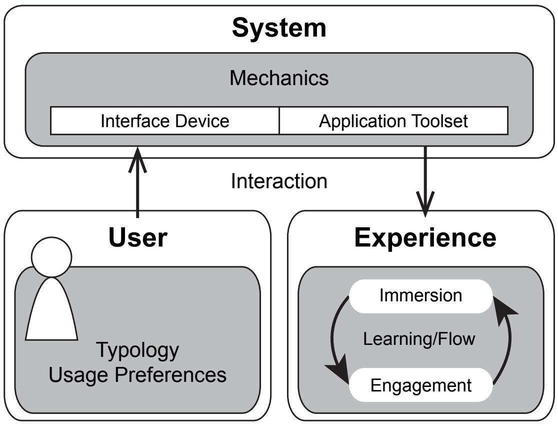


FIGURE 5.5: User-system-experience (USE) model. Adapted from Cowley, Charles, Black, and Hickey (2008, p. 2).

Another framework in which the flow theory has a prominent role is the GameFlow model developed by Sweetser and Wyeth (2005). It is suggested that the GameFlow model be used in the evaluation of PX, especially attributes related to enjoyment. It consists of eight elements derived from the flow theory and game design heuristics: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Each element has a number of criteria that can be used to inform game design, as well as in expert reviews of (finalised) games. For instance, the concentration element means that a game should capture the player's attention and hold it throughout the whole game. Challenge means that a game should have tasks that match the player's skill level. The skill element captures aspects related to how players should learn, develop and master the game skills. This relates to the control element which covers aspects such as the sense of control players should feel over the game shell, the characters and the actions they take. It is crucial that players feel that their actions have an impact on the game. The clear goal element simply means that the game, as well as sections of the game (levels), should have goals that are made clear to the player. The feedback element means that players should get an immediate response to their actions and they should be informed on their progress towards a goal. The immersion element relates to the player's involvement in the game, as already discussed in the previous section. Finally, the social interaction element means that a game should support social interactions through the game, such as competitions, collaboration, as well as social communities inside and outside the game.

It should be noted that the GameFlow model has been critiqued for being too rigid. For instance, not all players desire social interaction, but a game without social features would be rated low according to the GameFlow model (Cowley et al., 2008). Thus, it should not be taken too literally.

Alklind Taylor, Backlund, Engström, Johannesson, and Lebram (2009a) used the GameFlow model to evaluate player enjoyment in a SG for stroke rehabilitation. Instead of evaluating the game or the game console itself, they used the elements of GameFlow in analysing player responses during an interview. As a result, they found some interesting insights into PX for an atypical user group; older, less experienced game players, who have suffered a stroke and consequently have a range of disabilities that makes interaction with conventional gaming gear difficult or impossible.

A completely different framework is presented by Rolfe, Jones, and Wallace (2010). They used the flow theory in conjunction with a narrative structure common for fictional media to create a narrative structure for games that takes the player on a 'psychological journey' that is both compelling and matches his or her skill level. It suggests that a game narrative should consist of five acts: exposition, rising action, climax, falling action, and conclusion. Rolfe et al. (2010) particularly point out that many games leave their player in a heightened state of flow in the last act, which is undesirable. Instead, a reduction of "the level of challenge affords the player the opportunity to relax and reflect on the experience they have come through, providing them with a satisfying sense of completion and closure" (Rolfe et al., 2010, p. 452). Most likely, this conclusion is transferable to the design of SGs.

Last, but not least, Takatalo et al. (2011) present a framework, called Presence-Involvement-Flow Framework^2 (PIFF^2), for studying UX in games. As the name implies, PIFF^2 incorporates many of the elements of PX described in this chapter. Furthermore, the framework also consists of 15 subcomponents, namely: interaction, physical presence, attention, role engagement, co-presence, arousal, interest, importance, challenge, competence, playfulness, control, valence, impressiveness, and enjoyment. As I have already touched upon most of these concepts earlier, I will not go into depth about their meaning.

To sum up, PX is an important and complex concept that transcends the concept of UX. Its constituents can be used to inform design, analyse gameplay, and evaluate game quality. It is as important for entertainment games as it is for SGs.

5.3 USER ACCEPTANCE OF SERIOUS GAMES

From a broader perspective, UXD is also dependant on, and affects user acceptance, buy-in, and diffusion. User acceptance is defined as a user's intention or willingness to use an information system in the future (Petter et al., 2012). If a user is negative towards using a system, it has failed to serve its purpose. Within the context of serious gaming, this means that SGs should be designed to be easy to use and enjoyable, have high utility, and include supportive features for all types of participation (e.g. learning, flow, community, facilitation).

The issue of what factors influence user acceptance or buy-in has been thoroughly studied in the IS field. Several theories and models have been suggested, such as the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), and the integrated model of behavioural intention presented by Yi, Jackson, Park, and Probst (2006).

TAM is one of the most well-known models of user acceptance. It proposes two main determinants for attitude and behavioural intention to use a system: perceived usefulness and perceived ease of use. *Perceived usefulness* is defined as "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organisational context", and *perceived ease of use* as "the degree to which the prospective user expects the target system to be free of effort" (Davis et al., 1989, p. 985).

During the 1990s, several other models appeared alongside TAM, and Venkatesh et al. (2003) sought to combine these into a unified theory. UTAUT emphasises four determinants of user acceptance:

- *performance expectancy*, defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (p. 447),
- *effort expectancy*, defined as "the degree of ease associated with the use of the system" (p. 450),
- *social influence*, defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (p. 451), and
- *facilitating conditions*, defined as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (p. 453).

The first three are hypothesised to affect behaviour intention, which in turn affects use behaviour. The facilitating conditions factor is instead hypothesised to affect use behaviour directly. Additionally, Venkatesh et al. (2003) postulate that all determinants vary to different degrees, depending on gender, age, experience, and the voluntariness of use.

Similar to the intention of UTAUT, Yi et al. (2006) strived for an integrated model. The model is composed of: personal innovativeness in IT, result demonstrability, image, perceived behavioural control, perceived ease of use, perceived usefulness, and subjective norm. Interestingly, *personal innovativeness in IT*, defined as "the willingness of an individual to try out any new IT" (Yi et al., 2006, p. 351), is suggested as an important determinant of behavioural intention for use, at least indirectly. This means that a person's propensity to use new technology will affect their belief in a system's usefulness, ease of use, and so on.

The early theories of user acceptance were mainly concerned about productivity systems. Later on, other researchers tried to adapt these to other types of systems, such as hedonic or pleasure-oriented information systems (Chesney, 2006; van der Heijden, 2004), virtual worlds (Fetscherin & Lattemann, 2008), online games (Hsu & Lu, 2004), and serious games (Alexander et al., 2005; Alklind Taylor, Backlund, Engström, Johannesson, Krasniqi, & Lebram, 2009; Padrós, Romero, & Mireia, 2011; Smith, 2007).

Van der Heijden (2004) has explored a revised version of TAM that also includes the factor *perceived enjoyment*, that is, the degree to which the activity of using the system is perceived as being enjoyable in its own right (see Figure 5.6). They were specifically interested in the impact of this determining factor on user acceptance in hedonic systems (non-productive or pleasure-oriented systems). They tested their hypotheses on a movie website and found that perceived ease of use and perceived enjoyment were stronger determinants of intention to use than perceived usefulness.

In a similar study, Chesney (2006) also tested the revised TAM, this time on Lego Mindstorms (Lego, n.d.). Although he came to a slightly different conclusion than van der Heijden (2004) (that all three determinants have an effect on intention to use, but only indirectly by perceived ease of use), perceived enjoyment was, again, an important predictor of user acceptance for pleasure-oriented systems.

Hsu and Lu (2004) also tested an extended version of TAM, but instead of perceived enjoyment, they added factors concerning *social influences* (social norms and critical mass, respectively), and *flow experience*. This particular model was intended to explain

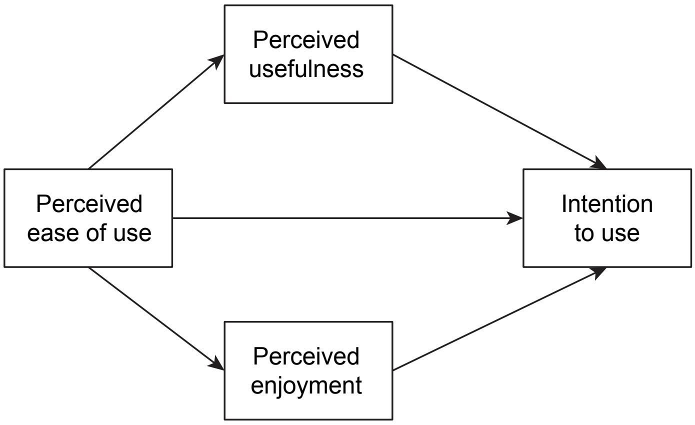


FIGURE 5.6: A revised TAM. Adapted from van der Heijden (2004, p. 701) and Chesney (2006, p. 228).

user acceptance of online games – hence the emphasis on social factors – and found significant results for all five factors. Interestingly, they found that an easy to use interface plays a pivotal role in affecting perceived usefulness and in achieving flow experience. Moreover, they conclude that perceived usefulness only has an indirect effect on players' motivation to play online games, by instead affecting players' attitude towards playing.

Another extension of TAM was suggested by Fetscherin and Lattemann (2008) to explain users' intentions to use virtual worlds. In their model, the following determinants were added to the original TAM: community, attitudes towards technology, social norms, and anxiety. As a cluster of moderating variables, they also included general social-demographical variables (gender, age, experience, location, and technology infrastructure to access virtual worlds). Among all of these variables, the most important factor, according to Fetscherin and Lattemann (2008), seems to be *community*, as it increases the perceived value of communication, cooperation, and communication channels on virtual worlds.

Taken together, all of these studies show that there are many factors that determine whether or not a user will accept a system. Looking specifically at serious gaming, the picture is complex, given the double nature of SGs as both productive and hedonic systems. For instance, Alexander et al. (2005) suggest that user acceptance of SGs is related to the users' attitude towards (physical) fidelity, that is, if they perceive that the game has low levels of realism, they will be less motivated to enter a 'training mindset', which in turn affects how much effort and attention to detail they spend during gameplay. Furthermore, Proctor, Lucario, and Wiley (2008) found that acceptance of a GBT exercise was low for those students who were uninterested in, or lacked experience of, games. They were specifically ambivalent of the 'fun' aspect of GBT, even if the game in question had high fidelity.

Another problem lies within the non-voluntary nature of gameplay in SGs, at least in formal educational settings (Berg Marklund, 2013). On the one hand, games are often upheld as being suitable for education, since students might be more motivated to play games than, for instance, read a book (Garris et al., 2002). On the other, being forced to play a game might severely decrease a learner's motivation to play it. Thus, finding the factors that determine user or player acceptance of SGs should be a prioritised issue for SG scholars.

Furthermore, students are not the only user group of SGs. The other side of the coin lies within instructors' and other facilitators' acceptance of SGs as appropriate learning or training tools. To the best of my knowledge, only a few scholars have looked at this, and mainly from formal educational settings, such as primary schools and colleges (e.g. Berg Marklund, 2013; Egenfeldt-Nielsen, 2010; de Freitas, 2006; Razak, Connolly, & Hainey, 2012; Tan, Neill, & Johnston-Wilder, 2012). For instance, Egenfeldt-Nielsen (2010) is concerned about the lack of adaptation of educational computer games in formal education. Instead of looking at the problem from an IS perspective, he uses the sociological theory called diffusion of innovation, which attempts to explain the adoption of an innovation based on how much it fits certain attributes, namely, (i) relative advantage (how better the innovation seems to be compared to existing ideas), (ii) compatibility (how well the innovation fits current norms, values, needs, etcetera), (iii) complexity (how easy it is for practitioners to understand and use the innovation), (iv) trialability (the effort involved in trying the innovation out before adopting it completely), and (v) observability (how easy it is to see the advantages brought about by the innovation).

Although innovation is used as a much broader concept, encompassing much more than mere technological innovations, there is a clear overlap between the diffusion of information theory and the user acceptance models described above. Looking at the available material on teachers' attitudes towards adopting GBL, it is clear that most are open-minded and positive towards using games, but lack insights into how this can be realised in practice with available resources (e.g. de Freitas, 2006; Razak et al., 2012; Tan et al., 2012) and the utility of games, other than being motivational for students (Berg Marklund, 2013; Egenfeldt-Nielsen, 2010).

Smith (2007) has looked at this from an even larger perspective; what makes an industry adopt a specific innovation such as gaming technology? He suggests five factors: computer hardware costs, game software power, social acceptance, other industry successes, and native industry experimentation. Overall, it is important to look at the contextual factors that affect adoption or willingness to use SGs; what are the costs involved in current practices – and not just costs from a monetary perspective, but also staff, facilities, technical infrastructure, competencies, and time.

To round off, I use two quotes. The first is from Jenkins et al. (2009, p. 460):

> A user-centered—and thus 'teacher-centered'—design approach greatly enhances the likelihood that teachers (on whom the success of these experiences ultimately lies) will be able to successfully integrate these technologies into the classroom.

The second quote comes from Bauman (2013, p. 80):

> The goal of technology integration should always focus on leveraging the new technology for the benefit of curriculum objectives, achievement, and enhanced learning or student experience. In order to ensure that technology meets these goals it is essential to support faculty in such a way that, at a minimum, ensure their buy-in with the hope of fostering champions who embrace the new technology and related pedagogy.

Herein lies several of the factors previously mentioned, such as perceived ease of use (Davis et al., 1989), facilitating conditions (Venkatesh et al., 2003), the cost-benefit idea behind diffusion (Egenfeldt-Nielsen, 2010), and, most importantly, a focus on user and player experience during SG design, where user denotes all types of participants and facilitators in serious gaming.

5.4 CHAPTER SUMMARY

This chapter has given an overview of user experience design (UXD) and how it is applied in games research. Since this thesis takes the stance that instructors form an important user group for SGs, studying UXD is central to the research question and, more specifically, reaching Objective 1. User experience (UX) is a complex term that incorporates a range of aspects, from sensory and emotional issues, to the narrative structure and socio-cultural context in which the experience takes place. A central concept, borrowed from the situated cognition framework, is participation. Furthermore, player experience (PX) is both a subset and an extension of UX. It refers to UX within the context of gameplay, but apart from traditional usability metrics, it also encompasses concepts more closely related to gameplay itself: engagement, immersion, presence, and flow. From a broader perspective, UXD is also dependant on and affects user acceptance, buy-in, and diffusion. Within the context of serious gaming, this means that we, for example, have to make sure that SGs are easy to use and enjoyable, that they have high utility, as well as include supportive features for all types of participation (e.g. learning, flow, community, facilitation). In terms of facilitating instructor role(s), this means that in order for instructors to accept and willingly use SGs, they have to be designed with the instructors' roles and tasks in mind.

CHAPTER 6
LEARNING AND TRAINING WITH GAMES

In Chapter 4, serious games (SGs) are defined and described from a general perspective. Since the research described in this thesis mainly deals with game-based training (GBT), the subsequent text is limited to SGs used for learning and training. To understand the issues involved in serious gaming, there are several areas that need to be scrutinised. In this chapter, I deal with those related to cognition and learning, such as different views on how learning works, the mastery of skills, transfer of knowledge from one context to another, as well as motivational aspects of gameplay. More specifically, the chapter explains how theories of learning and cognition can inform serious gaming, which is a central part of Objective 1. It also outlines some of the strengths and weaknesses found in using games for learning and training, since this has bearing on how and why SGs are or should be used for these purposes. This, in turn, is important to consider when analysing best practices for serious gaming.

6.1 DISAMBIGUATION OF LEARNING AND TRAINING

The literature on serious gaming seldom makes an explicit distinction between learning, training, and education. Since I use the terms GBL and GBT to mean slightly different things, it is beneficial to point out the similarities and differences between learning and training. As an overall definition, learning is a cognitive process involved in the acquisition of knowledge, skills, attitudes, and so on. It is not a static state, but an ongoing change in our cognitive structures that affect how we think and behave (Beard & Wilson, 2006). Another useful way of defining learning is as an enduring change in someone's performance or performance potential that is brought on as a result of experiencing and interacting with the world (Driscoll, 2012). Additionally, learning can be viewed not only from the perspective of an individual, but as the activities of people participating in a community of practice (CoP) (Lave & Wenger, 1991; Wenger, 1998).

A distinction can be made between formal and informal learning. According to Kyndt and Baert (2013), formal learning is characterised by being highly contextualised, instructor-led, and accomplished during a fixed and limited time frame. Informal learning, on the other hand, is not as planned and organised as formal learning; it usually has no learning support and is not facilitated by an instructor. Therefore, it is an effect of spontaneous and autonomous "engagement and reflection in daily work-related activities in which learning is not the primary goal" and in which the outcomes are unpredictable (Kyndt & Baert, 2013, p. 274).

Training, then, is a learning activity aimed at modifying or developing knowledge, skill and/or attitude, in order to enable an individual (or community) to acquire abilities that can be used to perform a given (work) task (Buckley & Caple, 2009). Although the distinction between learning and training is nonsensical from a cognitive science perspective (i.e. the same cognitive processes are most likely involved in both), training is more often used in learning contexts in which the tasks are more practical than theoretical. Consequently, training is often discussed in relation to education, for instance, Buckley and Caple (2009) claim that training tends to be more job-oriented, whereas education is more person-oriented. More specifically, this means that education has more general learning goals, whereas training is geared towards a specific and well-defined goal. Thus, training can be a part of an educational programme.

Furthermore, Chatham (2011) writes that training should deliver value to the organisation, which is not necessarily an objective of education. This makes sense if we view education as something that is organised and delivered by large institutions (e.g. primary schools, colleges, universities), and "designed to stimulate an individual's analytical and critical abilities" (Buckley & Caple, 2009, p. 11). Training, on the other hand, can be delivered in a narrower context, where the aim is to prepare the individual for a set of specific task, and to develop mastery in those tasks (Buckley & Caple, 2009).

In conclusion, learning is a more general concept that can be applied in both formal and informal contexts. In formal contexts, we tend to talk about education and training as a set of systematic activities that aim to enable learning in an individual. However, when reading literature on serious gaming, this distinction is far from clear. The International Journal of Game-Based Learning (IJGBL), for example, has a strong bias towards education and educational games, which is evident when reading its description (retrieved from http://www.igi-global.com/journal/international-journal-game-based-learning):

> The International Journal of Game-Based Learning (IJGBL) is devoted to the theoretical and empirical understanding of game-based learning. To achieve this aim, the journal publishes theoretical manuscripts, empirical studies, and literature reviews. The journal publishes this multidisciplinary research from fields that explore the cognitive and psychological aspects that underpin successful educational video games. The target audience of the journal is composed of professionals and researchers working in the fields of educational games development, e-learning, technology-enhanced education, multimedia, educational psychology, and information technology. IJGBL promotes an in-depth understanding of the multiple factors and challenges inherent to the design and integration of Game-Based Learning environments.

The term game-based training, on the other hand, is often reserved for corporate and military training, which fits fairly well with the above definition. The term 'brain training', is an exception, as it refers to games and other applications that are alleged to improve general cognitive abilities, such as working memory and attention. However, these are intended to be used as casual, entertainment games and not in educational or corporate training settings (Alvarez & Michaud, 2008).

Figure 6.1 summarises the relationships between learning, training and education, and the corresponding connection between game-based learning and training. In the next sections, I delimit the discussion to games used in formal settings, where GBL and GBT are both applicable.

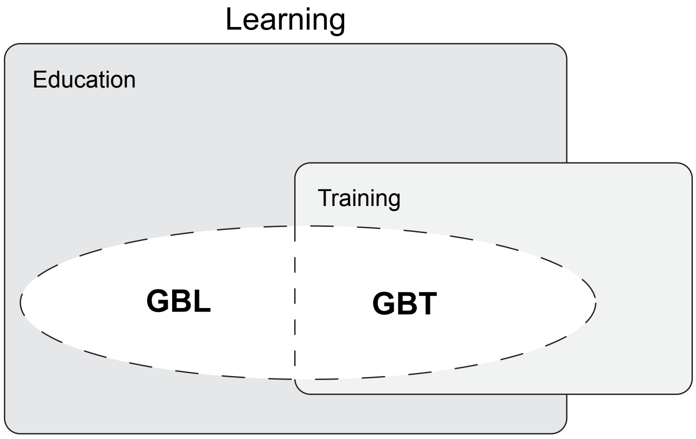


FIGURE 6.1: Conceptual map of GBL and GBT.

6.2 COGNITION AND LEARNING

Cognitive science as a research field is interdisciplinary and deals with the study of mind and intelligence (Bechtel, Abrahamsen, & Graham, 1999). This means that it tries to understand the workings of cognitive processes, such as attention, perception, memory, problem solving, and decision-making, all of which are central to learning. In addition, cognition is also studied from an embodied, situated, and distributed perspective, which extends cognition to also include matters of the body, the socio-cultural context, and artefacts used to facilitate and extend thinking (Clark, 1999) (see also Chapter 5.1.3).

6.2.1 LEARNING THEORIES

A serious gaming experience will inevitably reflect the developers' or instructors' view of what learning is and how it is enabled. Unfortunately, few SG studies take specific learning theories into consideration (Gunter et al., 2008; Wu, Chiou, Kao, Alex Hu, & Huang, 2012). For instance, Kebritchi and Hirumi (2008) found that, in their review of 55 games, only 24 explicitly documented their pedagogical foundations, of which 18 were established learning theories and instructional strategies. Historically, educational games have moved from a focus on observable behaviour to greater emphasis on the learner and the setting in which learning takes place. According to Egenfeldt-Nielsen (2007b), GBL practice has gone through three phases, which mirrors the learning theories that they employ (see Figure 6.2). In general, five learning theories have been or are widely used for serious gaming: behaviourism, cognitivism, (cognitive) constructivism, experiential learning, and social constructivism. The following review of these theories is by no means an exhaustive one, but aims to show how each theory views the role of the instructor and how they are connected to serious gaming (issues central to this thesis).

BEHAVIOURISM

Behaviourism relies on an objectivistic view of knowledge, that is, knowledge is believed to be independent of instruction (Lainema & Saarinen, 2010). According to Wu et al. (2012), behaviourism is grounded in three main assumptions: (i) learning is demon-

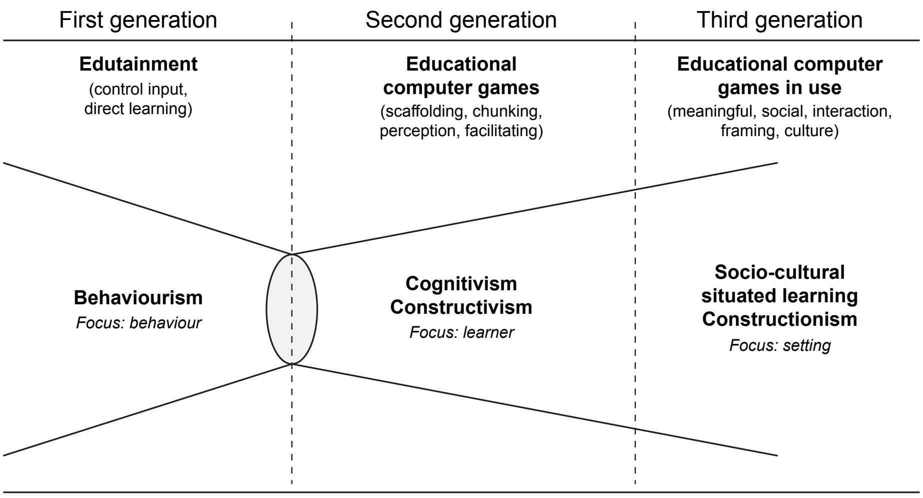


FIGURE 6.2: Egenfeldt-Nielsen's three generations of educational games. Adapted from Egenfeldt-Nielsen (2007b, p. 273).

strated through changes in behaviour, (ii) behaviour is shaped by the environment, and (iii) the learning process can be explained by the principles of contiguity and reinforcement.

Behaviourism views feedback as equivalent to reinforcement (Driscoll, 2012). As a result, the role of the instructor is considered to be one of triggering changes in behaviour, by operant conditioning, such as rewarding desired behaviours and punishing (or removing rewards for) faulty performance (Taylor, 2004). Thus, the instructor could easily be replaced by a computer program. This was one of the visions that led to the edutainment movement, which had its heyday in the 1980s. With its roots in behaviourism, it assumes that learners can be placed in front of a computer with an edutainment program and learn necessary content or skills, without the guidance of a teacher or parent (Egenfeldt-Nielsen, 2007b).

Although behaviourism has contributed to education by introducing concepts such as formative assessment, behavioural objectives, and the significance of practice (Driscoll, 2012), it has been abandoned by most educators and educational scholars. It fails to take into account the learner's previous knowledge and cannot be used to learn more advanced skills, such as communicative skills and problem-solving in novel contexts.

While few SG developers would admit as much, some behaviouristic principles are still used in several SG titles. According to Ang et al. (2008), there are a few situations where behaviouristic models are still useful. Automation is one such example; by repeating the same behaviour over and over again, the player is reinforced to act in a certain way in specific situations (e.g. pressing the 'jump' button when reaching a ledge). Reward structures, such as points and achievements, are also popular within the gamification movement that strives to use game elements in non-game settings (Hamari & Eranti, 2011), although opinions differ in terms of this being a good thing or not (see e.g. Ferrara, 2013).

COGNITIVISM

The cognitivist approach arose as a reaction to behaviourism's refusal to acknowledge internal cognitive processes (Driscoll, 2012). With cognitivism, the focus of attention shifted from merely observable events to the learner's cognitive abilities (Egenfeldt-Nielsen, 2007b). Particularly, cognitivism is seen as characterised by the information processing paradigm; learning is an information processing activity within the mind of an individual, involving attention, working memory, long-term memory, and the development of schemas (Bredo, 1994; Driscoll, 2012). Similar to behaviourism, knowledge is considered to be something that can be transferred from one person to another through the act of teaching, but cognitivism also acknowledges prior knowledge and problem-solving activities as important parts of the learning process (Greitzer et al., 2007). Thus, the cognitivists view learning as an active process as opposed to the passive digesting of content that behaviourists ordain.

When it comes to teaching, instructors must make sure they present content in various ways, preferably by using multimedia, in order to adhere to different learning styles and to avoid cognitive load by facilitating chunking of information (Egenfeldt-Nielsen, 2007b). Thus, cognitivists advocate scaffolding of information; structuring information in such a way that allows a logical progression through the material, and, if possible, presenting it in a realistic context (Greitzer et al., 2007).

From a cognitivistic perspective, games are good learning tools, because they constitute interactive multimedia that involves the acquisition and refinement of meta-skills, such as problem-solving, analysing, perceiving, and spatial ability (Egenfeldt-Nielsen, 2007b).

EXPERIENTIAL LEARNING

One of the most popular learning theories within the domain of serious gaming is experiential learning (Kebritchi & Hirumi, 2008; Lainema & Saarinen, 2010; Wu et al., 2012). Experiential learning grew out of the work of famous psychologists and philosophers Dewey, Lewin, and Piaget (Kolb, 1984), and is especially widespread in the domain of adult learning in industrial and non-school settings (Lainema & Saarinen, 2010; Sutherland, 1998). Beard and Wilson (2006) define experiential learning as "the sense-making process of active engagement between the inner world of the person and the outer world of the environment" (p. 19). It differs from behaviourism and cognitivism in that it views knowledge as something that is constructed, not transmitted (Kebritchi & Hirumi, 2008), and it assumes that learning is intentional and coloured by the individual's attitudes and values (Wu et al., 2012). Consequently, it is based on the philosophical tradition of pragmatism, rather than objectivism (Kolb & Kolb, 2009). Furthermore, although it also accepts more passive or didactic forms of instruction, it emphasises direct experience (a more active form of learning) as the ultimate form of learning (Kebritchi & Hirumi, 2008), hence its name.

One of the most widespread models of experiential learning is that of Kolb (1984). He describes it as a cycle consisting of a sequence of events: concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Figure 6.3). The cycle can start anywhere, but is usually described as starting with an immediate concrete experience, in which the learner collects data or observations about that experience. In order for learning to actually occur, the learner must then transform the experience in two stages; first, by reflecting upon it and, second, by assimilating and refining it into abstract concepts (Kolb & Kolb, 2009). These concepts are generalisations from which the learner can draw conclusions, or form hypotheses about the world (Kiili, 2005). Lastly, the learner can test these hypotheses through active experimentation and, thus, complete the circle by creating new experiences. Kolb and Kolb (2009) point out that the circular nature of the model is an oversimplification, and that it should rather be construed as a spiral, since each turn yields a richer, broader, and deeper experience.

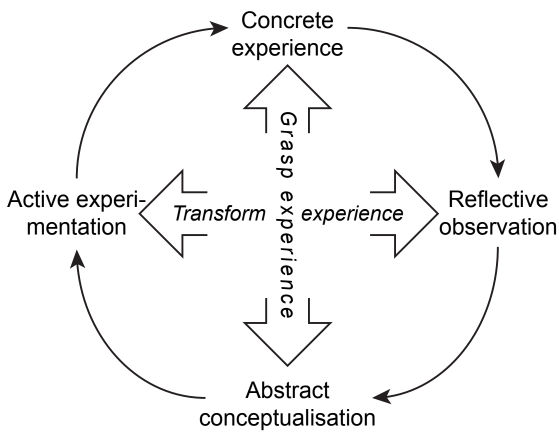


FIGURE 6.3: The experiental learning cycle. Adapted from Kolb and Kolb (2009, p. 299).

The experiential learning cycle has met some criticism, which is summarised by Beard and Wilson (2006). First, experiential thinking based on action has its limitations, as it can result in false conclusions, fail to help us understand and explain changes and new experiences, and can result in dogmatic thinking. Second, the learning cycle fails to account for social activity and the learning that occurs when interacting with other people, as well as the impact of historical and cultural aspects on learning. Third, the four stages of the learning cycle are too discrete and fail to account for how each process is interrelated with one another and actually constitute different aspects of the same process. Lastly, the cycle has been accused of being too simplistic, although Beard and Wilson (2006) defend this by saying that "[c]ircles and other simplistic models do have a significant value, for both the provider and the participant, in terms of accessibility and applicability" (p. 43). Thus, experiential learning cannot lay claim to explaining all the underlying structures of learning, but approaches the subject from a practitioner's viewpoint.

Having said that, experiential learning advocates a learner-centred and personalised learning experience, where the instructor is thought of as a facilitator of that experience, emotionally as well as cognitively (Taylor, 2004). The instructor can help the learner in all four phases of the learning cycle by providing the necessary resources for hands-on experience and experimentation, as well as exercises that enable reflective and abstract thinking (Beard & Wilson, 2006).

As already mentioned, the experiential learning cycle has also had a great influence in SG research and design, since it matches the organisational structure of most games (Lainema & Saarinen, 2010). The work by Kiili (2005) is a good example of how experiential learning is used in serious gaming. He developed the experiential gaming model based on experiential learning, flow theory, and game design. The experiential gaming model consists of three parts: a challenge bank, an ideation loop, and an experience loop. The challenge bank makes sure that the learners receive challenges that match their current skill level (thus keeping them in the state of flow, see Chapter 5.2.2). In the ideation loop, the learners, preferably in groups, are encouraged to come up with novel, creative solutions to the challenges. In the experience loop, the learners test their solutions by active experimentation. To facilitate reflection upon the subject matter, Kiili (2005) suggests conversation tools, intelligent tutorials, and computer-based tutors.

Although experiential learning has been accused of being yet another cognitivistic approach (Beard & Wilson, 2006), it has many ideas in common with the next approach, constructivism. In some accounts, experiential learning is therefore presented as part of the constructivistic approach (see e.g. Kirkley, Duffy, Kirkley, & Kremer, 2011; Taylor, 2004)

COGNITIVE CONSTRUCTIVISM

Constructivism is not a single theory, but actually a collection of perspectives that share the same fundamental assumption about learning (Driscoll, 2012). As the name implies, constructivists view knowledge as something that is actively constructed by the learner, inside out, by way of imposing meaning to the surrounding environment. From this perspective, constructivism bears much resemblance to experiential learning and, according to Lainema and Saarinen (2010), experiential learning has been influential in the constructivist approach. As mentioned in the previous section, experiential learning has mainly been adopted in adult learning settings, whereas constructivism has gained a foothold in education (Sutherland, 1998), which has led to their parallel development.

Similar to experiential learning, Jean Piaget is often cited as the progenitor of cognitive constructivism (e.g. Ang et al., 2008; Bogost, 2007). Piaget's ideas are especially interesting in this context, since he linked play and imitation to the cognitive development of children (Shute, Rieber, & Van Eck, 2012). He also viewed challenges or epistemic conflict, together with self-reflection, as the driving force behind learning; learning happens as a process of equilibration, where the learner solves the conflict through accommodation (the adjustment of old knowledge to fit with the new), and assimilation (using prior knowledge to understand the world) (Annetta, 2010).

Common approaches in constructivism are case-based learning, discovery learning, and problem-based learning (Kebritchi & Hirumi, 2008; Lainema & Saarinen, 2010; Wu et al., 2012). The role of the instructor is to facilitate the learner in developing critical thinking skills, self-directed learning skills, and content knowledge relevant to solve a specific problem (Lainema & Saarinen, 2010). Since learners create their own meaning to what is real, constructivism considers it irrelevant for instructors to recognise absolute truths (Kriz, 2010). Thus, what content the learners should know and when they should know it is inconsequential for instruction. Instead, learners are encouraged to put their personal understanding to the test against that of other learners (including the teachers) (Driscoll, 2012). The constructivist rejection of direct (explicit) instruction has been critiqued by cognitivists, who have found that a minimum of guided instruction is less effective than guided learning (Jin & Low, 2011; Kirschner, Sweller, & Clark, 2006). A constructivist approach is most useful when complemented with some kind of scaffolding (instructional support), especially for novice learners (Kirschner et al., 2006).

From a constructivist viewpoint, games "teach abstract principles that service general problem-solving skills and learning values" (Bogost, 2007, p. 239). Thus, they are considered useful as complex learning environments in which learners can test their own understanding of a subject matter (Driscoll, 2012).

SOCIAL CONSTRUCTIVISM

Social constructivism, or constructionism, can be seen as an extension of cognitive constructivism that includes and emphasises the socio-cultural setting in which learning takes place. Thus, the locus of knowledge is said to reside within tools, culture, and communities, not within the individual learner (Egenfeldt-Nielsen, 2007b). Approaches such as activity theory, case-based reasoning, distributed cognition, and situated learning are part of social constructivism (Lainema & Saarinen, 2010). Here, I focus mostly on situated learning, since that has had most impact on GBL.

In Chapter 5.1.3, I introduce situated cognition, a framework that incorporates embodied and distributed cognition, as well as situated learning. Situated learning is inspired by the social development theory of Vygotsky (1978) and characterised by concepts such as tools, artefacts, negotiation of meaning, and participation in communities of practice (CoP). First, it views learning as mediated by cultural tools or artefacts, including language. These artefacts are used in a meaning-making process, called reification, that helps participants of a community (e.g. learners) make concepts concrete (Wenger, 1998). Physical artefacts or tools are especially useful in learning new concepts, since they "give a shared starting point and potentially show the student new ways to proceed" (Egenfeldt-Nielsen, 2007b, p. 274).

Second, situated learning describes learning as something that occurs by participation in communities of practice. A CoP is characterised by three dimensions: (i) mutual engagement, (ii) a joint enterprise, and (iii) a shared repertoire (Wenger, 1998). Newcomers to a community are seen as novices that need to be initiated to and learn the practices of that community, by participating alongside more experienced participants (peers and teachers). Lave and Wenger (1991) refer to this process as moving from legitimate peripheral participation (where the novice takes part in low-level tasks) to centripetal participation (where the learner has matured into full participation). This process is further characterised by negotiation of meaning, the very essence of learning, in which participants co-create and refine their community (Wenger, 1998).

According to Wenger (1998), participation is relevant at the individual, the community and the organisational level. The individual level signifies the importance for an individual to engage in and contribute to their CoP. The community level, on the other hand, signifies that learning should involve continuous refinement, as well as acceptance of new members. Lastly, the organisational level signifies that communities should strive to interconnect with one another and contribute with valuable knowledge to the organisation.

Another important concept is cognitive apprenticeship, which reveals the social constructivists' view of the learner-instructor relationship. Cognitive apprenticeship highlights the importance of supporting learning "by enabling students to acquire, develop, and use cognitive tools in authentic domain activity" (Brown, Collins, & Duguid, 1989, p. 39). Looking more closely at the role of the instructor, Brown et al. (1989) use the term 'coach' to signify that the teacher has a function of fading support, that is, novices acquire enough scaffolding to complete the first tasks, but as they progress they also receive less support. Furthermore, Lainema and Saarinen (2010) also point to the importance of language as a cognitive tool. As learners progress from novices to experts, they must convey their understanding of a subject by articulating it verbally or visually. A key role for the instructor, then, is to ask the right questions and to go to the right places (Egenfeldt-Nielsen, 2007b), thus giving the learners the opportunity to explicitly reflect on their own knowledge.

Moving on to the social constructivist's approach in SGs, Squire (2006, p. 22) writes:

> Today's generation of games contain [*sic*] a whole new set of features, making them intriguing suites of learning. Specifically, they are sites where we can look at learning both as (a) interaction in the social and material world, where learners participate in open and closed problem solving; and (b) participation in distributed social organizations such as self-organizing learning communities, which are "microcosms for studying the emergence, maintenance, transformation, and even collapse of online affinity groups" (Steinkuehler, in press a). In short, just as previous generations of psychologists studied expert chess players, Vai tailors in West Africa, or the navigators of destroyer warships as examples of "cognition in the wild," we might study games as sites of digitally mediated learning

The idea of viewing serious gaming as a social constructivist activity has been made popular in the SG community by James Paul Gee (2004), who pointed at gaming as an embodied experience that makes situated meaning possible. Bogost (2007) takes this a step further by proclaiming that games "do not just offer situated meaning and embodied experiences of real and imagined worlds and relationships; they offer meaning and experiences of *particular* worlds and *particular* relationships" (p. 241).

Ang et al. (2008) indicate that social constructivism is only relevant when gameplay involves social interaction with others, such as multiplayer online games and other games that involve player-player interaction. Although social interactions such as collaborative play would facilitate negotiations of meaning during here-and-now gameplay, I believe that Ang et al. (2008) have a too narrow interpretation of social constructivism. The approach specifically points out the importance of viewing learning in a broader, cultural context, not just the immediate social interactions (Lave & Wenger, 1991). Thus, activities surrounding the here-and-now gameplay become just as important for learning as the characteristics of gameplay itself.

Building upon the social constructivist approach, Bronack et al. (2008) developed a pedagogical model called Presence Pedagogy (P2), which is specifically intended for online learning environments. Although the term online learning environments is wider than game, P2 can be applied to multiplayer serious gaming. Bronack et al. (2008) outline ten core principles of P2 that aim to be a guide in learning practices:

- Ask questions and correct misperceptions;
- Stimulate background knowledge and expertise;
- Capitalise on the presence of others;
- Facilitate interactions and encourage community;
- Support distributed cognition;
- Share tools and resources;
- Encourage exploration and discovery;
- Delineate context and goals to act upon;
- Foster reflective practice;
- Utilise technology to achieve and disseminate results.

Without going into the details of each of these principles, it is noteworthy that learners and instructors will, by following them, create their own CoP. Thus, learners engaged in a P2 learning environment "are not limited to those within a particular section, class, course, or program", but are seen as participants in a larger community in which everyone "is a potential instructor, peer, expert, or novice who learns with and from one another" (Bronack et al., 2008, p. 61). Furthermore, the P2 model also highlights the importance of social and perceptual presence, that is, participants should be able to see who is present in the virtual world (through the use of avatars), and discern which ones are experts in a specific area (instructors and more experienced peers). Later, Cheney and Bronack (2011) also suggested that the P2 model could be used not only as a tool for pedagogical praxis, but also as a framework for conducting research within virtual worlds, SGs, and simulations, especially when investigating the sense of presence in avatar-based immersive media.

In addition, social constructivism leads to more creative ways of looking at SGs; instead of merely playing games, learners can be engaged in constructing them. In line with this, Egenfeldt-Nielsen (2010) classifies GBL into learning *through* games, learning *with* games, and learning *by making* games. Learning through games is the most common view of SGs; specifically designed games for learning. Learning with games is, according to Egenfeldt-Nielsen (2010), when teachers use entertainment games in an educational setting. Finally, learning by making games enables the learners to construct a personally meaningful product, and draw their own conclusions "through creative experimentation and the making of social objects" (Razak et al., 2012, p. 35). For instance, Kafai (2006, p. 39) claims that this practice has several advantages:

> Just as fluency in language means much more than knowing facts about the language, technological fluency involves not only knowing how to use new technological tools but also knowing how to make things of significance with those tools and most important, develop new ways of thinking based on use of those tools.

According to Squire (2012), making games is the last step that learners take on their path from novices to experts. He describes this as 'trajectories of experiences within game communities'. At the beginning, learners are merely users of a game who try to achieve enough competence to become full members of the game community. As the learners become more proficient, they start to identify exploits in the system, which leads to the community changing the rules. By sharing ideas, the participants of the community eventually identify superior strategies with which to play the game. This is when the learners have reached a point of expertise where they seek out new challenges by inventing new rule systems for their own enjoyment. Some go even further into meta-gaming practices, such as creating mods, scenarios, or even new games (Squire, 2008). The last step is becoming a fully-fledged game designer who contributes to the production of new knowledge (Squire, 2012).

TABLE 6.1: Summary of learning theories with a focus on instructor roles and categories of games for learning.

LEARNING THEORY	INSTRUCTOR ROLE	GAMES FOR LEARNING
Behaviourism	'Reinforcer'	Edutainment (input-output; repetition leads to automation)
Cognitivism	Guide or 'conveyer of information'	Cognitivistic educational games (interactive multimedia)
Experiential learning	Facilitator or coach	Experiential serious games (authentic experiences, experimentation, and activities for reflection)
Cognitive constructivism	Facilitator or coach	Educational serious games (problem-solving and values)
Social constructivism	Facilitator or coach	Situated serious games (social interaction, participation, and player experience)

Table 6.1 summarises the learning theories and how they relate to the instructor role and games for learning. The classification of games is partly inspired by Egenfeldt-Nielsen's three phases (Figure 6.2). In the first generation of SGs, he links edutainment to behaviourism. I have termed the instructor role 'reinforcer' because the teacher uses reinforcements to steer the learner towards the right knowledge. Furthermore, while Egenfeldt-Nielsen (2007b) clusters cognitivism and cognitive constructivism into one approach, and then links them to the second generation games (educational computer games), I have chosen to view them as separate since the instructor role is fundamentally different in cognitivism and cognitive constructivism, respectively. Instead, I use the term cognitivistic educational games to fit with the cognitivistic approach to learning, while keeping it as close to Egenfeldt-Nielsen's own term as possible. Cognitivistic educational games are seen as advanced multimedia applications that train meta-cognitive

skills in which the instructor plays a minimal part in the learning experience, as a guide or 'conveyor of information'. Compared to the role of reinforcer in behaviourism, however, this role is less passive, but focus is still on the content to be learned.

To experiential learning, an approach mainly adopted in adult learning domains, I have linked experiential SGs to denote the type of SGs that highlight authentic experiences. The same term could also be appropriate for games that follow a cognitive constructivist approach, but given the popularity of this in education, I have termed them educational SGs. These terms are merely rhetorical, not absolute, and chosen in order to separate them with regard to different pedagogical emphases. In contrast to edutainment and cognitivistic educational games, which are often designed to enable the replacement of the instructor, experiential and educational SGs consider the instructor role to be vital, as facilitator or coach.

Lastly, Egenfeldt-Nielsen (2007b) links 'educational computer games in use' to social constructivism. Given my discussion in Chapter 4.2, I have termed these games situated SGs, since focus is shifted away from the game itself to the socio-cultural setting in which it is used. The role of the instructor is essentially the same as in experiential learning and cognitive constructivism, but with a stronger focus on coaching.

In sum, all the learning theories presented here carry some assumption of the benefits of using games for learning. Although experiential learning and social constructivism are the dominant approaches currently in use, it does not mean that all insights brought by behaviourism and cognitivism should be discarded. For instance, the behaviouristic approach is good when we want to automate certain behaviours (e.g. eye-hand coordinated movements). Also, just because we view knowledge as something that is co-constructed within a CoP, it does not negate the fact that we do have limited cognitive resources and need to have information presented to us in a well-structured and logical manner (see e.g. usability and playability issues presented in Chapter 5). It is from this perspective that I take my stance, although experiential learning and social constructivism are most prevalent in my work. Henceforth, I use the term SG as an umbrella term for experiential, educational and situated SGs.

6.2.2 DEVELOPING EXPERTISE

As indicated by social constructivism, the goal of learning is to develop expertise. Expertise is here thought of as a learner being proficient enough in a specific area to contribute to the production of new knowledge to the community (Squire, 2012). More specifically, an expert is someone who has honed his or her cognitive tools to perceive meaningful patterns in a very specific domain (Lajoie, 2009) and exhibit reliably superior performance (Ericsson, Roring, & Nandagopal, 2007). For instance, expert chess players can quickly pick out promising potential moves without having to go through every possible move of all chess pieces (de Groot, Gobet, & Jongman, 1996). This 'professional vision' allows the experts to structure their world and create artefacts that are the core of their profession (Goodwin, 1994). Thus, studying how people become experts and how instructors can facilitate this transition from novice to expert is essential for the development of SGs that support instructor-led serious gaming.

Hubal and Pina (2012) outline five levels of competencies: awareness or familiarity, basic competence, proficiency or intermediate understanding, mastery or advanced understanding, and expertise or elite performance. They furthermore claim that few SGs strive for expertise, but rather proficiency within a set of conditions. For instance, in a cooperative work situation, individuals take on different roles that require a different skill set, even if the conditions are otherwise identical (Hubal & Pina, 2012). The expert knowledge is thus distributed over several people, as well as artefacts such as databases and rule sets (e.g. heuristics). In other contexts, such as military, medical and aviation, high levels of expertise are crucial for "safety, effectiveness, organisational development, and even survival" (Salas et al., 2009, p. 328). Such domains are often characterised as being complex and competitive, which fosters a need for highly adaptive and flexible individuals. Shadrick and Lussier (2009) particularly point out that, in less typical situations than the ones they are used to, some highly specialised experts perform worse while others manage to adapt.

This variation can be explained by different types of expertise, namely, routine and adaptive expertise. Routine experts are very good at solving certain sets of problems and practise only the routines in which they are proficient (Schwartz, Bransford, & Sears, 2005). Adaptive experts, on the other hand, reflect more actively on the challenges they encounter, embrace lifelong learning, and are thus able to come up with innovative solutions to novel problems (Schwartz et al., 2005). Schön (1983) explains this in terms of 'reflection-in-action' and 'reflection-on-action', that is, when the expert encounters an uncommon situation, he or she might start to question the underlying understanding of that and similar situations (the 'knowing-in-action' or procedural knowledge). Reflection-in-action occurs as the person performs a task, whereas reflection-on-action happens afterwards (or during a pause in the activity). Although both types of reflection are a type of re-examination of current knowledge structures, Schön (1983) argues that reflection-in-action is preferable to reflection-on-action, because the former activity has the advantage of direct experimentation as the action is performed. Direct experimentation can yield new understanding (what Piaget calls accommodation) or new surprises that lead to a new reflection-in-action cycle (Schön, 1983). However, Harteveld et al. (2010) state that reflection-in-action is difficult, if not undesirable, in serious gaming, since it would break the flow of the game. Instead, they claim that reflection-on-action, or debriefing, is more appropriate when using SGs for learning and training. I would, however, argue that both types of reflection are important, but that serious gaming requires novel ways of encouraging participants to perform reflection-in-action while still immersed in the gaming activity.

Knowing-in-action is described by Schön (1983) as being tacit. Tacit knowledge, which is another characteristic of expertise, is often described in terms of 'common sense knowledge' or 'professional intuition' and is associated with successful performance (Hedlund et al., 2003). Tacit knowledge is shown through action and cannot be readily expressed verbally; the expert might not even be aware of having the knowledge other than being able to solve, to them, everyday problems and to adapt to changes in the surrounding environment (Hedlund et al., 2003). However, in situations of cognitive apprenticeship, experts must be able to externalise their knowledge in order to teach it to others. As articulated by Lajoie (2009) : "[t]he teacher's ability to think out loud and make the contents of their thinking visible to students sensitizes learners to details of expert performance as the basis for making incremental adjustments in their own performance" (p. 65).

A large portion of expertise can be explained by individual differences or traits, such as aptitude, interest and self-efficacy (Ackerman, 2013; Salas & Cannon-Bowers, 2001). Leaving those aside for the moment, I first look at methods that are postulated to lead to a positive improvement in performance. 'Practice makes perfect' is a common saying, but Bransford and Schwartz (2009) suggest that it should instead be "Practice makes permanent, not perfect" (p. 432). What they imply is that expertise comes from well-guided and intentional practice, as opposed to rote learning. Ericsson (2006) describes this type of practice as 'deliberate practice' and claims that it is critical for developing skills beyond mere acceptable. The essence of deliberate practice is to practise in a specific and purposeful way, constantly stretching oneself beyond one's comfort zone and persistently striving for improvement. Thus, it is not just about putting in hours of practice, but also the need for concentration, reflection and useful feedback about one's performance. Key requirements of deliberate practice are (i) demanding (but not impossible) tasks, (ii) specific goals for improvement, (iii) continuous feedback, and (iv) opportunities for repetition (Ericsson, 2006). These requirements make simulations and games especially suitable for developing expertise, since they can replicate important features of tasks and physical environments. In addition, the same scenario can be replayed numerous times and the only change is the learner's choices and actions (Ericsson, Pretula, & Cokely, 2007; Salas et al., 2009).

The requirements of deliberate practice also bear a striking likeness to the seven elements of enjoyment that lead to flow (see Chapter 5.2.2), especially those concerning challenging activity, concentration on the task at hand, and clear goals and feedback (Csíkszentmihályi, 1990). Thus, deliberate practice seems to be an activity that can lead to a state of flow. However, according to Ericsson and Ward (2007, p. 349):

> Deliberate practice is a direct violation of the general rule, or perhaps even law, of least effort, which purports that the human system continuously strives to perform activities with minimal exerted effort or metabolic cost. It is clear that skilled individuals can sometimes experience highly enjoyable states ("flow" as described by Mihály Csíkszentmihályi, 1990) during their performance. These states are, however, incompatible with deliberate practice, in which individuals engage in a (typically planned) training activity aimed at reaching a level just beyond the currently attainable level of performance by engaging in full concentration, analysis after feedback, and repetitions with refinement.

Vallerand et al. (2007) contend this conclusion by stating that flow can actually be beneficial for the development of expertise. They claim that flow is an essential part of passion towards an activity, which spurs the individual to continue practising beyond his or her current ability. As already clarified by Csíkszentmihályi (1990), reaching a state of flow is not always an enjoyable experience as it is being achieved, but is remembered as such afterwards. Consequently, flow is not necessarily incompatible with deliberate practice.

Of interest for my particular research question is that deliberate practice also requires the presence of a coach or mentor who guides and pushes the learner in the right direction (Bransford & Schwartz, 2009; Ericsson, 2006; Ericsson, Pretula, & Cokely, 2007; Salas et al., 2009). The goal is for the learner to be a self-monitoring adaptive expert (Bransford & Schwartz, 2009), which makes deliberate practice easy to combine with the idea of cognitive apprenticeship and fading support (see Chapter 6.2.1).

6.2.3 TRANSFER

Although expertise is an important goal in serious gaming, learners should become experts at handling future or current work assignments, not just at playing the game (Harteveld et al., 2010; Shaffer, 2012). This real-world application of skills, knowledge and attitudes, gained from a training context (e.g. serious gaming), is known as transfer (Barnett & Ceci, 2002; Liu, Blickensderfer, Macciarella, & Vincenzi, 2009). Thus, transfer is a key concept when researching serious gaming.

An interesting study of transfer from games is offered by Rosser et al. (2007). They let a number of surgeons play three different entertainment games (*Super Monkey Ball 2*, *Star Wars Racer Revenge* and *Silent Scope*) and managed to show that the gameplay enhanced their surgical ability in terms of efficiency (performed laparoscopic surgery more rapidly) and safety (made fewer errors). Most surprisingly, this study revealed that, even though the games used for training bore no resemblance to laparoscopic surgery, the surgeons improved their eye-hand coordination and applied that ability in their work context. Consequently, there must be something more at play than merely superficial similarities between game and task (Tobias & Fletcher, 2012). As Tobias et al. (2011) have already pointed out, the study by Rosser et al. (2007) still needs replication before we can confidently say that transfer of training can be achieved through the use of games. In fact, the mechanisms behind transfer in serious gaming are yet to be fully understood (Tobias & Fletcher, 2012; Wagner & Wernbacher, 2013). One thing is clear, however, “it is not so much the game itself but rather the way a game is played or used that is responsible for transfer effects to occur” (Wagner & Wernbacher, 2013, p. 347).

It seems reasonable to assume that what works in other learning environments will also work within a serious gaming setting. Thus, looking at general transfer research can help to understand how SGs can be designed and used to promote transfer. Returning to the example of the laparoscopic surgeons, it is clear that just anyone playing the same games would not make them skilled surgeons; the surgeons had previous experiences and knowledge that affected their ability to transfer the ‘right’ kind of knowledge from the gameplay, and they also had the motivation to become better at their profession. Schwartz et al. (2005) call this to ‘transfer in’ to situations in order to learn, that is, they use their previous knowledge to make sense of the new situation. Most research on transfer is concerned with what people are ‘transferring out’ of a situation, thus viewing transfer as a training product or outcome (Foxon, 1993). There are, however, input factors that will either inhibit or support transfer, such as organisational culture or climate, how the training itself is designed and delivered, as well as individual learner characteristics (Bickley et al., 2010; Foxon, 1993; Liu, Blickensderfer, et al., 2009). For example, Foxon (1993) claims that it is important for the organisation to have a ‘culture of transfer’, that is, the learner perceives that supervisors and co-workers identify and appreciate the new skills, and that the organisation supports transfer through the availability of necessary resources and technologies. She especially points out that irrespective of the training, most learners will emulate the organisational role models in their immediate work environment. Thus, if management is informally reinforcing something that is incongruous to the learner’s training, transfer will not occur (Foxon, 1993). This is in agreement with the idea of learning through communities of practice (Wenger, 1998).

Perhaps even more interesting, from a serious gaming perspective, is how the design and delivery of training can inhibit or promote transfer. One issue that is often brought up as important is the degree of similarity between the training context and the context in which the knowledge, skills or attitudes are expected to be applied (see e.g. Gunter et al., 2008; Hubal & Pina, 2012; Liu, Blickensderfer, et al., 2009; Mason, Jeon, Blair, & Glomb, 2011; Salas et al., 2009). For instance, in the surgeon example described above, there were no apparent similarities between the games themselves and the laparoscopic surgery situation. The fact that transfer still could still occur is explained by the terms near and far transfer. *Near transfer* is assumed to occur when both contexts are similar (e.g. training pilots in a high fidelity flight simulator), whereas *far transfer* is transfer from dissimilar contexts (e.g. applying math skills obtained in a lecture situation at school when shopping at the supermarket) (Barnett & Ceci, 2002). Near transfer is most useful in situations where the learner is supposed to perform specific behaviours or procedures that are fairly stable over time (not requiring adaptive expertise), or when the objective is a short-term skill development that can be applied immediately (Bickley et al., 2010; Schwartz et al., 2005). Far transfer, on the other hand, is usually the overarching goal of general education and for the development of higher cognitive abilities associated with adaptive expertise, such as leader development or creative problem solving (Bickley et al., 2010; Schwartz et al., 2005).

Barnett and Ceci (2002) point out that similarity is an ambiguous term that can mean many things, which makes it difficult to specify the exact difference between near and far transfer. They solve this by introducing a number of underlying dimensions of similarity that can be used in measures of near and far transfer. These dimensions are: knowledge domain, physical, temporal, functional, and social context, as well as modality. These dimension of similarity described by Barnett and Ceci (2002) correspond nicely to the different types of fidelity discussed in Chapter 4.1.3. Again, returning to the surgery example, it is easier to speculate why the surgeons were able to transfer their gaming skills to their work situation. More specifically, the games were chosen because they train the same skills required to handle the equipment used in laparoscopic surgery, that is, "fine motor control, visual attention processing, spatial distribution, reaction time, eye-hand coordination, targeting, nondominant hand emphasis, and 2-dimensional depth perception compensation" (Rosser et al., 2007, p. 183). Thus, even if the input devices of the games and the gameplay itself were dissimilar, the games had enough task fidelity and cognitive fidelity for transfer to occur. Therefore, a thorough analysis must be done in advance to ascertain the kind of similarity or fidelity that is necessary to incorporate within the game or simulation, in order to obtain the expected outcomes (Beaubien & Baker, 2004; Bickley et al., 2010).

In addition, Foxon (1993) also addresses inappropriate course content as an inhibiting factor for transfer. For instance, it could be too theoretical, be perceived as in conflict with the organisation's values, or not in line with what the work performance actually requires. In these cases, learners will have trouble transferring their knowledge to their work practices. Moreover, learner characteristics, such as motivation, attitude and ability of the individual trainee, affect transfer efficiency (Liu, Blickensderfer, et al., 2009). Thus, without the intention to use the new-found skills in other contexts, learners are unlikely to do so. Intention to transfer is affected by the learners' self-efficacy in using the new skills, how relevant they perceive the skills are for their work, and to what degree they believe the new skills will improve their work situation (Foxon, 1993).

Another way of conceptualising transfer is as a process, with various stages of different degrees of transfer. Foxon (1993) suggests such a process with five stages that represent "what actually happens as learners try out some of the skills, practise them, discontinue their use, or fail to use the skills." The first stage is *transfer intention*, where the learner has either a high or low intention to transfer. If the learner has a low transfer intention, he or she is unlikely to move on to the next stage. The second stage is *transfer initiation* and denotes the learner's first attempts in applying the new skills at the workplace. Both individual and organisational factors affect whether these attempts are successful (Foxon, 1993). For instance, Billett (1998) points out that knowledge can be conceptualised as being embedded within a particular socio-cultural context. This means that learners might need help in disembedding the knowledge (make it more abstract) in order to then embed it in another context once again (transfer initiation).

The third stage, *partial transfer*, occurs when some (but not all) skills have been transferred to the new context. Partial transfer is often seen as 'good enough' and acceptable, even if it is sporadic and inconsistent (Foxon, 1993). Apart from the factors already mentioned, the opportunity to use the new skills, as well as the elapsed time from the training situation to the work situation, are also influential. However, it is not until the learner makes a conscious effort to use the new skills, namely, *conscious maintenance*, that the risk of transfer failure is low enough for transfer effects to be a permanent improvement of performance. My interpretation is that reflection-in-action (Schön, 1983) plays an important part at this stage, that is, the learner reflects upon his or her performance while carrying out a task, especially in situations where actions lead to unexpected outcomes. Lastly, *unconscious maintenance* occurs when the new skills have been fully integrated into the learner's work practices. Foxon (1993) calls this 'optimal transfer', since there is no risk of relapsing into 'old habits' at this stage.

Transfer of training is difficult to measure (Liu, Blickensderfer, et al., 2009). Schwartz et al. (2005) claim that inconsistencies in operationalising and measuring transfer have led to very different conclusions. The problem, they claim, is that many activities designed for transfer or designed for testing transfer assume that transfer is about routine tasks and automation. As I mentioned in the previous section, adaptive expertise is preferred to routine expertise. As Schwartz et al. (2005, p. 29) assert:

> By preparing people so that the problems they will face in life are essentially routine problems—or at worst very "near transfer" problems—the gap between goal states and present states is either eliminated or made to be very small. This allows people to perform quite effectively.
>
> All of this works well provided the environments for which we are preparing people are "good environments" (e.g., based on strong human values and ideal working conditions) that are stable and do not need improving. As people like Fullan (2001) and Vaill (1991) argue, however, we are living in a "whitewater world" where change is the norm and not the exception. Because efficiency is so emphasised in our time-limited society, it tends to take over as a prime way to assess progress. But, there are also potential downsides of an overemphasis on efficiency. This is where an emphasis on innovation comes into play.

Thus, an innovation approach to transfer is especially important for far transfer in ill-structured environments. An innovation approach involves educational practices that are designed to reduce functional fixedness in learners, such as exposing them to new and complex problems (Schwartz et al., 2005). Functional fixedness is a well-known cognitive bias in which people are unable to solve problems as a result of failing to see further uses of tools and other objects than the already experienced (common) uses (Bröder & Schiffer, 2006). Innovation, according to Schwartz et al. (2005), is often the result of disequilibrium, which means that, in order to solve a problem, the learner might have to take a few steps back and 'de-learn' previously learned routines. This might, on a short-term basis, seem inefficient from an organisational viewpoint, but is necessary in order to foster creativity and adaptability. Another way to cultivate innovation is interaction with other people and artefacts (Schwartz et al., 2005). It is important to note, however, that Schwartz et al. (2005) do not promote an innovation-only approach to transfer, but rather propose that learning environments must be designed to balance routine activities and innovative ones. Training practices that only include repetitive or routine problems will lead to routine expertise, as described in the quote above. However, working towards learning environments that only include creative and innovative problem solving (environments in constant change and with no consistent structure) is unrealistic and undesirable, because humans need consistencies in order to learn at all (Schwartz et al., 2005). SGs could provide this mix of consistency (e.g. rules and stable virtual environment) and innovation (e.g. solving novel and complex problems).

Another issue relevant in the study of games is the transfer of aggressive behaviour from violent games (Bösche & Kattner, 2011; Przybylski, Rigby, & Ryan, 2010). A common criticism of games is that the presence of violence and other hateful attitudes in games creates the same behaviours or attitudes in players, who transfer these to situations outside the games (Squire, 2006). The reasoning is that if we can learn from games, we can also learn bad things (Bösche & Kattner, 2011). Although some studies have found a link between aggression and violent games (e.g. Anderson et al., 2004), the underlying mechanisms are not fully understood (Przybylski et al., 2010). An interesting perspective is proposed by Przybylski et al. (2010), who studied the relationship between motivation, aggression and violent games. They found that, for most players, it is not the violent content of games that has motivational value, but engagement is rather "a function of the competence and autonomy need satisfaction they provide" (p. 159). Moreover, as Squire (2006) points out, we have to take into account the context in which a game is played, and not just focus on the game's representations and surface features. A concrete example concerning the training of marksmanship is offered by Bösche and Kattner (2011, p. 8):

> In conclusion, general cognitive and perceptive skills can be trained by digital games that might be useful for marksmanship. Additionally, when a digital shooting game is combined with real firearms training or hardware that adequately simulates a real weapon and therefore also allows for learning the proprioceptive cues and train the manual dexterity for firearm use, vital cues for marksmanship can be learned and trained.

> However, it is highly doubtful whether such marksmanship skills learned from a digital [game] can be assumed to be an unintended by-product. If one accompanies game playing with a realistically simulated and to be operated weapon and / or with real firearms training, there is obviously an intentional background involved.

Using the same line of reasoning, I would assume no-one would expect to be able to learn laparoscopic surgery from merely playing video games; gameplay has to be supplemented with field training and accompanied by the learner's intention to learn and to transfer that knowledge to another context. This also relates to the discussion about stealth learning in Chapter 4.1.1; complex skills are not learned as a bi-product of gameplay. Serious gaming does not exist in a vacuum, but affects and is affected by the sociocultural context within which it is situated. Potential aggressive behaviour is fostered by the gaming and training practices, not the game itself (Squire, 2006), which means that facilitators bear a great deal of responsibility in designing GBL experiences.

6.2.4 MOTIVATION

One of the most cited arguments for SGs is that games or gameplay enhance people's motivation to learn (see e.g. Garris et al., 2002; Gee, 2007; Hofstede, de Caluwé, & Peters, 2010; Ricci, Salas, & Cannon-Bowers, 1996). The idea stems from the fact that people can exhibit goal-directed behaviour (play) in entertainment games for long periods of time without feeling fatigued or bored (Przybylski et al., 2010). Consequently, if this motivational pull of entertainment games could also be harnessed for learning purposes, it could revolutionise education and training (Clark, 2007; Lepper & Henderlong, 2000; Malone, 1980). Facilitating motivation in SGs will, according to Garris et al. (2002), increase the level or intensity of arousal, attention, enjoyment, engagement and task persistence, which is why motivation is an important concept for my research question. I have previously touched upon the subject; motivation is a prerequisite for learning (e.g. a willingness to learn or engage in a CoP), expertise (e.g. a willingness to strain oneself in deliberate practice), and transfer (e.g. the intention to transfer knowledge from one context to another).

Morris, Hancock, and Shirkey (2004) claim that contextually relevant stress in SGs can increase motivation and, consequently, performance. In military training, for example, activities that are highly unpredictable and intense can produce the same type of stress that is experienced in the equivalent real-world work setting and this would generate a higher degree of "motivation to succeed" (Morris et al., 2004, p. 144). Similarly, violent content in SGs can boost motivation, if only for players with moderate to high levels of aggression (Przybylski et al., 2010), although this remains a controversial issue (Bösche & Kattner, 2011).

The most basic definition of motivation refers to it as being "moved to do something" (Ryan & Deci, 2000, p. 54). It can vary in *amount* (the level or intensity of motivation a person feels towards doing something), *duration* (how long a person will persist at an activity), and *type* (what kinds of activities a person feels motivated to do) (Ryan & Deci, 2000; Salas & Cannon-Bowers, 2001). Thus, motivation refers to the affective dimensions of learning (Wouters et al., 2013). As put by Garris et al. (2002, p. 444):

> Motivated learners are easy to describe. They are enthusiastic, focused, and engaged. They are interested in and enjoy what they are doing, they try hard, and they persist over time. Their behavior is self-determined, driven by their own volition rather than external forces.

Motivation can be further broken down into intrinsic and extrinsic motivation. *Intrinsic motivation* refers to a person's willingness to do something because he or she experiences the activity as inherently enjoyable or interesting (Ryan & Deci, 2000). Individual factors (e.g. challenge, fantasy, curiosity and control) or interpersonal factors (e.g. cooperation, competition and recognition) can enhance intrinsic motivation (Reid, 2012). For instance, the flow theory (Csíkszentmihályi, 1990) has been linked to intrinsic motivation (Paras & Bizzocchi, 2005; Reid, 2012). To be motivated, a learner must furthermore deem the task valuable and have enough self-confidence to believe that he or she can accomplish it (Clark, 2007; Paras & Bizzocchi, 2005). Clear, specific and difficult goals give the learners something to strive towards (Clark, 2007) and allow them to recognise discrepancies between the goals and the feedback given on the progress towards them (Garris et al., 2002). Especially positive and endogenous (embedded within the narrative) feedback has a positive impact on intrinsic motivation (Paras & Bizzocchi, 2005; Ryan & Deci, 2000).

Extrinsic motivation, on the other hand, refers to a person's willingness to do something because of external factors, such as external rewards or incentives, threats, deadlines, or competition pressure (Ryan & Deci, 2000). This willingness can come from a constructive attitude towards or understanding of the underlying value of the task, or be tainted by resentment, resistance or disinterest (Ryan & Deci, 2000). While the external factors can enhance extrinsic motivation, they have also been found to simultaneously destabilise intrinsic motivation (Clark, 2007; Ryan & Deci, 2000). These findings suggest that, in a learning situation such as serious gaming, it is impossible to reach maximum intrinsic and extrinsic motivation at the same time (Reid, 2012). However, Filsecker and Hickey (2014) paint another, more complex, picture, by claiming that rich learning environments such as serious gaming environments based on social constructivist theories offer both external and internal rewards that both contribute positively to learning. Their reasoning is that these environments offer rewards that are contextually relevant to a CoP, have a more informational than controlling value (give feedback on performance) and offer opportunities to improve – qualities often lacking in previous studies on extrinsic motivation. Filsecker and Hickey (2014) manage to show that the introduction of an extrinsic reward structure does not affect learners' motivation negatively, and that it even has a positive effect on their understanding of the material.

A useful distinction in understanding the varying effects of external rewards on intrinsic motivation is between exogenous and endogenous rewards (Filsecker & Hickey, 2014). Exogenous rewards have an arbitrary relation to the learning content, whereas endogenous rewards are part of the activity and, thus, have more in common with intrinsic motivation in that they elicit curiosity and interest (Filsecker & Hickey, 2014). According to Egenfeldt-Nielsen (2007b), SGs that rely on a behaviouristic approach to learning tend to put more emphasis on extrinsic motivation (exogenous rewards) than intrinsic motivation. Nowadays, however, SGs are thought of as mainly relying on intrinsic motivation and endogenous rewards (Clark, 2007; Johansson, Nählinder, & Berggren, 2009; Paras & Bizzocchi, 2005). Garris et al. (2002) suggest that games and SGs are intrinsically motivating because they create a persistent re-engagement through repeated judgement-behaviour-feedback loops, that is, gameplay leads to "certain user judgments or reactions such as increased interest, enjoyment, involvement, or confidence; these reactions lead to behaviors such as greater persistence or intensity of effort; and these behaviors result in system feedback on performance in the game context" (p. 445).

Most theories of the motivational effect of games and SGs are based on Malone (1980), who concluded that games make learning fun because of three factors: challenge, fantasy and curiosity. He later also added a number of interpersonal factors: competition, cooperation and recognition (Malone, 1985). Malone's model was later extended by Lepper and Henderlong (2000) to what they call the '4Cs': challenge, curiosity, control and context. The most comprehensive framework, however, is offered by Tüzün (2006). He critiques the earlier attempts to find the core building blocks of motivation as being too limited to the individual learner. While not discarding the previously mentioned factors, he adds others that relate to the social and educational context. His 'Multiple Motivational Framework' consists of 13 interconnected categories, which he arranged into four dualities:

- The *subject* duality refers to identity presentation and social relations, that is, meaning-making activities that enhance either the player's identity (e.g. customising the player's avatar) or social relationships (e.g. interacting, cooperating or competing with others);
- The *activity* duality refers to the interplay of learning and playing, which Tüzün (2006) describes as being inseparable and intertwined. Although one activity (playing or learning) might take precedence over the other during a specific point in time, the other is "still remembered and given importance" (p. 80);
- The *outcome* duality refers to achievement and rewards, that is, the intrinsic motivational effect of achieving a difficult goal and the extrinsic effect of incentives such as points, awards and social approval;
- The *object* duality refers to identification and negotiability, which is an immersive context, a narrative based on fantasy, and a feeling of uniqueness leads to an identification with the game contents, whereas creativity, curiosity, and control and ownership lead to an investment in the game contents and the learner's impact on the unfolding story.

The Multiple Motivational Framework corresponds well to the social constructivist approach to learning (Tüzün, 2006). It must be stated, however, that Tüzün (2006) studied the motivational effects of serious gaming in a setting where participation was voluntary. Learner control is one of the strongest predictors of intrinsic motivation for learning, especially when tested against program control (DeRouin, Fritzsche, & Salas, 2004; Kay, 2001). By exercising a level of autonomy or self-direction, the learner is more inclined to seek out challenges and be curious about the learning contents (Ryan & Deci, 2000). Clark (2007) also points out that motivation is enhanced if learners can exercise control or choice over the duration or the pace of the learning activities. Since this is not always the case for settings that utilise SGs, it is probably difficult to reach the same levels of intrinsic motivation with the same motivational elements as in entertainment games (Hubal & Pina, 2012). Even if a serious gaming session is not voluntary, the SG can be designed to give the learners a sense of autonomy, by allowing them control "over instructionally irrelevant parts of a learning activity", such as selecting strategies and choosing the direction of an activity or the narrative (Garris et al., 2002, p. 451). Tüzün (2006) also suggests giving the learners meaningful choices in terms of gameplay, such as letting introvert players have the option of participating alone, or implementing customising options that allow the players who want to focus more on learning than playing to minimise the number of 'childish' game elements. Facilitators should be aware, however, that "[t]he more control of the game world that is relinquished to learners, the less control that an instructor has over the learning objectives of the game" (Neville & Shelton, 2010, p. 620).

Overall, there are varying results concerning the motivational pull of SGs (Whitton, 2007; Tobias et al., 2011). When accounting for the novelty effect, there is little evidence that SGs have the same motivational effect as entertainment games (Tüzün, 2006), or even more than conventional instructional methods (Wouters et al., 2013). Wouters et al. (2013) postulate that this is due to the lack of autonomy in SGs, the challenge of combining games with instructional content, or the fact that most studies measure motivation after gameplay instead of during. Another issue is that not everyone likes to play games, and these people will probably not be motivated by SGs either. I agree with Whitton (2007, p. 1066), who writes:

> [S]imply to rely on the fact that games are motivational is not in itself a sufficient rationale for using a game. Nevertheless, this is not to say that games should not be used

> in teaching, only that the sole reason for using them should not be because they are perceived to be motivational. The rationale for using games to teach must be that they can embody sound educational principles and have the potential to create experiential, immersive and engaging, problem-based learning experiences that appropriately map the curriculum. If a game is perceived as being the most effective way to learn something then students will be motivated to use it to learn, not simply because it is a game.

Thus, working towards a motivating experience is just one of many important goals when designing SGs. The "culture, values, and norms of the context of the game implementation" have a critical role in motivating learners to participate in serious gaming (Tüzün, 2006, p. 81).

6.3 SERIOUS GAMES FROM A CRITICAL PERSPECTIVE

The majority of literature on the effectiveness of SGs shows they have a modest positive effect of on learning and training (Backlund & Hendrix, 2013; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Dondlinger, 2007; Hainey, Connolly, Stansfield, & Boyle, 2011; Ke, 2009; Kirriemuir & Mcfarlane, 2004; Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014; Mishra & Foster, 2007; Papastergiou, 2009b; Sitzmann, 2011; Tobias et al., 2011; Vogel et al., 2006; Young et al., 2012). It has been argued that SGs are useful for a wide range of areas, including work-related knowledge and skills (Sitzmann, 2011), organisational learning (de Caluwé, 2008; Hofstede, 2008), cognitive and affective dimensions of learning (Connolly et al., 2012; Wouters et al., 2013), higher-order thinking (Ke, 2009), as well as strategic thinking, communication and negotiation skills (Estes & Snow, 2010; Kirriemuir & Mcfarlane, 2004; Raybourn, 2007). However, Appelman and Wilson (2006) caution against taking serious gaming too lightly, especially if the cost of failure (the consequences of the failure to transfer to the work context) is high. Similarly, Chatham (2009) warns of (falsely) assuming that SGs are 'instant training devices' in that they are supposed to be cheap, effective, trainer-less and universal. SGs might be cheaper than large, sophisticated simulation facilities (Ford, Barlow, & Lewis, 2003), but, as discussed in Chapter 4.1.2, they have different properties that will inevitably lead to trade-offs in how they are designed and used.

Overall, there seems to be no single 'active substance' (dependent variable) that determines the success of games for learning (Young et al., 2012). The general conclusion of most reviews on GBL and GBT is that serious gaming is not superior to other types of learning material, particularly when compared to other methods that are equally engaging in the learning experience (Sitzmann, 2011; Tobias et al., 2011) or when SGs are not supplemented with other instructional methods (Wouters et al., 2013). Thus, SGs are not a 'magic bullet' or panacea that will revolutionise learning (Corti, 2006; Ford et al., 2003; Ma, Williams, & Prejean, 2012; Tang & Hanneghan, 2010).

A number of benefits or strengths have been attributed to GBL and GBT, such as increased motivation and engagement (Dondlinger, 2007; Garris et al., 2002; Guillén-Nieto & Aleson-Carbonell, 2012; Papastergiou, 2009a), collective feedback and reflection (de Caluwé, 2008), testing competencies (Corti, 2006), portability (Ford et al., 2003), providing authentic learning experiences (Galarneau, 2005), problem-based learning (Kiili, 2007), working in groups (Wouters et al., 2013), scaffolding (Leemkuil, 2008), facilitator guidance (Bellotti, Kapralos, Lee, Moreno-Ger, & Berta, 2013; de Caluwé, 2008; Salas et al., 2009), and debriefing (Crookall, 2010). Hofstede et al. (2010) offer a comprehensive account of what is thought to be the 'active substances' of serious gaming.

There are also characteristics that are considered to be beneficial for learning in some contexts, but regarded as having the opposite effect in others. For instance, the use of Easter eggs (hidden items or messages, often humorous) is seen as reinforcing the player's curiosity and encourages the exploration of as much of the game space as possible (Bauman, 2013; Charsky, 2010). However, Watson and Fang (2012) warn that this type of unstructured play does not fit all types of educational settings, especially those with strict time constraints.

Another example is competition, which is seen as a motivational factor that increases the fighting spirit, stress and engagement with the tasks and winning the game (Gajadhar et al., 2009; Herz & Macedonia, 2002; Quick, Atkinson, & Lin, 2012; Vorderer, Hartmann, & Klimmt, 2003). However, there are usually a number of ways in which a learner can reach a goal and some of these methods might not be appropriate. For instance, Frank (2012) reports that military cadets have been observed adopting different player behaviours, when training with SGs. He identified two coexisting attitudes that affected how the game was played: the professional attitude, in which the players take on the role and think as commanders, and the lusory attitude, which "involves committing to play the game in ways defined by the game rules" (Frank, 2012, p. 120). Ideally, there should be a balance between these two attitudes, but if the lusory attitude becomes too prominent, the players enter what Frank (2012) calls 'gamer mode', that is, they treat the game only as a game and not as a training tool. This is related to what Gee (2009) calls 'gaming the game' or 'gaming the system'. Cadets in so-called gamer mode tend to use tactics that are not advisable in real life (e.g. overuse of resources or exposing the supply unit to direct fire). Entering gamer mode is not a serious issue for experienced officers, who might be more motivated this way to spending a few extra hours training. For inexperienced learners, however, it might lead to erroneous learning in that cadets may believe these tactics are feasible in real life (Frank, 2012). In a follow-up study, Frank (2013) tested the effect of reward structures on the cadets' gaming strategies and found that those who played with victory points used strategies indicative of gamer mode, while those who played without points behaved more cautiously and less aggressively (i.e. more realistic and desirable from a military perspective). While serious gaming is supposed to be a safe environment in which learners can try out different ideas, certain reward structures, such as victory points, can have detrimental effects on learning (Frank, 2013). According to Egenfeldt-Nielsen (2006), "the immersive effect of video games leads to a lack of awareness of the contents, structures, and concepts integrated in the video game. This results in weaker learning overall and especially in the transfer of game experience to other contexts" (p. 204). Egenfeldt-Nielsen (2006) states that this is mainly a problem when using entertainment games as SGs, but the results from Frank (2013) suggest that it is also a potential problem in SGs specifically designed for learning and training.

An even more serious concern, largely ignored by the SG community, is the issue of transfer. As presented in Chapter 6.2.3, transfer of knowledge from the gaming context to the work context is an important goal in serious gaming. In her thesis, Bennerstedt (2013) argues that the transfer concept itself is contested by educational science, which makes it problematic to use as a building block in SG theory. Transfer is especially problematic when approaching serious gaming from a social constructivist perspective, since knowledge is seen as a cognitive tool "that mediates activity rather than memorized information" (Egenfeldt-Nielsen, 2006, p. 199). Thus, knowledge developed through gaming is mostly geared towards acting within the game space and not outside of it (Bennerstedt, 2013). As a consequence, researchers and practitioners should not assume that games in and of themselves lead to general knowledge that can be used in other contexts (Arnseth, 2006; Bennerstedt, 2013; Linderoth, 2012). In my description of the issues of expertise (Section 6.2.2) and transfer (Section 6.2.3), I have stressed the importance of explicit learning as opposed to implicit or stealth learning, as well as the significance of contextual factors outside the here-and-now gameplay, which should account for the concerns raised by Bennerstedt (2013).

Another assumption seldom contested is that GBL is the preferred method of learning for the so-called 'digital natives' or 'gamer generation' (see e.g. Annetta, 2010; Prensky, 2001; Tang & Hanneghan, 2010). Digital natives are assumed to have high gaming experience and skill (so-called 'ludoliteracy'). For instance, Annetta (2010, p. 109) writes:

> The *net generation*, or *digital natives* as they have been called, have the seemingly innate ability to expand visual–spatial abilities and cognitive load. They thrive in environments that challenge them, making them adapt to those challenges and predict avenues to circumvent other challenges. [...] Modern youth arguably have become the masters of multitasking. [...] Their cognitive loads seem to have higher capacity than their older counterparts.

However, research has found little evidence to support the claim that the digital natives have a distinctly different learning style or cognitive abilities from other learners (Bennett, Maton, & Kervin, 2008; Helsper & Eynon, 2010). More specifically, age alone is not a good predictor of ludoliteracy and attitudes towards serious gaming (Bekebrede, Warmelink, & Mayer, 2011; Proctor et al., 2008), and multitasking prevents an individual from achieving a state of flow (Adler & Benbunan-Fich, 2013). What makes someone inclined to be positive towards gaming as part of a learning experience is still unknown, but some research points towards factors such as experience and breadth of use of technology (Helsper & Eynon, 2010), the socio-demographic situation (e.g. gender and education) (Helsper & Eynon, 2010), personality and attitudes (Lee, Heeter, Magerko, & Medler, 2013; Wagner & Wernbacher, 2013), and culture (Hofstede, 2008). A conclusion that can be drawn from this is that not everyone knows how to use or even wants to play digital games, and this poses a challenge for the facilitator of serious gaming (Chatham, 2009; Hofstede, 2008; Slomp, van der Zee, & Molleman, 2008; Whitton, 2007). This is why user acceptance (see Chapter 5.3) is an important issue for SG research.

There are several other problems with SG research and implementation. For instance, SG research is fraught with methodological flaws (Egenfeldt-Nielsen, 2006; Whitney et al., 2013). Particularly prominent is the lack of longitudinal studies on how SGs are incorporated into learning experience practices (Hainey et al., 2011; Young et al., 2012). Longitudinal studies would also help in ruling out the novelty factor as a confounding variable (Backlund & Hendrix, 2013). Connolly et al. (2012) further assert that SG research needs to do more randomised control trials, although identifying a suitable control condition is a serious barrier to breach. Comparison studies are also hampered by the fact that learning experiences are iterative, learners are in a state of constant change (knowledge cannot be measured as a fixed entity), and SGs constitute extremely dynamic stimuli (Shapiro & Peña, 2009). In parallel, more qualitative studies are needed, in order to capture a more systemic view of serious gaming (Connolly et al., 2012; Lainema & Saarinen, 2010). This thesis constitutes a step towards filling that gap by, in part, studying established serious gaming practices.

Furthermore, there seems to be a slight publication bias towards studies that show positive results, which risks skewing the conclusions drawn from literature surveys (Sitzmann, 2011). However, Wouters et al. (2013) did not find a publication bias in their sample. A related problem is researcher bias, which seems to increase when the one evaluating a game has also been part of developing it (Backlund & Hendrix, 2013).

An even more serious concern is that many SGs are developed without an explicit application of a particular theory of learning (Gunter et al., 2008; Lainema & Saarinen, 2010; Tang & Hanneghan, 2010; Wu et al., 2012). Simply asking learners whether or not they have learned something useful from the experience does not constitute proof of a sound educational practice (Lainema & Saarinen, 2010; Tobias et al., 2011). Hofstede et al. (2010) specifically stress the importance of fostering reflection as part of the serious gaming practice. Despite this, few practitioners incorporate activities for reflection (e.g. debriefing) explicitly (Egenfeldt-Nielsen, 2006). Thus, research into effective procedures for GBL and GBT is needed, as well as research on conditions that could hamper them (de Freitas, 2006; Tobias & Fletcher, 2012; Tobias et al., 2011).

6.4 CHAPTER SUMMARY

This chapter has presented an overview of the research conducted on SGs used for learning and training. It serves as a theoretical foundation for understanding the issues involved in GBL and GBT (Objective 1). The following concepts are identified as important for the research question: theories of learning and training, expertise, transfer and motivation. It is critical to note that the outcome of serious gaming will depend on its underlying learning theory applied during the design and use of the game. This entails both how learning activities are realised within and around the game as well as the role of the instructor before, during and after serious gaming. The prevailing theories in concurrent SG literature are experiential learning, cognitive constructivism and social constructivism. They offer a sound perspective on learning that reject the idea of learning as the transmission of information from the instructor or instructional tool, and instead highlight the importance of concrete, authentic experiences, as well as problem-solving and socio-cultural aspects of learning, such as becoming and being a member of a community of practice (CoP). This means that a framework outlining serious gaming practices (Objective 3) should view the instructor as a facilitator and coach, rather than as someone who merely conveys information to the learners. Furthermore, in order to ensure that the learners become experts at accomplishing current and future work tasks, the framework should include activities promoting reflection-in-action, reflection-on-action, as well as deliberate practice.

Another important issue to consider is the transfer of knowledge from the gaming context to the work context. A serious gaming framework must include activities outside the game, in order to foster attitudes and intentions to transfer knowledge, which means abandoning the concept of stealth learning that has been a prevailing view within the SG community. Lastly, although motivation is one of the most cited reasons for using games for learning, it should not be the only motif, since not all learners like playing games and are motivated by sometimes discrepant aspects of serious gaming activities.

The chapter concludes that SGs provide a number of benefits for learning, but there are also many pitfalls of which practitioners need to be aware. Thus, there is a need for the kind of research presented in this thesis, that is, research into practical issues concerning serious gaming, from a systems thinking approach.

CHAPTER 7
FACILITATION OF SERIOUS GAMING

A review of the matters of cognition and learning, addressed in Chapter 6, reveals a common denominator; the need for different types of guidance to enable learning, as well as how to assess and give feedback on performance (see e.g. Jin & Low, 2011; Quinn, 2007; Tobias et al., 2011). Although more guidance from the instructor can result in less learner control and agency in the virtual environment, it has been found to be more effective for learning and transfer (Ma et al., 2012). As put by Ukens (2007), it is important that the facilitators "stay in control without assuming an authoritarian position [...] Unless an activity calls for the facilitator to take an active role, participants should be allowed to experience the event on their own" (p. 134). This chapter outlines in more detail what is actually meant by facilitating a learning experience through serious gaming. As such, it represents a significant step towards reaching Objective 1.

7.1 SCAFFOLDING AND GUIDANCE

As described in Chapter 6.2.1, scaffolding is an essential part of serious gaming and refers to gradually diminishing support that enables the learner to carry out tasks beyond his or her current skill set (Lave & Wenger, 1991; Leemkuil, 2008; Mason et al., 2011). The concept originates from zone of proximal development (ZPD), a concept introduced by Vygotsky (1978), who described it as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Thus, by working in close cooperation with more experienced learners or instructors, a learner can perform better than when working alone. Research in distributed cognition also emphasises physical and technological tools and artefacts (e.g. calculators, notes) as well as spacial contexts (e.g. placement of objects within a physical or virtual environment) as scaffolds that extend human cognition beyond the ability of the individual brain (Orlikowski, 2006; Susi & Ziemke, 2005).

Scaffolding within a serious gaming setting can be realised in a number of ways, such as the presence of an experienced participant who can relieve the learner of some of the more difficult tasks (Beaubien & Baker, 2004), giving learners structured tasks, guides and explicit strategies (Ertmer & Simons, 2006; Gee, 2008; Ma et al., 2012; Sandford, Ulicsak, Facer, & Rudd, 2007), providing positive and corrective feedback (Mason et al., 2011), providing just-in-time background information (Hussain et al., 2010; Leemkuil & de Jong, 2011), conducting debriefing sessions after gameplay (Charsky, 2010; Leemkuil, 2008), utilising collaborative gameplay (Amory, 2010; Whitton, 2010), and designing SGs with in-game resources and interface tools/cues/affordances (Gee, 2008; Linderoth, 2012). Leemkuil (2008) outlines several challenges for learning through gameplay that require some kind of scaffolding, such as:

- Players have difficulty knowing which actions to take or how to interpret or evaluate a situation/solution, due to a lack of domain knowledge. They also do not know where to locate relevant information or tools that could help them proceed;
- Players have difficulty choosing an appropriate solution to a problem. They might use a trial-and-error strategy or lack the resources needed to choose what they have deemed the preferred solution;
- Players have difficulty evaluating and reflecting upon situations, due to a lack of relevant in-game information (e.g. data from previous actions or game states are missing, or game goals are vague and abstract) or a lack of intelligible progress feedback;
- Players become mentally blocked or fixated on one solution or strategy, which makes them unable to change their behaviour or to generate new knowledge;
- Players try to game the system instead of focusing on the learning goals.

Figure 7.1 shows an example of a physical scaffold in the form of visual cues on the keyboard. It gives novice learners some guidance in what keys are used for interacting with the game and how each key maps to in-game actions.

FIGURE 7.1: Example of scaffolding by physical cues that help the learner to learn and remember the keyboard mappings to actions within the game.

Knowing how much scaffolding is needed is probably one of the more challenging tasks when designing a learning experience. For instance, Linderoth (2012) argues that learning in (entertainment) games is overestimated, due to scaffolding techniques used in games. His argument is that games include a number of facilitatory elements that alleviate the player to a point where no learning is needed to play the game. As an example, Linderoth (2012) points to role-playing games (RPGs) and massively multiplayer online games (MMOGs), which usually have a level system in which the player's avatar becomes more powerful or skilful, without requiring the player to acquire a different or more nuanced skill set in order to meet the new challenges. The player can also obtain objects (e.g. magic boots) that give the player some type of advantage. Many games (e.g. first-person shooter (FPS) games) also include interface techniques, such a highlighting, which graphically accentuate objects and avatars that are important for the current challenge (e.g. using symbols or glowing colours to draw attention to enemy locations). Thus, the player only has to learn how to interpret and use these facilitatory elements or tools. Linderoth (2012, p. 58) concludes:

> The tool does the work for the player. Compared to performatory actions in other domains like playing an instrument, performing surgery, playing a sport, dancing, writing a novel or acting on a stage, such tools are not introduced systematically. If I want to learn to play 'Purple Haze' on an electric guitar, I cannot sit and grind for hours and just pluck one string until I receive a magical glove that does the work for me.

Of course, Linderoth (2012) mainly studied this issue in entertainment games, but his main point is still true for SGs; scaffolding must be done with an explicit instructional goal in mind, so that learners receive just enough support to reach a state of flow, but not so much that it negates learning. By explicit instructional goal I mean that SGs have to be designed so that the learner is forced to practise the skills needed for the transfer of knowledge to another domain, while having scaffolds for skills and knowledge areas that are not necessary in that other domain or at a particular level of expertise (i.e. more scaffolding for novices than for more experienced players). While some might perceive this as a tug-of-war between usability/PX issues (see Chapter 5) and pedagogical aims, I do not think that they are in true opposition. Just as entertainment games should be easy to learn, but difficult to master (Malone, 1982), so should SGs. The difference lies in the challenges and game goals, which in SGs are interconnected with specific learning goals. While entertainment games can sacrifice 'true' mastery in order to engage players (Linderoth, 2012), SGs, by definition, cannot relieve players from the straining activity of deliberate practice. As a consequence, SG developers should not assume that they can compete against entertainment games in terms of engagement (Virvou & Katsionis, 2008).

Apart from scaffolding, guidance and debriefing also serve to encourage reflection, in order to facilitate transfer. In the following sections, I look closer at a few scaffolding or guidance practices that I have identified as important for serious gaming, namely, scenarios, feedback and debriefing.

7.2 BACK-STORIES AND SCENARIOS

SGs can be described as *designed experiences* (Squire, 2006), which have a compelling scenario as a central game element. A scenario sets the game in motion by introducing an objective that needs to be met or a problem that needs to be solved (Bartels, McCown, & Wilkie, 2013). This is usually done through some kind of narrative that compels the players to reach the game goal and to enter into their respective roles. A narrative can be described as an abstract cognitive structure or mental image that consists of a world situated in time, populated by characters who participate in events and actions (e.g. problem-solving) (Ryan, 2002). Narratives in games differ from narratives in other media (e.g. films and books) in that they are interactive and often non-linear, due to the reciprocal actions between the players and the game (Ang et al., 2008; Qin, Rau, & Salvendy, 2009).

Although the introduction of an objective is seldom interactive, it is often embedded within a background story (back-story) which informs the player of the incidents or plotlines that led up to the the point in time in which the main story (to be played out during gameplay)commences (Ma et al., 2012). The main story can either be a baseline scenario, which is the simplest type of scenario (e.g. only including the virtual environment itself and the learner), or more intricate, with events, triggers and adaptions (Martin, Hughes, Schatz, & Nicholson, 2010). Well-made stories enhance the authenticity of the game and contextualise it in a way that helps the learners to immerse themselves in the narrative, feel empathy for the characters and, thus, behave in a realistic manner (Charsky, 2010; Hussain et al., 2010). This means that scenarios need to be dynamic, in order to enhance believability. However, since instructors might experience a loss of control of the learning situation, as the scenario takes off in unpredictable directions, Westera, Nadolski, Hummel, and Wopereis (2008) caution that the methods of creating complexity can be counter-productive to education. They differentiate between emergent complexity, which is created from a self-organised collection of (simple) interacting agents, and complexity created by design, which is a pre-structured complexity based on a narrative or scenario. In the former case, every gameplay session will be diverse and unpredictable. While this might be exciting from a gameplay perspective, it "is a direct threat for education because it is unclear whether the emerging events match the required learning goals" (Westera et al., 2008, p. 422). Thus, a balance between unpredictability and control of the narrative is desirable from an instructor perspective.

If it is the learners' first encounter with the game, a scenario should be constructed as a tutorial where the objective is to successfully manoeuvre in and interact with the virtual world (Backlund et al., 2009). In line with the gradually diminishing support that characterises scaffolding, subsequent scenarios should increase in difficulty and also involve tasks related to the training goals. Thus, in order to create a well-balanced scenario, the scenario author should be well-aware of the learners' background and their skill level. Ideally, scenarios should be user-authorable (as opposed to static pre-authored ones), so that they can be altered and fine-tuned to the current training needs (Chatham, 2009).

A common problem in scenario authoring is to make it as transparent as possible, so that there are no misinterpretations of what needs to be done and the options for getting there (Bartels et al., 2013). Moreover, the instructor responsible for creating a scenario should also consider whether the scenario will be self-contained or will need interventions during gameplay. A self-contained scenario will have to be adaptive to the individual learner's choices and flexible enough to avoid being too predictable (Lopes & Bidarra, 2011), as well as to augment replayability (Hullett & Mateas, 2009). Furthermore, a narrative that is too elaborate can be counter-productive in that an engaging story might direct the players' attention away from the learning content (Wouters et al., 2013). To remedy this, learning content must be embedded within the narrative, that is, be integrated in an endogenous manner (Gunter et al., 2008).

Once the game has begun, the scenario will take on a life of its own, where the players – through their actions – decide its direction, pace and conclusion (Raybourn, 2007). In line with the constructivist view of learning, it is important that the scenario author keeps an open mind with regard to different outcomes and does not create a scenario on the premise of proving a point or providing only one right solution (Bartels et al., 2013).

7.3 ASSESSMENT AND FEEDBACK

A recurring theme in literature on flow, learning, expertise and transfer is the importance of feedback. Without feedback, learners have no insight into the result of their actions and cannot determine whether their performance was right, wrong, or somewhere in-between (Leemkuil, 2008; Salas et al., 2009). Furthermore, Tobias et al. (2011) also point out that feedback, given in a polite rather than direct manner, allows the learner to save face after making errors. It is important that feedback not only provides the learners with information about the correctness of their response or the adequacy of their performance, but also includes corrective and explanatory information about how performance can be improved (Driscoll, 2012; Moreno & Mayer, 2005). The most effective feedback is immediate and unambiguous (Annetta, 2010; Wilson et al., 2009).

In order to give feedback, the learner's performance has to be assessed. This assessment can be done by the game, the instructor, or a combination of both. Before I delve deeper into that issue, however, I first explain what I mean by feedback.

7.3.1 DISAMBIGUATION OF FEEDBACK

Gameplay is characterised by a fast action-feedback system where players' actions have immediate reactions from the system that guides the next action, and so on (Garris et al., 2002). In other words, players learn through their actions and adapt their behaviour accordingly (Wilson et al., 2009). This is one of the reasons why SGs are thought to be effective learning tools (Mislevy et al., 2012). Linderoth (2013) describes gameplay in terms of an activity closely linked to perception, that is, the player explores the user interface (graphics, sound, and the behaviour of objects and agents) in order to discover what actions are available at a given moment in time. Upon acting within the game world, the system reacts to the player's actions (e.g. a button-press) and responds accordingly. The changes in the perceptual field give the player further hints about the effect of the last actions and how he or she could continue. This, in turn, leads to a reaction from the player, either a fast automatic response or a more deliberate action based on some type of decision-making. The fast action-feedback system is a central part of the input-process-outcome game model described by Garris et al. (2002) and depicted in Figure 7.2.

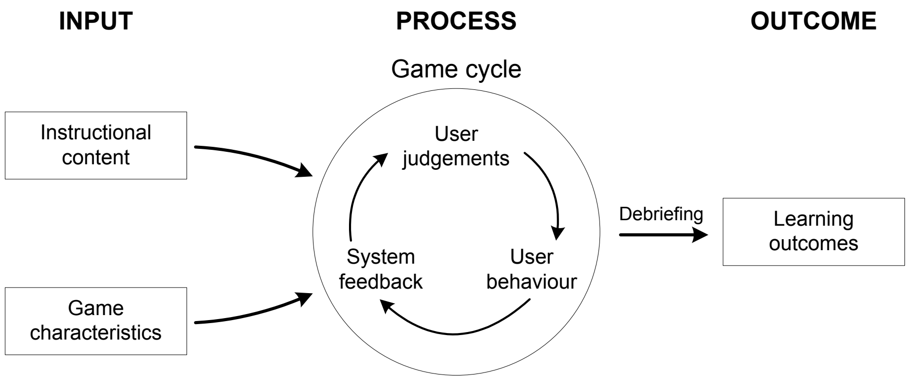


FIGURE 7.2: The input-process-outcome game model. The input consists of instructional content and game characteristics, the process is an iterative game cycle that involves repeated judgement-behaviour-feedback loops, and, finally, the output is a result of the combination of the game cycle and the following debriefing. Adapted from Garris, Ahlers, and Driskell (2002, p. 445).

Feedback is a term used in many domains and has different meanings depending on the context or the level of granularity from which we view the interaction cycle. Table 7.1 tries to disambiguate these different meanings. The first level, presents the type of feedback just described – sounds, movements, text, colours – conveyed to the player's perceptual apparatus via the system's user interface. I have termed this type *system interface feedback*. Some of these cues are specific to the game interface (e.g. highlights) and have to be learned within that context. Others try to mimic the feedback that the learner will encounter in the work domain. While the former scaffold gameplay, the latter are essential for the transfer of knowledge. As gameplay is a situated activity, one must not only account for the feedback given to the individual player, but also other situational factors, including the player's background and how other actors (co-players, instructors, and so on) within the game space inform the player's actions. A thorough

TABLE 7.1: Disambiguation of feedback, in terms of different feedback types. System interface feedback is the type of feedback used in interface design, while system-controlled and instructor-controlled feedback is more related to instructional design.

FEEDBACK TYPE		DESCRIPTION
System interface feedback		Game-specific and work-specific perceptual cues
System-controlled feedback	Formative	Game-specific and learning-related game mechanics (e.g. points, achievements)
	Summative	Final score, ranking, statistics, graphs, etc.
Instructor-controlled feedback	Formative	Comments, advice, coaching, etc.
	Summative	Grades, certificates, etc.

analysis of domain experts is needed, in order to understand which cues are essential to carry out the work tasks to be trained through serious gaming (Salas & Cannon-Bowers, 2001; Tobias et al., 2011). Furthermore, once it is decided which cues should be present within the game, knowledge from the domain of UXD (see Chapter 5) is also necessary to design system interface feedback.

The next level is *system-controlled feedback* and relates more closely to higher level learning and instructional design. It involves conveying hints on the player's progress in-game, by ,for example, scores and experience points, and usually requires some kind of algorithms or artificial intelligence (AI) to assess performance. System interface feedback and system-controlled feedback are directly related to the here-and-now gameplay and cannot be controlled by the instructor during the game session. For system-controlled feedback, there is also a difference between game-specific and learning-related game mechanics, that is, whether the scores only represent progress within the game (have little or no real-life correlation) or are integrated with the learning goals. For instance, in fire-fighter training, saving a victim trapped in a burning building might be rewarded with a certain amount of points, but it is the search strategies and communication with the incident commander that is being assessed. If the latter also renders system-controlled feedback, then game-specific feedback and learning-related feedback are indistinguishable from one another.

The last level is the type of feedback that is not automatically created by the game engine. I have termed this type *instructor-controlled feedback*. This involves comments, advice and other coaching techniques that the instructor might deliver to the learners as a complement to the system-controlled feedback. This type of feedback not only differs from the other two by the form in which it is mediated, but because it is also focused on the learning goals and not on the game goals (unless they are integrated).

Another distinction that can be made for both system-controlled and instructor-controlled feedback is formative and summative feedback. *Formative feedback* is most commonly provided during gameplay and aims at giving the players information about their progress and how they can change their behaviour, in order to achieve the learning goals. Slomp et al. (2008) found that the appropriate frequency of feedback is dependent on the complexity of the game. For instance, they noticed that players of a complex game are likely to become frustrated if constantly provided with feedback, whereas a longer duration between feedback conveys the impression of success. *Summative feedback* is given once the players have carried out the learning activity and aims to inform the players whether or not they managed to reach the learning goals (e.g. in terms of grades, final ratings or certificate) (Belland, 2012). This can be delivered to the learners directly (by the instructor or through the game) or reported to an online learning management system (LMS) (Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, & Fernández-Manjón, 2008).

7.3.2 ASSESSMENT OF LEARNER PERFORMANCE

As mentioned earlier, an assessment of learners' performance and how it relates to the criteria set for the exercise must first be done, in order to give feedback. The term assessment is related to evaluation, but while evaluation is mostly used for the systematic appraisal of organisations or systems, assessment is restricted to "the measurement of an individual's learning achievements" (Hainey et al., 2012, p. 175). Assessments should be ubiquitous and situated. *Ubiquitous assessment* means that learning and assessment are seamlessly integrated and feedback is constant (anywhere and anytime) and non-intrusive (Shute, Levy, Baker, Zapata, & Beck, 2009). *Situated assessment* means that the assessment is done in realistic situations that are related to the learners' work context (Hubal & Pina, 2012). Generally, it is easier to devise guidelines and coding of assessment measures in games that have a fixed structure, compared to open-ended games in which learners, by and large, control most of the game space (Neville & Shelton, 2010). Within the realm of simulation-based training, quantitative (numerical) measures are regarded as useful, because they can be employed in evaluating the quality of a training programme, that is, they offer a straightforward method of comparing individual skill levels. However, they are not very useful in providing corrective feedback (Hall & Brannick, 2009).

In formal education, assessments are usually achieved through some kind of test, where the students are asked to verbalise their reasoning or answer a number of questions, in order to measure their level of understanding. However, assessments can also be done by examining evidence generated from students' performance (Belland, 2012). This can be done at the individual or team level (Salas et al., 2009). Hall and Brannick (2009) differentiate between subjective and objective measures. *Subjective measures* are those carried out by human judges or experts, most likely one or several instructors. Due to their expertise, instructors have developed a professional vision (Goodwin, 1994) that allows them to perceive patterns of behaviour that constitute the sought-after skill. However, subjective measures are not very reliable, mainly because different instructors might disagree with one another (Hall & Brannick, 2009). For instance, they might attend to different sets of behaviours or interpret the same behaviour in different ways. For this reason, many practitioners prefer *objective measures*, that is, recordings or calculations of learner performance (Hall & Brannick, 2009). Objective measures are more reliable, precise and easier to standardise, compared to subjective measures. They are also useful when subjective measures are not possible, for example, when using simulators (e.g. flight or tank simulators) where instructors cannot observe the learners directly, but must rely on data collected automatically, or when the subjective measures are not precise enough (Hall & Brannick, 2009).

However, Hall and Brannick (2009) point out that objective measures are "not necessarily superior to the use of subjective methods" (p. 161) and highlight a number of potential weaknesses or limits. Firstly, objective measures have limits in their utility; they might be useful for learning goals that are easily quantifiable (e.g. aiming angle in marksmanship training or number of victims saved in rescue operations training), but become more difficult to interpret when used for soft skills training and other less quantifiable goals. This especially poses a problem when users disagree on the meaning of outcome data or on how the objective measures should be used (Hall & Brannick, 2009). Secondly, systems and tools for automated data collection might involve additional costs, which require that a thorough cost-benefit analysis must be done before purchasing and installing them. For instance, many data collection systems produce large files of raw output data, which require extra tools that can analyse and present the data in a useful, condensed and coherent way (Hall & Brannick, 2009; Mangos & Johnston, 2009). Lastly, Hall and Brannick (2009) also mention that learners, instructors and managers "may be reluctant to use or even record objective measures of performance" (p. 161) in certain training situations (e.g. involving sensitive, private or classified data). Thus, the choice of measurement should be driven by the vision of how the data are to be used, in accordance with the learning or training goals, as well as what is possible from a practical perspective. Of course, by combining both types of measures, assessment becomes more robust, although Salas et al. (2009) point out that this would need a mutually agreed upon measurement framework, in order to effectively integrate the various methods. Additionally, Wilson (2009) reports that many teachers do not trust automated assessment in games and prefer to supplement it with external assessment techniques, such as pen-and-paper, which further supports the use of a combination of subjective and objective measures. Salas et al. (2009) list a number of best practices for performance measurements in simulation-based training, of which several are relevant for serious gaming. A list of their insights is presented in Table 7.2.

The choice of how to assess will be greatly influenced by how we view performance; as an outcome or a process? Too often, performance is seen as an outcome, which trivialises the need for in-game assessment and puts too much focus on end-results. Rather, a focus on process measures will have positive results on outcomes as well. As put by Salas et al. (2009, p. 353):

> Essentially, if performance is conceptualised and measured as a process and this aids in the performance measurement goals of diagnosis and intervention, then there is the underlying assumption that by improving process, outcomes will also benefit.

Similarly, Rupp, Gushta, Mislevy, and Shaffer (2010) make a distinction between process data and product data. According to them, process data are assessment data that are derived from learner-learner interactions and learner-instructor interactions. I extend this definition to also include interactions between the learner and the game (the virtual environment and virtual agents within it). Product data, on the other hand, refer to assessment data that are derived from "the collection of the learners' tangible work products" (Rupp et al., 2010, p. 7), such as written reports or a designed artefact. Furthermore, assessments can be fully automated, semi-automated (where an instructor checks the output from an assessment algorithm) or done by the instructor without the aid of an in-game monitoring system, that is, external assessment (Loh, 2012; Underwood, Kruse, & Jakl, 2010). Due to the nature of gameplay, games are considered to be well suited for automatic and semi-automatic assessment (Mislevy et al., 2012). As players advance in a game, they accumulate points that generate higher degrees of difficulty, which rhymes well with assessment (Bellotti et al., 2013). Automated assessment, however, is limited to direct and overt behavioural responses (objective measures) and is therefore not suitable for measuring more complex learning goals involving cognitive processes, such as reasoning and reflective skills (Salas et al., 2009). In these cases, serious gaming must be accompanied with proper instructor guidance (Bellotti et al., 2013; Wilson et al., 2009).

In-game assessment is particularly suitable for *formative assessment*, that is, a continuous assessment that is meant to inform and guide the fine-tuning of skills and not grade the performance as a whole (Hainey et al., 2012). Formative assessment is valuable for learning, because it can be used to adapt the scenario content (Mangos & Johnston, 2009), as well as indicate whether the learners are on track towards meeting the learning goal, and what is required to fully reach it, thus, eliciting reflection (Belland, 2012; Clark,

TABLE 7.2: Best practices for performance measurement in training simulation, according to Salas, Rosen, Held, and Weissmuller (2009, p. 361).

MEASUREMENT SYSTEM REQUIREMENT	Best practice performance measurement (usually) works best when...
Multiple levels of measurement	...it captures multiple dimensions of performance at appropriate levels of analysis.
	...event-based techniques are used to capture data at multiple levels of analysis.
	...multiple measures from various sources are captured.
	...a systematic plan is in place to integrate data from multiple measures.
Address process as well as outcome	...it captures the processes of performance.
	...expert models of the task are used to compare and evaluate performance processes and outcomes.
	...the collection and transmission of objective measures is automated.
Describe, evaluate and diagnose performance	...measures are descriptive of performance.
	...performance can be compared to standards for desired levels of performance.
	...it is diagnostic-when it provides insight into the causes of performance.
	...it allows for performance diagnosis to be partially or fully automated.
	...it allows for performance evaluation to be partially or fully automated.
	...there is flexibility designed into embedded measures (different measures can be substituted).
	...it captures a broad spectrum of measures and the context of performance.
	...observers are trained to high levels of reliability.
	...observers use protocols.
Provide a basis for remediation	...it supports learning.
	...it allows for the automated and manual creation of AAR aids for training remediation and feedback.
	...it enables automated scaffolding and performance-based coaching.
	...it drives real-time corrective feedback.
	...it is integrated with trainer controls and feedback generation.

2007; Moreno & Mayer, 2005). Therefore, by receiving formative feedback, learners are able to correct their behaviour immediately and do not have to wait until a later training session, when some skills might have become automated and more difficult to retrain (Iuppa & Borst, 2007). Formative assessment and feedback are especially useful for the development of meta-cognitive skills, such as analysing and evaluating decision-making processes (Bente & Breuer, 2009; Raybourn, 2007).

According to Shute, Ventura, Bauer, and Zapata-Rivera (2009), formative feedback should, as far as possible, be embedded within the gaming space, so that flow and immersion is not interrupted. They introduce the concept of 'stealth assessment', that is, embedded formative assessments "seamlessly woven into the fabric of the learning environment that they are virtually invisible" (Shute, Ventura, et al., 2009, p. 299). Stealth assessment should not be confused with stealth learning; stealth learning means that players are unaware that they are learning, whilst stealth assessment means they are unaware that their learning is being assessed, because they are busy playing the game. This means that the learner might experience less performance anxiety and, thus, perform better (Hall & Brannick, 2009). Moreover, a stealth assessment approach enables the analysis of sequences of actions instead of just measuring whether or not the player can answer a question correctly. This is realised through machine learning techniques that collect and analyse large amounts of data created as the learners progress through the game. As a consequence, feedback can be tailored to the individual learner (Underwood et al., 2010).

According to Shute, Ventura, et al. (2009), the challenge for stealth assessment is not collecting this rich data stream, but how to interpret it in a way that makes sense from a learning perspective, as well as how to communicate it to the learners. If the learning objective is well-structured and the number of available solutions to a problem is limited, the assessment task is fairly straightforward (Bente & Breuer, 2009; Underwood et al., 2010). However, soft skill training is usually characterised by an ill-structured domain, where learners' actions are difficult to predict in advance and where several solutions to a problem are equally 'right' (Hubal & Pina, 2012). Thus, in ill-structured domains, assessments must focus on how the learners deal with specific challenges which require a more intricate understanding of what constitutes successful and unsuccessful performance than can be assessed through a post-game test (Hubal & Pina, 2012; Shute, Ventura, et al., 2009). One way to handle this issue is to assess learner performance over a set of gameplay sessions. Another is to restrict the number of possible actions available to novice learners and then increase it as the learners become more proficient in their tasks (Hubal & Pina, 2012). It is, however, important not to simplify gameplay to such a degree that it does not represent the natural 'messiness' of real-world situations at all. According to Hubal and Pina (2012), situated assessments have to retain some of the real world's complexity, in order for transfer to occur.

A well-designed scenario can help in-game assessment, since it can involve cues or event points where the player's performance is checked against components of the desired behaviours (Salas et al., 2009). In order to determine what set of behaviours is acceptable, cognitive task analysis or similar methodologies can be helpful (Salas & Cannon-Bowers, 2001; Tobias et al., 2011). Interviewing subject matter experts is also one way of distinguishing between in-game behaviours.

Whereas formative assessment serves to measure the ongoing performance of learners, *summative assessment* aims to determine to what degree a learner or a group of learners has been successful in reaching a learning goal towards the end of an instructional unit (Hainey et al., 2012). The result of a summative assessment regulates whether or not a learner can proceed to the next step or has to re-take the module or course. Summative assessment can be achieved in many ways; just as with formative assessment, it can be automated, semi-automated or external. For instance, Loh, Anantachai, Byun, and

Lenox (2007) contemplate whether assessment components should be integrated within the game engine, a LMS (e.g. *Moodle* or *Sakai*), or some third option not thought of yet.

Evans, Jennings, and Andreen (2011) also suggest that achievement systems (rewards in the form of trophies or points when achieving a specific in-game task) can be used for the assessment of skills that are generally difficult to measure, such as creativity and the nuances of problem-solving and decision-making ability. Achievements can be seen as a meta-ranking scheme that encourages players to spend time on certain tasks or replay certain scenarios or levels. For instance, players can be rewarded by completing a tutorial, by exploring a majority or the game content, or completing a specific task in a short amount of time (Evans et al., 2011). Thus, learners' skills are only indirectly measured through player actions. A downside to the use of reward systems, especially those that suggest a winning/losing condition, is the risk of learners entering gamer mode, as Frank (2012, 2013) has shown (see Chapter 6.3). The most extreme case of gamer mode is when trainees revert to cheating in order to win the game. For instance, Chen and Michael (2005) mention cheat codes as a threat to assessing learning in SGs. Learners cheat when the challenge becomes too difficult or frustrating, which is a risk when scaffolding is gradually taken away (Consalvo, 2008). Although some types of cheating can sometimes be allowed (e.g. players working together), it is usually seen as a serious problem that needs to be dealt with in-game, before gameplay is disrupted (Chen & Michael, 2005; Consalvo, 2008). Since cheating often means taking advantage of deficits in game rules in one way or the other, it is difficult to anticipate during game design. Thus, new assessment and data analysis methods are needed to meet these challenges in SGs (Ekanayake et al., 2011; Loh, 2012).

However, as most practitioners realise, winning a game is not the same as proof of learning. Instructors need to have 'proof' that the learners have retained content that is transferable to other contexts and have not just learned how to beat the game (Loh et al., 2007). In particular, there is pressure to find ways to assess learning that are both valid and reliable (Hall & Brannick, 2009; Ketelhut, 2011; Underwood et al., 2010). An assessment method has high validity if it is able to measure transfer from the game environment to the work environment (Mislevy et al., 2012). Thus, it must be based on proper operationalisations of learning and measurement methods that can consistently measure learning (reliability). For instance, measuring learning in a SG by looking at game scores might be reliable, given that the same learner performance will yield the same result. However, game scores might not be valid as a measurement of the kind of learning that the serious gaming activity is aiming for.

7.4 DEBRIEFING AND AAR

Debriefing, or after-action review (AAR), is an essential part of any experience-based learning situation, as it allows the participants to reflect upon and generalise from the training experience (Crookall, 2010; Peters, Vissers, & van der Meer, 1998; Thatcher, 1990). It specifically facilitates reflection-on-action (Harteveld et al., 2010; Schön, 1983) and transfer of training, since the learners are encouraged to make connections between game events and real-world events (Garris et al., 2002; Peters & Vissers, 2004).

Historically, the term debriefing has had different connotations, depending on the context of use. Within the military domain, debriefing aims to provide information about an experience, so that those who have not participated can understand it, or as a way to help a participant, or a victim, cope with trauma (Fanning & Gaba, 2007; Peters & Vissers, 2004). Specifically, it is related to the kind of reporting that occurs after a warfare campaign or the questioning of hostages and other crisis victims (Lederman, 1992). Therefore, the term AAR is more often used for military simulation training (Meliza, Goldberg, & Lampton, 2007). Furthermore, within psychology, debriefing is used to describe the kind of disinformation practice used in psychological experiments, where the participants are informed about the deception afterwards (Lederman, 1992). Within the domain of experience-based training, debriefing is defined as "a process in which people who have had an experience are led through a purposeful discussion of that experience" (Lederman, 1992, p. 146). In the context of GBT, it specifically aims to extend actions during the gaming experience to actions that are applicable in real situations (Kriz, 2010).

When adult learners are being debriefed, the facilitator should be aware that they "have a high degree of pride and may fear a loss of respect as well as reputation" (Ukens, 2007, p. 133). Furthermore, some learners tend to fixate on the negative feedback and ignore the positive, while others do the opposite. This could be due to low self-esteem or low self-efficacy (Backlund, Engström, Johannesson, Lebram, & Sjödén, 2008), or the individual's personality trait in terms of being promotion- or prevention-oriented (Lee et al., 2013). Regardless of which, the goal of the learning experience should be for the learner to view all feedback as guidance for improvements. Moreover, adult learners have previous knowledge, values, attitudes and tendencies that will affect how they will receive, process and assimilate information (Fanning & Gaba, 2007; Ukens, 2007). Although this could pose a potential problem for serious gaming and debriefing, adult learners' previous knowledge and experiences could also prove beneficial in contributing to new ideas and perspectives (Ukens, 2007).

Apart from facilitating reflection, debriefing also serves to check whether participants learned what was intended to be learned, that is, provide summative feedback (Fanning & Gaba, 2007; Hofstede et al., 2010; Meliza et al., 2007). Even if the game has been well designed and perceived as engaging by the learners, it is not enough to create a sense of closure and insight into the larger purpose of the serious gaming session (Fanning & Gaba, 2007; Jones, 1998). Fanning and Gaba (2007) differentiate between simulation sessions in which the learning objectives are well-defined and those where objectives are emergent. With regard to well-defined objectives (e.g. learning a specific technical skill), debriefing aims to close the gap between participants' actual performance and the goal performance (summative assessment and feedback) (Peters & Vissers, 2004). This means that debriefing should be an integral part of SG design (Crookall, 2010; Hofstede et al., 2010) and that debriefing will not cover all aspects of the participants' performance, only the ones that relate to the current objectives (Meliza et al., 2007). For emergent objectives, however, the target objectives are only loosely stated from the start, and the debriefing serves to draw them out by jointly reflecting on the behaviours and choices made during gameplay (Fanning & Gaba, 2007). This may or may not be designed into the game.

Crookall and Thorngate (2009) present three broad types of serious gaming situations that relate to debriefing practices. In the first situation, SGs are primarily designed and used to enable participants to apply previous knowledge in a practical situation. In the second, SGs are supposed to elicit new knowledge based on some concrete experiences within the game. In the third, knowledge and action are integrated. Depending on which perspective of the interrelationship of action and knowledge is in focus, the debriefing activities will be delivered differently. As put by Crookall and Thorngate (2009, p. 18):

> If we believe that the primary 'transformation' is knowledge into action, then we are likely first to teach content and then run a simulation/game to demonstrate how students can apply that knowledge to some practical situation, followed by a light verification debriefing. On the other hand, if we see the essential thrust of knowledge as flowing from action, then we are more likely to plunge students into a simulation with little pre-teaching, and then ask them to relate their experience to real-world situations in a variety of debriefing tasks—talk, essays, research.

From a situated cognition perspective, knowledge and action are interrelated, which can make their argument seem somewhat odd. The way I interpret their use of the terms, however, is that knowledge refers to the abstract conceptualisation part of the experiential learning cycle while action refers to the concrete experiences part (see Figure 6.3, page 62). In the third serious gaming situation, presented by Crookall and Thorngate (2009), debriefing and other learning activities are primarily used to enable or encourage participants to make associations between their actions and the related knowledge.

Debriefing is most often accomplished outside the game, either as intermediate debriefings (formative feedback between rounds or levels) or as a final phase after the game (Peters & Vissers, 2004). It is most commonly held as a focused activity where all participants (learners and instructors) are present at the same time and place, but can also be distributed in the sense that participants are geographically dispersed (Wiese, Freeman, Salter, Stelzer, & Jackson, 2009). The latter situation raises new constraints, since it requires some kind of collaborative technology (Wiese et al., 2009). Furthermore, debriefing can, in theory, be scheduled hours, days or weeks after the actual training session. However, SG literature often states that debriefing is more effective if it is conducted shortly after the event to be debriefed (see e.g. Fanning & Gaba, 2007; Johnson & Gonzalez, 2008). For instance, the serious gaming session might be used to challenge existing beliefs among the learners (Raybourn, 2007), which would be more effective with their in-game behaviours near in memory. Therefore, the term after-action review might be more accurate in describing the practice.

Thiagarajan (1992) claims that successful debriefing is mainly due to two factors: flexibility and the debriefers' readiness to relinquish control to the learners. Fanning and Gaba (2007) describe it as a "a tension between making participants active and responsible for their own learning versus ensuring they address important issues and extract maximum learning during debriefings" (p. 118). This is a skill that facilitators have to learn, both through formal education and performing debriefings together with an expert debriefer (Fanning & Gaba, 2007). Debriefers should view themselves as co-learners and facilitators, not lecturers (by using techniques such as open questions, active listening and silences) (Fanning & Gaba, 2007; Rodrigo & Huang, 2000; Ukens, 2007). Although instructors intend to follow this approach, many find it difficult to follow in practice. Thus, Fanning and Gaba (2007) suggest that facilitators should use regular video recordings at their debriefings for self-appraisals and feedback from fellow instructors in order to hone their skills.

Three other important factors for debriefing are time, a supportive environment and trust (Fanning & Gaba, 2007; Hofstede et al., 2010; Rodrigo & Huang, 2000). It is imperative that participants feel that they can share ideas, experiences and emotions without judgement or fear of losing face or status (Hofstede, 2008). Moreover, facilitators must allow enough time for debriefing, which can take longer than the gameplay itself (Crookall, 2010; Ukens, 2007). Unfortunately, time is often a scarce resource for many educational organisations, which means that not enough time is spent on debriefing. As articulated by (Hofstede et al., 2010, p. 838):

> In spite of the importance that is ascribed to debriefing in most publications, it is usually the first item from which organisers take away time if it is in scarce supply. This is bad practice, as any gaming practitioner can affirm. A good, unhurried debriefing can add enormous benefit to a gaming session, provided that session was a good one with committed participants. If the game run was lukewarm or disagreeable then debriefing can be awkward. If debriefing is organised in an active way with contributions from participants, then its duration is hard to plan. It takes self-confidence for a facilitator to plan a long debriefing session in advance.

According to Petranek, Corey, and Black (1992), an oral debriefing should focus on what they call 'the four Es', that is, events, emotions, empathy and explanations. Moreover, Steinwachs (1992) claims that debriefing usually contains three phases: (i) the description phase, (ii) the analogy/analysis phase, and (iii) the application phase. In the description phase, players describe their experiences and impressions from the game. In the analogy/analysis phase, players discuss key issues from the game, and in the application phase, the players relate their in-game experiences to real-life situations. Thus, debriefing plays an important part in learners' acceptance of serious gaming (Bauman, 2013).

Apart from making sure that the learners take the 'right' message with them and leave the experience without negative feelings, such as anger, mistrust or shame (Jones, 1998), the debriefing session should also have an explicit pedagogical function and be clearly linked to the learning objectives established for the exercise (Peters & Vissers, 2004). Kriz (2010) outlines an ideal structure of six phases for debriefing sessions:

Phase 1: Describe emotions
(How do you feel?)

Phase 2: Describe what happened
(What has happened?)

Phase 3: Relate game to reality
(In what respects are events in the gaming simulation and reality connected?)

Phase 4: Identify learning and challenge mental models
(What did you learn?)

Phase 5: Speculate on alternative scenarios
(What would have happened if ... ?)

Phase 6: Plan goals for future actions
(How do we go on now?)

Stafford (2005) also points out the importance of de-roling, in the sense that the debriefing should also help participants identify in what ways an individual differs from the character or role assumed during gameplay, and which parts of that role should be assimilated and which should be discarded. This should be done during the first phase of debriefing (Stafford, 2005). The six phases should also be seen as a cyclical, iterative procedure, where the participants return to previous questions in order to revise previously gained information in the light of new information obtained during one of the later phases (Peters & Vissers, 2004).

Debriefing can take many forms, the simplest being a discussion between the instructor(s) and the learners. However, as Greenaway (2007) points out, just discussing verbally is not the optimal way of debriefing. He makes a distinction between effective and dynamic debriefing, where the latter "is more than a lively discussion. When a debriefing is truly dynamic, each person is fully engaged in the learning process and has some influence over its direction" (Greenaway, 2007, p. 61). Visual aids and other media play a central role as tools for communication in dynamic debriefing, since some things may be difficult to express with words and/or some participants may not be equally reflective and articulate (Greenaway, 2007; Hofstede et al., 2010). Logs of player activity and diagnostic tools are also important, especially when participants are not able to perceive everything that took place, when they fail to recall, or when they have different opinions about what happened during a specific event (Johnson & Gonzalez, 2008; Meliza et al., 2007). As such, SGs constitute an ideal format for dynamic debriefings, given that they contain some kind of AAR module.

The debriefing session can itself also be turned into a game. For instance, Thiagarajan (1992) proposes a number of frame games for debriefing, called d-games, that is, content-independent games that can be used to support the instructor in structuring the debriefing activities around the different phases described above. For example, the d-game *Take five* centres around a brainstorming activity that is designed to induce the participants to reflect and agree upon what happened, what could have been done differently, and how the experience can be improved (Thiagarajan, 1992). It should be noted that all d-games described by Thiagarajan (1992) are performed as a separate activity from the game or simulation itself. Another approach would be to integrate debriefing within the game engine (see e.g. Backlund et al., 2009; Crookall, 2010; Peters & Vissers, 2004), although some activities, such as de-roling and diffusion of tension, would benefit from a decoupling of the game from the debriefing (Fanning & Gaba, 2007; Stafford, 2005).

Johnson and Gonzalez (2008) outline five steps to ensure that the "the correct lesson [is] conveyed to the correct trainee at the right time" (p. 109) if AAR is automated:

1. The performance must be diagnosed as correct or incorrect;
2. The learner must then be able to recall the performance;
3. The learner is presented with examples of good or expert performance;
4. The learner must then be guided into generalising the behaviour into similar situations;
5. The final division is the assessment of the learner's competence, which will guide further training.

A related issue is self-debriefing, which has gained increasing interest, due to the costs of expert debriefers (Fanning & Gaba, 2007). However, "it is unrealistic to expect even the most self-directed learners to construct knowledge on their own" (Garris et al., 2002, p. 455). Since it has been shown that self- and peer-assessments are often inaccurate, some level of expert guidance seems to be necessary (Fanning & Gaba, 2007), even if debriefing is incorporated within the game.

7.5 CHAPTER SUMMARY

Chapter 6 concludes that the instructor should act as a facilitator or coach, and it has reviewed what the literature says that this entails. Overall, it has provided an overview of the different facilitation techniques used in serious gaming environments, with a focus on scaffolding, scenarios, feedback and debriefing. These techniques constitute central parts of serious gaming and involve careful analysis of the challenges in the game and the learning goals. Scaffolding entails gradually diminishing support to ensure that the learner is able to make progress in the game, while at the same time develop independence and self-regulatory skills. Scenarios provide scaffolding by situating the game within a narrative that drives the game forward. Feedback provides guidance to the learners about the adequacy of their performance and how it might be improved. In order to give feedback, an assessment of the performance with respect to the established learning goals must be completed. Assessment can be fully automated, semi-automated or external (done by the instructor without the support of the digital system). Lastly, debriefing, or after-action review (AAR), provides reflection-on-action and summative feedback.

From the perspective of the research question, the instructor roles can and should be facilitated in a number of ways. First, scaffolding should be a thought-through activity where the learners are forced to practise the intended skills while receiving help with issues less relevant to the current learning goal. This means that the instructor should be able to turn certain scaffolding elements on or off, depending on the specific learning situation. Second, a well-designed SG should include scenario authoring tools with which the instructor can create or modify scenarios to fit current training needs. Third, assessment is a major component of running a serious gaming environment. Thus, it is imperative that SGs include assessment tools for automatic, semi-automatic and external assessments. Fourth, SGs should always include tools for running a debriefing session, even if this is done off-game. The literature review shows that often too little time is spent on debriefing activities, which should, if possible, go beyond merely discussing what has happened during gameplay. Possible AAR tools include visualisation aids, player activity logs and protocols consisting of generic and specific questions to drive and guide the debriefing.

All in all, this chapter has provided insights into important activities that instructors are involved in during serious gaming. Furthermore, it hints at areas in which instructors may need system system support, such as automated assessment and AAR tools for debriefing. Thus, it constitutes a significant step towards reaching Objective 1, as well as the first steps towards synthesising guidelines and success factors for instructor-led serious gaming (Objective 4 and Objective 5, respectively).

CHAPTER 8
INSTRUCTOR-LED SERIOUS GAMING

Chapters 6 and 7 provide a comprehensive account of the qualities and issues concerning learning and training with games. While there is a wealth of studies on the subject, the same cannot be said on the issue of teaching with games, especially in GBT settings with adult learners. This chapter aims to outline the contemporary research on instructor-led serious gaming and its implications for the design of SGs. As such, it aims to examine how contemporary research has dealt with research questions that are similar to the one presented in this thesis. Thus, the literature review presented in this chapter constitutes a significant contribution to the area of instructor-led serious gaming.

8.1 INSTRUCTOR ROLES IN SERIOUS GAMING

As already described in Chapter 6.2.1, instructors can have varying roles, depending on their perspective of learning (see also Table 6.1, p. 66). They also transition between different roles, depending on the current situation, and they may also take on several roles at the same time. Table 8.1 summarises instructor roles mentioned in the literature. The most common role mentioned in SG literature is that of *facilitator*. The terms coach, trainer or tutor are sometimes used as synonyms, although coach is mostly used for the in-game facilitator (Aldrich, 2009). Facilitators provide structure and guidance to a learning experience, rather than providing the correct answers in an authoritarian way (Axe & Routledge, 2011; Bickley et al., 2010; Hofstede et al., 2010; Kirkley et al., 2011; Ukens, 2007). This guidance can be more or less active. For instance, during the introduction or briefing of the game, the facilitator has a key role in making sure that all participants comprehend the notion of serious gaming, which is critical to the learning process (van Kessel & Datema, 2008). The introduction sets the tone and atmosphere of the game, as well as the style of guidance (van Kessel & Datema, 2008). An in-game scripted introduction would most likely be unable to capture these subtle nuances as effectively as a human facilitator, especially in dealing with critical participants, false expectations or group tensions.

The facilitator is also active in another obvious part of a GBT experience and that is in the debriefing. The facilitator role is then as *debriefer*, that is, someone who guides reflection-on-action, assesses the performance, and makes sure that everyone goes away

TABLE 8.1: Summary of the most common types of instructor roles. Please note that some of these roles are not exclusive to instructors. For instance, an IT support technician can also provide technical support, especially for more advanced issues.

INSTRUCTOR ROLE	DESCRIPTION
Facilitator	Provides structure and guidance, motivates and paces the experience, gives feedback and meta-cognitive aid.
Debriefer	Encourages off-game reflection/reflection-on-action by guiding learners in analysing and interpreting their in-game experience and performance, and provides a cool-down event.
Coach or in-game facilitator	Provides guidance and formative feedback as the game is in progress and scaffolds in-game performance (i.e. acts as director, process manager, game master).
Player or participant	An extreme form of in-game facilitator who participates in the game as a player or puckster.
Off-game facilitator	Observes the game's progression from a detached and passive (fly-on-the-wall) position.
Leader	Stays in control of the learning experience without taking an authoritarian position.
Expert	Provides content expertise during the preparation of GBT (e.g. scenario authoring) and in assessing learner performance.
Subject matter expert	Provides content expertise during SG development.
Champion	Promotes GBT practices at the workplace.
Technical support	Provides help with technical issues related to GBT practices.

emotionally unscathed (Aldrich, 2008; Kirkley et al., 2011; Tan et al., 2012; Ukens, 2007). Between-game debriefings also allow the facilitator to "influence the subsequent run of the game by allowing participants to reflect on its progression and to formulate actions for improvement together" (van Kessel & Datema, 2008, p. 187). Thus, the facilitator plays a critical role in the transfer process, by guiding participants towards a reflective practice, in which making connections between the game and the work practices are fostered.

However, with regard to the facilitators' activities during gameplay, the role is less clear-cut and ranges from active participant in the gaming experience to passive observer (Tan et al., 2012). In adult learning, instructors play a pivotal role in facilitating a change in behaviour from a mere acceptable level of performance to one that will excel at work tasks (Bransford & Schwartz, 2009). Or, as put by Kriz (2010, p. 667):

> Some researchers suggest a facilitator is doing well when participants scarcely notice their presence. However, a facilitator must always remain sufficiently active in the background to ensure arrival at an appropriate end point. Additionally, they must be present in a very focused and observing manner to be aware of participants' decision processes and group dynamics. This attentiveness ensures the facilitator can make appropriate regulatory interventions, which is described as a form of "active inactivity"

The *in-game facilitator* or *coach* is able to provide just-in-time information and meaningful feedback (Aldrich, 2008; Bauman, 2013), provide scaffolding by handling some of the learners tasks (Beaubien & Baker, 2004), act as a director or process manager in the learning experience (Frank, 2007; Wagner & Wernbacher, 2013), and has an insider view of the experience that gives depth and legitimacy to the debriefing (de Caluwé, 2008). Thus, the instructor can, by careful timing of events, create situations in which reflection-in-action can occur.

An extreme form of in-game facilitator that is rarely described in SG literature is when the instructor him- or herself takes part in the gameplay. The instructor then becomes a participant alongside the learners, by, for instance, controlling one or several avatars (becomes a puckster). More or less 'disguised' as another player, the instructor can provide guidance without breaking the flow of the game (Charsky, 2010). Of course, from an instructor's point of view, gameplay will be a different experience compared to that of the learners. Instructors take on a role that is related to that of game master, which means they have an almost God-like overview of events and can interfere when the game takes the players in a direction that is counter to the instructional goal of the exercise (Villalta et al., 2011). In contrast, learners only have a limited view of the virtual environment and the events taking place, which reflects the level of information that their role has access to in reality. For instance, a trainee playing as commander will have access to more information than one playing a role with a lower ranking. Instructors, on the other hand, usually have no restrictions tied to their role, no matter what character they play. This can be especially useful if the learners enter gamer mode (Frank, 2012), which could potentially result in learners using methods that work for winning the game, but would be inappropriate in real life. As game master, the instructor could tweak the game in real-time so that learners using a sound strategy would win the game and others would not. Furthermore, a human facilitator is necessary in order to spot and correct cheaters (Consalvo, 2008). Brennecke and Schumann (2009) also point out that letting the instructor join the fun of gameplay will be more motivating for instructors and, thus, increase their acceptance of serious gaming.

The *off-game facilitator*, on the other hand, is able to observe the game unfold, from a detached perspective, which can also be useful during debriefing (de Caluwé, 2008), especially as a counterpart to the participants' own views and inferences (Peters & Vissers, 2004). Thus, the off-game facilitator is more similar to a-fly-on-the-wall instructor role (Hofstede et al., 2010). Consequently, a combination of both roles can be very powerful (de Caluwé, 2008; Peters & Vissers, 2004). It is worth noting, however, that complete detachment from the gameplaying stage, even as a passive observer, is not advisable, since "debriefing is likely to be rather general and abstract, for it is more difficult now to discuss specific experiences of participants or concrete events that did take place. Important to note is that this way to proceed will give participants the impression that their behaviors were highly predictable" (Peters & Vissers, 2004, p. 81).

Another aspect of the in-game facilitator is that different instructors vary in style; some are very active during gameplay, while others let the game run without too many interventions. Van Kessel and Datema (2008), during their study of 59 facilitators, noticed two aspects in which facilitators mainly differed: focus (content or process) and the extent of interventions (many or few). Each combination has its strengths and weaknesses. For instance, the content-focused facilitator who intervenes a lot is able to show all the possibilities of what is to be learned (van Kessel & Datema, 2008). Interventions can, however, break the fidelity and flow of the game, which will be frustrating and, in the worse case, confusing to the learners (Bauman & Wolfenstein, 2013). An instructor who is too controlling may fail to facilitate transfer, by giving the participants the 'correct' answer before they have had the opportunity to reflect upon different solutions themselves, which can thus make the game a frustrating experience (van Kessel & Datema, 2008). At the other end of the spectrum, the process-focused facilitator who lets the game run its course with no or few interventions will teach the participants to change, but will also miss important opportunities for critical moments of in-game reflection (van Kessel & Datema, 2008). Consequently, the in-game facilitator must be able to recognise situations where interventions are appropriate and at the same time know when to let the learners explore the game freely. Finding the right balance helps to pace the game, synchronise the participants, and steer them in the right direction when necessary (Aldrich, 2009; Bauman & Wolfenstein, 2013; Wagner & Wernbacher, 2013).

In sum, instructor-led serious gaming means there is an increased need for instructors with not only high levels of expertise or professional vision, but also able to externalise their knowledge in order to accommodate a culture of cognitive apprenticeship (see Chapter 6.2.2 and Lajoie, 2009). Since formal training for SG instructors is rare, most skilled facilitators have reached their level of expertise through informal channels, such as pure interest or passion for GBT (Bauman, 2013) or through an organisational infrastructure that encourages instructors to share knowledge and learn from each other's mistakes and successes (Axe & Routledge, 2011; Bickley et al., 2010; Henriksen & Löfvall, 2013). This means that existing instructors with interest and competence in serious gaming (so-called *champions*) should be encouraged to share their knowledge with their less experienced colleagues (Bauman, 2013).

Apart from tasks related to didactics, *technical support* is another important role or task for the facilitator, which either falls to the instructor or a separate individual or organisation that deals with the more advanced technical issues (Aldrich, 2009; Sandford et al., 2007). Involving digital games, technical problems will always be an issue that might deter instructors from fully embracing serious gaming (Egenfeldt-Nielsen, 2008).

Lastly, some instructors also take on the role of *subject matter expert* during the development of a particular SG. As such, they are responsible for making sure that the right content is added to the game and that it is represented correctly (Hussain et al., 2010).

8.2 BENEFITS AND BARRIERS

As should be evident by now, the instructor can and does take on many roles as a facilitator of GBT. This has a number of positive implications, such as:

- increased *instructor buy-in* through active involvement in the game production and play (Bauman, 2013; Bickley et al., 2010; Brennecke & Schumann, 2009);
- increased *learner buy-in* and motivation through the presence of the instructor, who legitimises the use of games for serious purposes (Bauman, 2013; Brennecke, 2009; Franzwa, Tang, & Johnson, 2013);
- leverage of *emotional aspects* of serious gaming, such as boosting morale (Hofstede, 2008), decreasing anxiety (Bauman, 2013; Hofstede, 2008), and establishing rapport between the instructor and the learners (Duke, 2008);
- ensuring that *deliberate practice* is achieved by learners who have yet to become self-monitoring (see Chapter 6.2.2);
- avoiding the type of gaming that leads to behaviours unsuitable or even detrimental for specific work practices, such as the behaviours exhibited while in *gamer mode* (see Chapter 6.3 and 7.3.2, and Frank, 2012, 2013);
- forming or reshaping *communities of practice* in which instructors and learners are all participants in creating shared experiences, and the instructors facilitate learning through advice, coaching and other instructor-learner interactions (Aldrich, 2009; Frank, 2007; Leemkuil & de Jong, 2011; Wagner & Wernbacher, 2013);
- enabling *transfer* of knowledge from the gaming context to the work context by explicit learning and reflective activities (see Chapter 6.2.3 and 6.3);
- more *effective learning* through guided discovery and feedback (Kriz, 2010; Leemkuil,

2008; Leemkuil & de Jong, 2011; Mayer, 2004; Moreno & Mayer, 2005; Proctor et al., 2008; Raybourn, 2007);

- decreasing the need for complex and resource-heavy simulations, since the instructor, as in-game facilitator, adds *complexity, noise, and dynamics* (Raybourn, 2007).

Most importantly, instructor involvement leads to more high-quality serious gaming (van Kessel & Datema, 2008). A skilled facilitator is able to make real-time assessments and create an adaptive and dynamic experience that goes beyond the game artefact itself (Frank, 2007; Franzwa et al., 2013; Lee et al., 2013; Tobias et al., 2011; Raybourn, 2007). For instance, Bauman and Wolfenstein (2013) claim that instructors can react in real-time to inappropriate in-world behaviour and appearance, such as bullying or contextually unsuitable (avatar) appearance. This is especially useful for aspects of the gaming situation that have not been hard-coded into the game engine or rule set, but important for the learning experience. There are, however, two sides to this coin. As expressed by Qiu and Riesbeck (2004, p. 171):

> In order to support purely computer-based accurate feedback, the vocabulary of operations and situations in the system has to be specified in advance so that rules can be written. Once deployed, students can only do what the system has been prepared to support. It is considerably harder for instructors, as non-programmers, to modify a computer application when they want to customise it for their courses.

Instructors' lack of programming skills is not the only barrier to instructor-led gaming. SG literature mentions the following barriers or potential weaknesses:

- Even if instructors recognise the benefit of being involved in SG production, they may hesitate in actually becoming involved, due to *time restraints* and *priorities* towards their teaching duties (Tan et al., 2012);
- Instructor-led serious gaming implicates *teacher control* instead of learner control, and facilitators who take a directive role, enforce control, and perform a great deal of hand-holding and micromanagement, which is detrimental to learning and the development of self-regulatory skills (Axe & Routledge, 2011; Bauman & Wolfenstein, 2013; Tüzün, 2006; Walker & Shelton, 2008);
- Interferences *break the fidelity or flow* of the game (Bauman & Wolfenstein, 2013; Harteveld et al., 2010);
- Assessments from human instructors are often *subjective* and comparisons between learners are inaccurate (Ekanayake et al., 2011);
- Increased *costs* in terms of return of investment (Fletcher, 2011), licensing and other expenses (Axe & Routledge, 2011), labour-intensive and time-consuming individualised instruction or coaching (Ekanayake et al., 2011; Stevens-Adams, Basilico, Abbott, Gieseler, & Forsythe, 2010), lack of competent facilitators (Chatham, 2009; Goldstein & Carr, 1977), and increased need for technical and pedagogical support for inexperienced instructors (Brennecke & Schumann, 2009; Gunter et al., 2008);
- Difficulties in adapting games with *fixed content* (Brennecke & Schumann, 2009; Qiu & Riesbeck, 2004);
- Difficulties in *following dynamic gameplay in real-time* (Goldstein & Carr, 1977), at least without additional functionalities that support in-game facilitation;
- Difficulties in providing real-time feedback and support when gameplay is *asynchronous and distributed*, such as during a distance course (Abell, 2000);
- Incompatible learning theories with regard to instructor-led serious gaming, such as ill-defined instructor roles (Frank, 2007), or other *organisational obstacles* (Henriksen & Löfvall, 2013).

The increase in costs is usually considered the most serious barrier to instructor-led GBT and is also most often used as the main argument for instructor-less training systems. For example, Bickley et al. (2010) note that costs are cut by reducing instructor hours. This could, however, prove more costly in the long run. As put by Bauman (2013): “There is often an up-front cost—monetary and human resources—to introducing simulation and game-based learning into and across curricula. Once this infrastructure is in place, neglecting the content, pedagogy, or delivery mechanism can be costly” (p. 94). Thus, reducing instructor hours can also reduce training effects, which will lead to mistakes in the workplace. Since monetary costs related to serious gaming usually affect different cost units and training effectiveness is inherently difficult to translate into monetary values, calculating the cost-effectiveness of instructor-led versus instructor-less GBT will yield different results, depending on assumptions made about the costs involved (Fletcher, 2011).

A further concern is that research into serious gaming practices tends to focus on younger learners, while ignoring adult or elderly learner groups (Frank, 2007; Ke, 2009). Some of the practical challenges for facilitators, which are applicable in most serious gaming contexts, mentioned in the literature are: deciding whether to use SGs and, if so, when to use them (Appelman & Wilson, 2006), difficulties persuading other stakeholders to adopt serious gaming within the organisation (Kirriemuir & Mcfarlane, 2004), finding or obtaining the time to learn how to practise serious gaming (Kirriemuir & Mcfarlane, 2004), identifying which games are available and suitable for the intended learning outcomes (Kirriemuir & Mcfarlane, 2004), monetary, staff and technological restrictions (Backlund & Hendrix, 2013; Bauman, 2013), licensing costs and constraints (Chatham, 2009; Ford et al., 2003), initial efforts in setting up computers and learning the game user interface (Egenfeldt-Nielsen, 2006), dealing with problems concerning usability and user acceptance (Padrós et al., 2011), determining how to practically use games as learning tools (Appelman & Wilson, 2006; Ke, 2009; Schrader & McCreery, 2012), and harmonising SGs with the constraints of the educational setting (Egenfeldt-Nielsen, 2006). Within the military domain, there is also the trade-off between publicly available games (with realistic scenarios) and the risk of terrorists/enemies misusing them (Ford et al., 2003).

There are a number of suggestions to manage these challenges, which can roughly be divided into organisational, technical, and UXD-related solutions. Organisational solutions involve creating an infrastructure that facilitates knowledge management at different levels. For instance, formal and informal structures for educating instructors and encouraging them to learn from each other are needed (Dessne, 2013; Henriksen & Löfvall, 2013; Walker & Shelton, 2008). These efforts should especially focus on understanding the possibilities and limitations of SGs and creating communities of best practices for the sharing of stories (Axe & Routledge, 2011). Knowledge sharing is “the willingness of individuals in an organisation to share with others the knowledge they have acquired or created” (Bock, Zmud, Kim, & Lee, 2005, p. 88). However, knowledge sharing cannot be forced or mandated (Bock et al., 2005); it is a result of trust, attitude, subjective norm and an organisational climate geared towards knowledge sharing (Bock et al., 2005; Lin, Hung, & Chen, 2009). That is, individuals must feel that the act of knowledge sharing will be beneficial for them and reciprocated by other members of their community. Difficulties in knowledge sharing are a well-known issue in knowledge management, but it is still not clear what organisations can do to encourage knowledge sharing (e.g. Alavi & Leidner, 2001; Lin et al., 2009). Furthermore, Bauman (2013) emphasises the importance of instructors engaging in research, in order to exploit the full potential of GBT. In essence, organisational solutions involve making use of the inherent enthusiasm of champions to spread knowledge and increase buy-in, without stifling their enthusiasm through ill-considered reward structures (Bauman, 2013). Another type of organisational solution involves support structures for both pedagogical and technical issues that the instructors might need help with (Bauman, 2013; Bickley et al., 2010), including how to make modifications (i.e. mods) to COTS games (Aldrich, 2009).

Technical solutions gear towards either replacing parts of the human instructor's task with a tutoring system or pedagogical agent, or augment the tasks with technical solutions, such as sensors, logging tools and automatic assessment (see e.g. Aldrich, 2009, for a list of suggested features in SGs). For instance, many SGs utilise non-playable characters (NPCs) to deliver content, tasks, or act as mentors (Charsky, 2010; Kirkley et al., 2011). As such, these pedagogical agents can provide scaffolding and drive the narrative forward (Bellotti et al., 2010; Charsky, 2010). There is also work on the enhancement of virtual agents and human behaviour modelling (HBM) that tries to alleviate the need for human controllers (or 'pucksters') in serious gaming or simulation (see e.g. Clark, 2004; Colonna-Romano et al., 2009). For instance, Colonna-Romano et al. (2009) describe a system where a single human puckster controls a group of virtual agents, instead of controlling every individual avatar. Similarly, Sycara and Lewis (2004) examine multi-agent systems where the virtual agents support human teams in carrying out their tasks. The challenge for these projects is to create agents that model human behaviour as closely as possible, that is, to make human-avatar interactions natural to the point of being almost indistinguishable from human-human interaction. One example is "AutoTutor" (2011), a system that employs natural language to support students learning such subjects as Newtonian physics, computer literacy and scientific reasoning. According to the web site (autotutor.org), the system acts as a dialogue partner with the learner and encourages students "to articulate lengthy answers that exhibit deep reasoning, rather than to recite small bits of shallow knowledge". However, Chatham (2009) notes that NPCs "are today mostly vending machines and jousting dummies" (p. 244) and not very believable as real humans, when interacting with them for more than a few utterances. His statement remains by and large true today (Brusk, 2014). Most adaptive modelling in games is based on ontologies of game entities (objects, NPCs, story elements) that are combined into modules that fit into the narrative (Kickmeier-Rust & Albert, 2009). This means that tutoring systems and other adaptive features are limited to well-defined or quantifiable aspects of the gameplay and narrative, that is, those aspects that can be reduced to algorithms. Although these techniques have proven useful for creating interactive and emergent narratives (see e.g. Bellotti et al., 2010; Kickmeier-Rust, Mattheiss, Steiner, & Albert, 2011), we are still far from creating AI-agents that are as adaptive as human instructors, especially when training leadership, decision-making and communication skills (Thorpe, 2010). Thus, there is a risk that the dynamics of the exercise are lost when pucksters are replaced with virtual agents. Moreover, HBM is an endeavour that many SG developers avoid, due to developmental costs and technological restrictions among the end users.

Technical solutions that aim to relieve some of the cognitive workload put on human instructors seem to be a more promising approach. Most research efforts have focused on automatic assessment systems that are integrated into the game (Bellotti et al., 2013; Stevens-Adams et al., 2010) and many also express the need for more work on AAR tools (Aldrich, 2009; Raybourn, 2007). To give an example, Ekanayake et al. (2011) created an algorithm that assesses driving behaviour in a driving simulator. The algorithm is not only based on the behavioural evaluation of achievement goals, but also accounts for the player's effort towards achieving those goals, such as the physical pressure on the throttle. Some efforts have also been in the area of integrating SGs into learning management systems (LMSs) (e.g. Torrente, Moreno-Ger, Martínez-Ortiz, & Fernandez-Manjon, 2009). More recent research is also focused on supporting teachers in the choice of suitable games, by providing databases for sharing the experiences of using specific games (e.g. Hendrix, Backlund, Lebram, & Lundqvist, 2013).

UXD-based solutions are related to technical solutions, but more geared towards higher-order considerations on how the instructor's tasks can be simplified or augmented. Some researchers have examined the challenge of involving instructors in game production and have found a number of solutions. The common denominator between these solutions is scenario authoring tools. For instance, Brennecke (2009) suggests that a scenario authoring tool could be designed as a game. In a case study, she tested this by implementing a game-based system for crime scene investigation (CSI) training. The idea was to have a cop-and-robber scenario; the teacher would prepare the training session by playing the game as the antagonist, stealing valuable items in a virtual apartment and leaving clues such as foot- and fingerprints. The students were then given the task of investigating the crime scene and trying to 'outsmart' the teacher. The elegance of this idea is that it encourages instructors, who have less technical skill, to create scenarios, since it involves no other skills than playing the game itself. It might also have a positive motivational effect, especially among instructors who enjoy playing games. To deal with the time pressure issue, scenario development could be carried out by a group of instructors. Stiso et al. (2004) outline the development of a Common Instructor Operator System (C-IOS) that supports collaborative and distributed scenario authoring. In order to enable the management of different permissions, that is, who is allowed to alter the scenario at specific times during the development cycle, Stiso et al. (2004) created an instructor hierarchy consisting of (i) the lead instructor, (ii) the element instructor, and (iii) the platform instructor. A single instructor can inhabit one or several of these roles, or several instructors can be allocated the same role. The main idea is to distribute the work load over several individuals and to enable scenario authoring by instructor teams that are distributed over remote sites or whose work is asynchronous. Distributed scenario authoring still assumes some level of technical competence among instructors, and therefore another popular research direction is to develop automatic or semi-automatic scenario generation (Martin et al., 2010). The goal is to relieve instructors of some of the time consuming work, by offering scenario authoring through the 'touch of a button'. Although these solutions still require some scripting skills, the aim is to generate adaptive scenarios from data about player preferences, skill level, game actions, and so on (Lopes & Bidarra, 2011). If successful, these scenarios will be able to adapt to the individual learner's performance, making scenario authoring fully automatic, yet retaining the dynamic nature of manual authoring.

Usability is, of course, a key issue in UXD-based solutions, as well as different interfaces specialised to visualise different aspects of the ongoing gameplay and the learners' performance, such as instructor dashboards or head-up displays (HUDs) and other control tools (Aldrich, 2009). Automatic assessments also need to present measurements to instructors, in a comprehensive and concise way, for use in both formative feedback (e.g. interventions) and debriefings (Stevens-Adams et al., 2010). For instance, Raybourn (2007) highlights the importance of being able to bookmark specific events during gameplay, which the instructor wants to re-play during the debriefing later on. This implies that the system needs to not only include logging functionality, but also access to the logs in real-time, through some kind of instructor interface, where events are clear, distinct and selectable. It also implies that the AAR functionality must be able to re-play recorded events, preferably from different angles (Raybourn, 2007).

Although many instructor tools can be added as features in a system adjacent to the game (e.g. a separate AAR module), I would argue that a more elegant solution would be to integrate these features within the SG itself, if possible. This would make transitions between different instructor roles more fluid and flexible, without the need to switch program or workstation, and also reduce the costs of educating instructors in different systems.

8.3 CHAPTER SUMMARY

This chapter makes a case for instructor-led serious gaming, by providing a comprehensive literature review of the issue. As such, the chapter constitutes the pinnacle of the theoretical background of this thesis. It relies on the conclusions drawn in the previous chapters, such as the importance of the socio-cultural context and off-game activities (Chapter 4); the importance of designing for user acceptance and player experience (PX), where the instructors form a significant target group (Chapter 5); the notion of instructors as facilitators who play an important role in helping learners transfer knowledge from the gaming situation to the work context (Chapter 6); and the different facilitation techniques that can be used in serious gaming environments (Chapter 7). Combining all these conclusions, this chapter focuses on issues directly related to the research question, specifically, the different roles that instructors take on, as well as the benefits and barriers associated with active facilitation in GBT. The chapter concludes with some approaches, proposed by scholars, to overcome the barriers.

In sum, instructors shift between different roles during serious gaming. Their main role is that of facilitator, which in turn has different characteristics, depending on the situation and instructional goal. Key roles identified in the literature are debriefer, coach or in-game facilitator, player/participant, off-game facilitator, leader, expert, and technical support. Apart from the above mentioned roles, some instructors also take on the roles of subject matter expert and champion, which are broader roles used outside the training situation. Thus, the instructor role extends past the here-and-now serious gaming to situations where experienced instructors introduce novices to the serious gaming practices, or are involved in game production. Furthermore, there are many ways of dealing with the barriers to instructor-led GBT, of which I have identified three themes: organisational, technical and UXD-related solutions. Organisational solutions revolve around infrastructures that facilitate knowledge management and knowledge sharing (e.g. reward structures for sharing good practices among colleagues). Technical solutions aim at facilitating instructors by either replacing part of their tasks with an AI-based tutoring system (e.g. virtual agents and interactive narratives) or augmenting them by solutions that reduce cognitive workload (e.g. automatic assessments). UXD-related solutions aim at designing tools (e.g. scenario authoring tools and AAR modules) and visualising data in ways that make instructors' tasks more efficient and enjoyable.

This chapter concludes the theoretical background of the thesis. Objective 1 can thus be said to be fully achieved. In the next part, I present the empirical work carried out to answer the research question.

PART III
CASE STUDIES

CHAPTER 9

ELINOR – A HOME-BASED GAMING SYSTEM FOR STROKE REHABILITATION

In 2007, a project was initiated together with stroke rehabilitation specialists, at the Skaraborg Hospital in Skövde. The main idea of the project was to use gaming as a tool that would motivate stroke patients to continue their training programme and, thus, increase the positive results of the rehabilitation scheme. Rehabilitation refers to a specific type of training or therapy in which skills, lost through disease or traumatic injury, are retrained (Rego, Moreira, & Reis, 2010). Many rehabilitation systems can only be used at the rehabilitation facility and a common problem with rehabilitation schemes is that patients often do not continue their training schedule once they have been discharged from hospital treatment. This, in turn, has a negative effect on the patients' recovery. One reason given for the drop in motivation is that the rehabilitation of coarse motor skills requires repetitive movements that are typically perceived as monotonous. The introduction of a game component to training was expected to enhance motivation (Alklind Taylor, Backlund, Engström, Johannesson, & Lebram, 2009a). During 2007 and 2008, our SG research team, in close collaboration with stroke rehabilitation experts, developed a console for stroke rehabilitation, which was named *Elinor* (Figure 9.1).

This case is interesting for my research question because it constitutes a serious gaming system in which the facilitators (the healthcare professionals) are an integral part – both as subject matter experts during game production and as debriefers in-between gaming sessions. It should be noted that this was a proof-of-concept study and did not explicitly aim to investigate how to facilitate the role of the healthcare professionals during system use. Thus, the case data have been re-analysed in order to identify and describe possible instructor roles in GBT practices (i.e. Objective 2).

In the following sections, I describe the aim of the project, the methods used for developing and testing *Elinor*, and those results that are of interest for this thesis.

FIGURE 9.1: The *Elinor* console for stroke rehabilitation in use.

9.1 AIM OF STUDY

The main goal of the *Elinor* study was to utilise enjoyment and the motivational aspects of games for stroke rehabilitation in a home environment. From the perspective of instructor-led serious gaming, this case was re-analysed with a different aim in mind; to describe the *Elinor* system from the facilitators' perspective, that is, the expected and actual use of the *Elinor* console by the healthcare professionals, including their role(s) as facilitators and rehabilitation experts. Thus, this aim corresponds to Objective 2, as described in Chapter 1.4.

9.2 METHODS

In order to investigate how the *Elinor* system was used by the healthcare professionals, the case data had to be revisited. First, however, it is relevant to present a brief account of the methods used in the original study, in order to understand the type of conclusions that can be drawn from the data collected. Figure 9.2 provides an overview of the methods used in the *Elinor* project, including the subsequent re-analysis.

9.2.1 PROTOTYPE DEVELOPMENT

An iterative and participatory design approach was chosen to test the feasibility of a home-based game console for stroke rehabilitation. Since the project also aimed at exploring the reliability of the system as a rehabilitation tool, and not just that patients *could* and *wanted* to play games as part of their rehabilitation, an experimental type of evaluation was deemed appropriate.

The development process of *Elinor* was conducted as a collaboration project between physical therapists, occupational therapists, a psychologist and computer game researchers with various competences (Alklind Taylor, Backlund, Engström, Johannesson, & Lebram, 2009b). The guiding principles for *Elinor* were that it should be easy to use, be

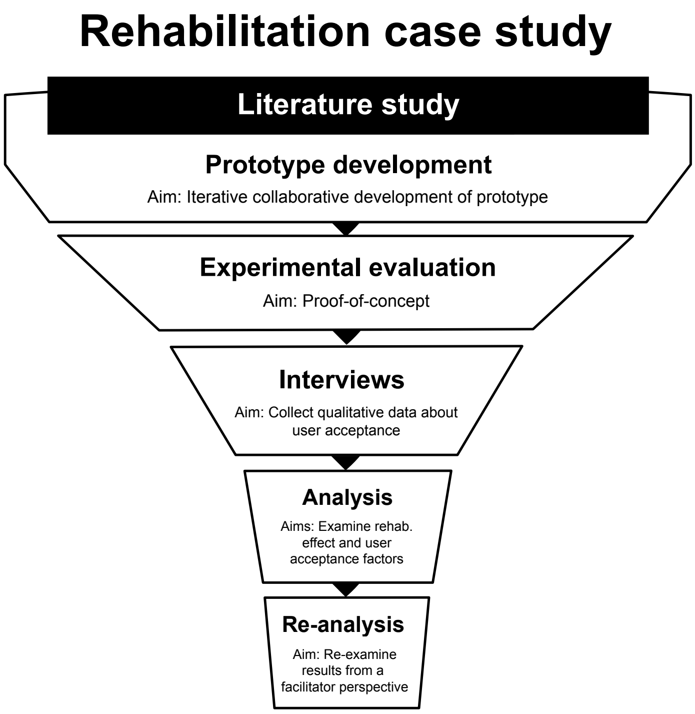
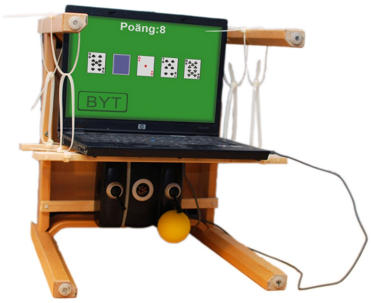


FIGURE 9.2: Research approach in the *Elinor* project.

adaptable to the severity of the impairment, and motivate players to use their weak arm as much as possible. Additionally, a mandatory pause every 15 minutes of gameplay was included, in order to avoid harmful excessive training. The console included fifteen casual games, which were allotted to players according to a schedule, in order to induce a reward structure and reduce information overload for new players.

Prototype development is a useful way of exploring novel concepts related to informatics (Hevner, March, Park, & Ram, 2004). In this case, a participatory design process was chosen, which meant that development was carried out in close collaboration with experts in stroke rehabilitation. Alklind Taylor, Backlund, Engström, Johannesson, and Lebram (2009b) describe the collaborative process in more detail. Figure 9.3 shows the iterative stages of the development of *Elinor*. First, it was important to get the rehabilitation experts (the subject matter experts) to understand the concept of SGs, since none of them had previous experience of such games. Thus, a very simple concept prototype was built using a laptop, a chair and an input device that could track the player's movements in 3D space (Figure 9.3a), in order to quickly acquaint participants with the concept. Two other prototypes (Figure 9.3b and 9.3c) were also built and evaluated together with the experts, as well as a few patients. Formative evaluations included tests of the interaction design, ergonomic issues, usability problems, as well as the overall game design. A last-minute and major change of the third prototype (Figure 9.3c) led to a change in its height.

The final version of *Elinor* (Figure 9.3d) consists of a library of 15 casual games, which require the player to use the weak limb in order to play. Each game requires different arm movements of increasing difficulty. The console also includes stealth assessment (see Chapter 7.3), in the sense that it logs user activities without interrupting gameplay.



(a) 1st concept prototype

(b) 2nd prototype

(c) 3rd prototype

(d) Final version

FIGURE 9.3: Prototyping stages in the iterative development of *Elinor*.

The logs can then be reviewed by the healthcare professional via a diagnostic screen (see Figure 9.4). The diagnostic screen includes data that the healthcare professionals need in order to assess a patient's progress in the *Elinor* rehabilitation programme, such as how often and when the console was used, which games were played, and the quality of the arm movement made for a particular game.

9.2.2 EXPERIMENTAL EVALUATION

The experimental evaluation of *Elinor* has been described in detail elsewhere (Backlund, Alklind Taylor, Engström, Johannesson, Lebram, Poucette, et al., 2011; Backlund et al., 2013; Slijper, Svensson, Backlund, Engström, & Stibrant Sunnerhagen, 2014), and is here only briefly accounted for. *Elinor* was tested on five stroke patients. The evaluation used a before-and-after paradigm, also known as single subject design, where the participants' limb function was tested before the intervention and after five weeks of use. Thus, no control group was used, since the patients were their own controls. This is a common experimental design in rehabilitation research when the availability of participants is scarce or the nature of the injury is highly individualistic, as is the case with stroke patients (Slijper et al., 2014).

After the first test, an *Elinor* unit was delivered to the home of each participant. The participating stroke patients were instructed to play as much as they liked during a five-week period. Once every week, that is, four times, they were also scheduled to meet their physical or occupational therapist, who used a combination of direct observation of gameplay and review of statistics from previous game sessions presented on the diagnostic screen

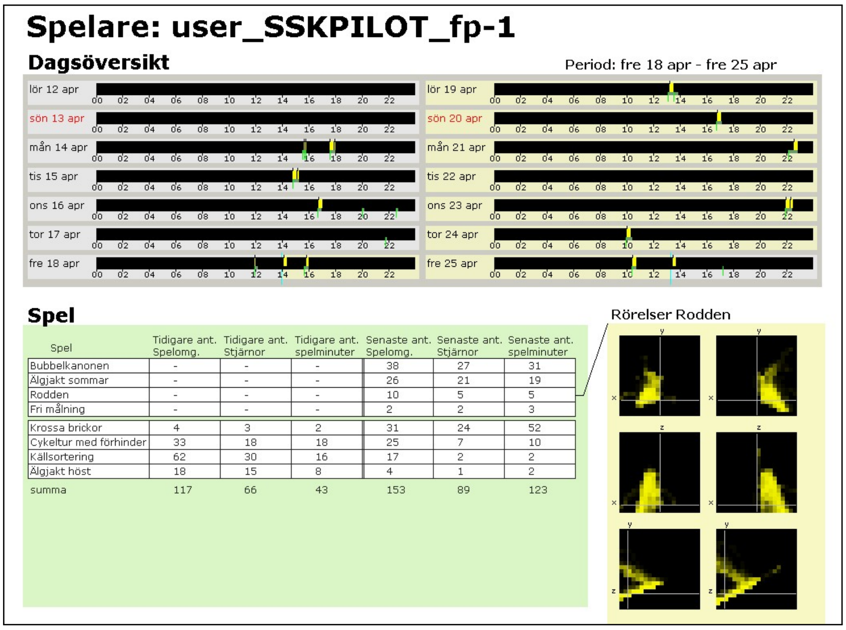


FIGURE 9.4: The diagnostic screen in *Elinor* illustrates gaming behaviour and movement patterns of the patient. The upper part gives a calendar view of player activity. The lower left part shows results for each individual game. The lower right part visualises arm movements that have been conducted in a particular game.

to assess the participants' progress. A representative from the development team was also present during these meetings, asking questions about how the subject experienced the different games. Brief notes concerning the patient's player experience (PX) were taken after these sessions.

9.2.3 INTERVIEWS

In addition to the procedure described above, the participants were also interviewed on three occasions. One interview was conducted and analysed by a psychologist and aimed to explore motivational aspects of the participants' experiences. The other two interviews aimed at studying how the user acceptance (see Chapter 5.3) of SGs for stroke rehabilitation was affected by the use of *Elinor*. Therefore, the participants were interviewed before the intervention and after, to see whether their attitudes had changed as a result of the experience and to explore what aspects of the experience had affected them. These interviews were conducted by myself, but transcribed and analysed by another member of the research team.

A similar set of interviews was also conducted with the two healthcare professionals (one physical therapist and one occupational therapist) involved in the study, since their acceptance was also important for the success of the system. These interviews were conducted and analysed by another member of the development team. All interviews were logged using a voice recorder and transcribed.

9.2.4 ANALYSIS

Since the project was a proof-of-concept study, the original analysis was carried out to determine (i) whether the system is viable as a rehabilitation method, (ii) the quality of the system's game design, (iii) what motivated the patients to use (or not use) the *Elinor* console, and (iv) the level of user acceptance among patients and facilitators. The rehabilitating effect of *Elinor* was analysed by comparing the pre- and post-measurements, as already described in section 9.2.2. The quality of the system's game design was analysed using the GameFlow model by Sweetser and Wyeth (2005). For more information about this analysis, see Alklind Taylor, Backlund, Engström, Johannesson, and Lebram (2009a). Motivational factors and user acceptance were studied by analysing the transcribed material from the interviews. These analyses are described in more detail in Alklind Taylor, Backlund, Engström, Johannesson, Krasniqi, and Lebram (2009), Backlund et al. (2013) and Krasniqi (2008). Since the original analysis mainly focused on the patients and not the facilitators, it is not described in more detail here.

9.2.5 RE-ANALYSIS

A new analysis of the material was carried out in order to examine the *Elinor* system from a facilitator perspective. The analysis was conducted by revisiting the case material and, by means of thematic analysis, finding parts where the issue of facilitation is mentioned. Facilitation was here defined as any task or role that the healthcare professionals take on in relation to the *Elinor* system, which also include their involvement in the development process. Since most material collected concerned the patients' side of the story, data on the healthcare professionals' practices were scarce. Consequently, the main source of data has been the transcriptions from the interviews with the healthcare professionals concerning their user acceptance.

9.3 RESULTS AND CASE CONTRIBUTIONS

The results presented in this section are those from the re-analysis and they focus on the facilitation of stroke rehabilitation using *Elinor*. Results from the original study can be found in Alklind Taylor, Backlund, Engström, Johannesson, and Lebram (2009a, 2009b), Alklind Taylor, Backlund, Engström, Johannesson, Krasniqi, and Lebram (2009), Backlund, Alklind Taylor, Engström, Johannesson, Lebram, Poucette, et al. (2011) and Backlund et al. (2013). The thematic analysis found three overall themes:

- The practice of using *Elinor* during assessment of patients' progress in the rehabilitation programme;
- The participatory design process, in which the healthcare professionals were part of the healthcare expert team and, hence, acted as subject matter experts;
- The healthcare professionals' experience of using the *Elinor* system.

In the following sections, I describe different issues related to these themes.

9.3.1 SERIOUS GAMING PRACTICES USING *ELINOR*

The study conducted in 2008 was a proof-of-concept study, but it does not necessarily present a good overview of how *Elinor* is imagined to be used in practice. First, the console is intended as a supplement to the rehabilitation methods already in use, and not intended as a replacement of any clinic-based therapy, something that both healthcare professionals stressed repeatedly in their interviews. The core idea is to increase the training done at home. Since stroke affects people very differently, the duration for which *Elinor* is used and the frequency of visits to the clinic must be decided on a case-to-case basis by the patient's therapist. Both healthcare professionals interviewed expressed positive attitudes towards the concept of serious gaming as a method for stroke rehabilitation, adding that it is a good solution for patients who find gameplay fun. They also emphasised that it is not a one-size-fits-all solution. As put by one of the healthcare professionals:

> *I believe in variation. When I train, I want to have a lot of variation – to reach the same goal, but in different ways. So I never prepare a repetitive training scheme.*
> (Translated from Swedish)

Thus, serious gaming is seen as one more tool or method that healthcare professionals can use to create a variable and individualised training programme.

The console, in its current version, is used offline, therefore making in-game facilitation and assessment in real-time not an option. It is only during visits to the clinic that the patient can be asked to play a specific game while the the facilitator observes the movements directly. Otherwise, the facilitator is left to interpret the data presented on the diagnostic screen and uses that as a basis for debriefing. One of the healthcare professionals explains:

> *What I do as a physical therapist, it's also to see if the person is able to do the movement at all and in what manner it is performed.*
> (Translated from Swedish)

She also stresses the importance of observing gameplay directly and not leaving patients to their own devices, especially when the games become more challenging:

> *We also see how [the patient] is affected by the increase in speed in the games — that it sometimes is at the expense of the quality of the movement. [...] The aim is of course to also check that the patient understands how the games should be played. So we should be able to see how much the patient has played, and if the patient hasn't played a lot at all — the reasons for that and so on.*
> (Translated from Swedish)

The occupational therapist also commented on the increasing speed of the games as a means to create more challenging gameplay. She believes that challenges should be realised in a different manner:

> *In the world of computer games, difficulty equals faster gameplay. And this is done in some of the games here as well — that it should go faster and faster — and that is not the case in the world of rehabilitation. Faster is not always better. I have a patient who finds it more challenging to just stand still and keep the balance than to start walking and eventually to walk fast.*
> (Translated from Swedish)

Based on the analysed material, it is not possible to determine whether or not the need for direct observation of gameplay is necessary, due to ill-conceived game design in terms of what constitutes challenges, or if it is an essential ingredient independent of the game design. In its current form, however, *Elinor* needs a facilitatory element to make sure that it is used in a manner that will improve the patient's motor function.

Although *Elinor* was not designed for an educational context, some of the design solutions could be translated into a situation involving learners (the patients) and facilitators (the healthcare professionals). For instance, the diagnostic screen (Figure 9.4) allows for asynchronous assessment of performance and the facilitator can carry out debriefings at the clinic on a regular basis. The statistics about how often and when the console was used initially served as part of the data collection for the study itself; however, theoretically, it could also be used by the healthcare professionals to assess the patients' adherence to the rehabilitation programme and as a basis for a debriefing about how the training scheme can be improved. However, the current design of the diagnostic screen is not optimal in conveying movements in such a way that allows the facilitator to assess its quality in relation to the severity of the patient's disability. More work is needed in how the arm movement is recorded and represented in the user interface.

Furthermore, from a social constructivist viewpoint, *Elinor* also serves an important role in re-introducing patients to an active participation in a community. As put by one of the healthcare professionals:

> *I don't have the time, but my patients have of course more time — they have been removed from their surroundings, so to speak, for they have got such a serious disability so they may not be able to work as much as they did before. [...] It's an excellent way to reach a sense of contentment.*
> (Translated from Swedish)

Here, the healthcare professionals have a role as introducer to serious gaming in general and *Elinor* in specific. Being able to train at home and use an engaging activity, such as gaming, to motivate further training is thought to have a positive effect on patients' social life (Alklind Taylor, Backlund, Engström, Johannesson, & Lebram, 2009a).

Another issue was the use of stealth assessment to collect data about the gameplay. While embedding assessment in the game is useful, in order to avoid breaking immersion and flow (Shute, Ventura, et al., 2009), it also has a downside. One of the patients admitted that she sometimes had trouble sleeping, and at these times wanted to use *Elinor* to pass the time. However, she refrained from playing at these times, because she knew that it would be shown in the logs and she thought it would look bad if she was playing games in the middle of the night. Thus, from a broader perspective, even stealth assessment can disrupt gameplay. It further highlights the importance of having a skilled facilitator who has the trust of the patients.

In sum, serious gaming practices using *Elinor* should include a facilitatory element in which the patients' gameplay is observed directly. The diagnostic screen also serves as a tool in finding a training scheme that fits the individual patient. Some patients might be coached in how certain movements should be performed, in order to avoid unnecessary strain, some may be encouraged to play specific games that train specific muscle groups, while others might be recommended a completely different rehabilitation approach. Facilitators take on the roles of introducer, observer, debriefer and coach. The latter is probably most important, since it is in the role of coach that the facilitator maintains trust and can encourage the patient to continue to strive towards recovery. Coaching is, however, dependent on the existence of the other roles; the introducer establishes trust, the observer assesses performance and progress, and the debriefer gives feedback and assesses possible changes to the rehabilitation scheme.

9.3.2 FACILITATOR ROLE DURING DEVELOPMENT

During the development of *Elinor*, both healthcare professionals were involved as rehabilitation experts (henceforth subject matter experts, to be consistent with the instructor roles presented in Chapter 8). One of the healthcare professionals describes their role as having knowledge about medicine in general, their profession in specific, and knowledge about the patients. The experts' main concern was the safety of the patients; interaction with the game should train limb function, not cause harmful muscle tensions. Ergonomic issues, such as the patients' comfort in using the input device and the viewing angle, were a priority.

One of the major issues in the project was to bridge the gap between the healthcare professionals and the game developers (Alklind Taylor, Backlund, Engström, Johannesson, & Lebram, 2009b). Both domains have their own terminology and organisational culture that sometimes caused misunderstandings. One of the healthcare professionals describes it as such:

> *We really had two worlds. The university world with its knowledge and the rehabilitation world with our knowledge, and it was very fascinating to try and merge the*

> *whole thing.*
> (Translated from Swedish)

She also pointed out that there were also structural differences between the two worlds:

> *The university was funded and could do whatever they liked, but we are stuck with patient work and had to negotiate with our superiors who approved our release [from certain work duties].*
> (Translated from Swedish)

A related issue was that the subject matter experts had little to no experience with games. Thus, it was difficult for them to envision a game-based rehabilitation system. Creating a simple prototype early in the development process enabled the team of game developers and healthcare experts to reach a common understanding of the potential of games for rehabilitation. Similarly, the subject matter experts contributed with their expertise on stroke rehabilitation, which prompted further refinement of the system. However, although the iterative process supported the healthcare professionals in their understanding of the potential of games, they did not become fully aware of the system's strengths and weaknesses until it was used in a real situation. One of the healthcare professionals describes her experience with the third prototype (Figure 9.3c) as such:

> *We didn't quite keep up with it because we had our other responsibilities. But I got an idea of how it is supposed to work. And then we gave it back because it wasn't so good.*
> (Translated from Swedish)

The problems that the subject matter experts found with the prototype required a substantial redesign of the console, which the developers considered a major setback for the project. However, the changes also improved the quality of the system, especially from an ergonomic perspective. This shows that the role of subject matter expert is far from simple. The facilitators in this project had to struggle with understanding the system before it was in use, while trying to keep up with their regular work duties. This can lead to misinterpretations, exaggerated expectations, tensions between team members, and project delays.

9.3.3 EXPERIENCES OF USE AND ACCEPTANCE

The original study found that the user acceptance was high for both patients and therapists, results which were in accordance with previous studies on user acceptance (Chesney, 2006; van der Heijden, 2004), that is, perceived ease of use, perceived usefulness and perceived enjoyment are all key factors for the intention of use (Alklind Taylor, Backlund, Engström, Johannesson, Krasniqi, & Lebram, 2009). Krasniqi (2008) also points out that it is important to allow facilitators to become acquainted with the system at their own pace, since this would allow them to give patients correct and meaningful advice and feedback. In the interviews, both healthcare professionals mentioned that they did not have access to a console other than during the patients' visits to the clinic. One of the healthcare professionals commented on the disadvantage of not being able to become acquainted with the *Elinor* system:

> *We have been present at these clinic visits, but we haven't gone into details about how to analyse the movements. We haven't learned that. Now it is time again, but lately we haven't had these USB sticks so we can play ourselves. That's a downside, I think.*
> (Translated from Swedish)

A further related issue is that the facilitators felt pressured by their peers to show the system. One healthcare professional explains:

> *You know, my colleagues know that I'm involved in this game. And now they are even more aware because the patients are visiting. So they are even more curious. What are you doing? What does it look like? Can't you show us just the one time? And we can't show anything right now.*
> (Translated from Swedish)

Thus, it seems important to allow colleagues to try out the system, in order to increase buy-in in the workplace. This is in accordance with the findings of Bauman (2013) and Tan et al. (2012), as reported in Chapter 8.

9.4 CHAPTER SUMMARY

This chapter has outlined a study exploring the use of a gaming system for stroke rehabilitation called *Elinor*. As part of reaching Objective 2, the chapter tries to identify and describe facilitator roles that are linked to the development and use of the system. It also describes related issues that affect facilitation of *Elinor*, such as user acceptance. It should be noted that the facilitator role was not a focal point in the original project, so the conclusions are based on a re-analysis of the material. This means that the results are skewed towards the available material and do not represent a comprehensive picture of the facilitator roles that are or could be realised within the *Elinor* system.

All in all, four facilitator roles were identified in the re-analysis: introducer, observer, debriefer and coach. The introducer is responsible for suggesting serious gaming as a possible training approach. Thus, *Elinor* and other game-based systems for rehabilitation supplement other methods; they are just one more tool in the healthcare professionals' tool box, but have the advantage of engaging patients who enjoy playing games.

Although *Elinor* is designed to be a home-based system, direct observation of gameplay by a facilitator is necessary, in order to assess patients' progress and performance. Consequently, the facilitator roles of observer, debriefer and coach should be a natural part of a GBT system and included as such in a framework for instructor-led serious gaming (Objective 3). To support these roles, *Elinor* has a diagnostic screen that shows statistics over the individual patient's gameplay. However, more work is needed before the diagnostic screen can be said to fully support all facilitator roles. For instance, one flaw identified in its design was the visualisation of arm movements to support assessment of their quality and improvement.

Another issue is trust; facilitators play an important role in establishing and maintaining trust. When stealth assessment is implemented, some patients might experience it as a breach of privacy and only a skilled facilitator can alleviate these negative emotions.

Furthermore, subject matter experts play a critical role in SG development, in order to ensure good mapping between challenges in the game and in the real world. In the case of *Elinor*, some games should have used precision rather than speed to control a game's difficulty level. The role of subject matter expert has many challenges, however. Cultural barriers and lack of time for testing prototypes are two challenges identified in this case study. It is crucial that the subject matter experts develop an understanding of what the system actually entails and how it will affect their work practices. In retrospect, more time should have been spent trying to bridge the gap between the healthcare specialists and the game developers in the *Elinor* project.

Similarly, once delivered, the system should be available to facilitators and their colleagues, to be used as a learning tool for novice facilitators and to encourage a community of practice (CoP) for serious gaming. This is assumed to help facilitators fine-tune their roles and increase user acceptance of game-based rehabilitation.

CHAPTER 10

TACTICAL INCIDENT COMMANDER – AN ONLINE GAME FOR INCIDENT COMMANDER TRAINING

During 2009–2011, I participated in a project conducted at the University of Skövde in collaboration with the Swedish Civil Contingencies Agency (SCCA). The SCCA is responsible for augmenting and supporting societal capacities in preparing for and preventing emergencies and crises (www.msb.se). Part of this is educating and training rescue personnel, such as fire-fighters and incident commanders. In the project, we developed a game for training incident commanders that we also tested during one of their courses. Incident commanders are responsible for tactical decisions and directing the tasks of individual fire-fighters during an incident, such as fires, chemical leaks and other events that require emergency responders (Toups & Kerne, 2007). The game was simply named *Tactical Incident Commander*.

This case constitutes a further step in reaching Objective 2, that is, to identify and describe instructor roles during different phases in current GBT practices. In this case, we aimed to introduce new serious gaming practices at the SCCA, based on theories of social constructivism and experiential learning (see Chapter 6.2.1). Thus, Objective 2 will only partly be reached, since the SCCA did not have 'current' GBT practices, but had a need to develop new ones. In the following sections, I describe the project with a special emphasis on those aspects that relate to instructor roles and GBT practices.

10.1 AIM OF STUDY

The overall aim of the project was to: (i) study how SGs can enhance the educational environment, (ii) empirically test and analyse the use of game technology, in order to make recommendations for the construction of training simulators, and (iii) create a basis for the development of SCCA training techniques, through collaboration between researchers and practitioners. As part of this work, we developed a framework based on social constructivism and experiential learning. A secondary aim was to investigate a novel pedagogical model for GBT based on specific learning principles. It is this aim that is in focus in this chapter, since it directly relates to the research question.

10.2 METHODS

As with the *Elinor* project (Chapter 9), a participatory design process was employed, where subject matter experts were responsible for the educational content and participated in design workshops (see Figure 10.1). The subject matter experts were instructors who previously used different multimedia and simulation technologies as part of their curriculum, but had little or no experience of games as training tools. The game was also iteratively tested with students before being included in a course.

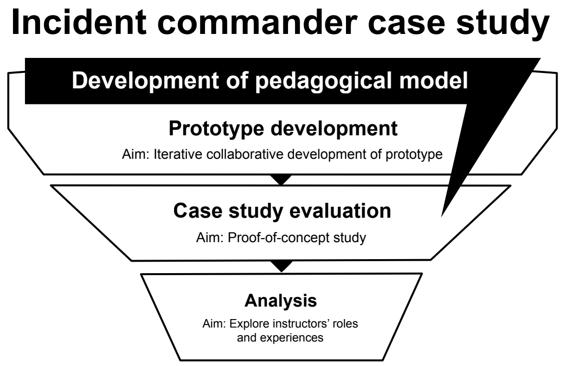


FIGURE 10.1: Research approach in the SCCA project.

10.2.1 PROTOTYPE DEVELOPMENT

The developer group consisted of nine researchers from the University of Skövde, although not all were involved during the whole project. The researchers came from various backgrounds, such as informatics, cognitive science and educational science. Most of us had been involved in a similar project where a CAVE-based system for smoke diving, called *Sidh*, was developed and successfully implemented as part of the educational programme for fire-fighters at the Swedish Rescue Services Agency (SRSA) in Skövde (Backlund et al., 2009, 2007; Lebram, Backlund, Engström, & Johannesson, 2009). Interestingly, the instructors at the SCCA found new ways in which *Sidh* could be used that went beyond the developers' first idea. The system had first been developed to be used without the supervision of a facilitator and included an in-game debriefing module for self-assessment; however, once the system was in use, the instructors enhanced it and envisioned scenarios where the instructor plays important roles. For instance, one suggestion included the addition of radio communication and that an instructor could act as incident commander requesting information from the smoke divers (SRSA Skövde, 2008).

Given the success of *Sidh*, we wanted to extend the system based on these suggestions. However, after extensive discussions, including a large workshop aimed at introducing rescue services personnel to serious gaming, it was decided that, instead of building upon the *Sidh* framework, a completely new game should be developed. The new game was to be incorporated in a distance learning course for novice incident commanders. This resulted in the following constraints and requirements:

- The game must be playable online using the computers that the learners already have at their disposal at their workplace or home. Thus, it must use simple graphics and simulations, in order to run smoothly on non-gaming hardware.
- The game should be used to educate fire-fighters about their (new) role as incident

commanders, which includes a change of focus from operative actions to tactical and strategic ones, such as handling resources during a fire or other emergencies.

- The instructors should be able to view the performance of the players and also run specific scenarios together with the learners, as part of their examination procedure.

Due to these requirements, we decided to devise a web-based game with 2D graphics to reduce the computational demand. As an interdisciplinary team, we were able to divide responsibilities according to our set of skills. For instance, my main contribution to the project was the development of a pedagogical model (described below). I also assisted in the user tests and conducted interviews with the trainees and instructors. The iterations and work flow have been described in Swedish by Alklind Taylor, Backlund, Bergman, et al. (2012). In short, the iterative work on the prototype began in June 2010 and continued until August 2011. During that year, four design workshops and two (formative) evaluation workshops were conducted with representatives from SCCA. We also had regular contact with subject matter experts from the SCCA to ensure that the learning objectives were correctly implemented into the game, and to draw up plans for how it would be used in practice. In autumn 2011, the game was incorporated into an introductory course for incident commanders and its use was evaluated.

10.2.2 PEDAGOGICAL MODEL

As mentioned in the previous section, the game was to be implemented in a distance learning course. Although distance learning allows for more flexible learning, it is often employed as a way to reduce costs; if learners train at home, cuts can be made in terms of facilities, expensive equipment (e.g. computers, simulators), technical staff and educators. However, as Wood, Douglas, and Haugen (2002) point out, the reduction in costs might not be as great as anticipated, especially at the start-up of e-learning programmes. Yet, distance learning also has advantages that make it a preferred solution over classroom lectures, such as flexibility, that is, learners can learn wherever and whenever they want (Abell, 2000), and accessibility, that is, it provides an opportunity for learners who live far from the training facility and/or cannot travel due to economic or personal issues (Wood et al., 2002). Nonetheless, even in distance learning, learners cannot be left to their own devices; instructors "must continually work on approaches to making the course interesting, timely and relevant" (Wood et al., 2002, p. 673).

One of the main objectives of the game was to help learners progress from the mind set of fire-fighters to that of incident commanders. This included moving from an operative way of thinking to a tactical one, as well as using the vocabulary of incident commanders. We found the learning frameworks of experiential learning (Kolb, 1984) and community of practice (CoP) (Wenger, 1998) useful as a basis for the pedagogical model (see Figure 10.2).

An assumption was that the trainees were already situated in the work practice of fire-fighters, but were required to enter the new CoP of the incident commander. The game must therefore fulfil a number of requirements to support a pedagogical agenda derived from CoP theory and experiential learning (Alklind Taylor, Backlund, Bergman, et al., 2012):

- The game should support the possibility for participants to create their own scenarios based on personal experiences and work as fire-fighters. This includes the localisation of scenarios to the individuals' own organisations;
- Players should be engaged in a constructive approach, not only as players, by building their own scenarios into the prototype. Thus, they become a writing community as they share work-related scenarios to solve 'authentic' problems;

- Players should be challenged to add relevant information, in detail, based on correct terminology, to be shared within the community of incident commanders;
- Players should be able to debrief former experiences as they share scenarios in a CoP;
- The prototype should foster leaders to consider critical situations as authentic, since these are created by themselves, by other trainees, or qualified incident commanders.

Furthermore, *Tactical Incident Commander* was intended to provide support for flexible and distance learning, in order to be useful in a new training institution supporting geographically diverse organisations with varying regional conditions. The final pedagogical model comprises seven activities (Backlund, Alklind Taylor, Carlén, et al., 2011):

Activity 1: *Introduction.* The instructor demonstrates how to play the game and how to analyse scenarios. The learners are encouraged to play through one or more predefined scenario.

Activity 2: *Debriefing.* The instructor, as a more experienced incident commander, discusses the logs and scenarios together with the learners, either on an individual basis or in groups. The learners can also be given tasks to analyse specific aspects of the scenarios together with other learners and an instructor.

Activity 3: *Scenario authoring.* The instructor encourages the learners to create their own scenarios, either imaginary ones as worst case scenarios, or based on the learner's own personal experiences.

Activity 4: *Gameplay.* The learners play and comment on each other's scenarios. The learners can also improve their own scenarios, based on the comments they receive from their peers.

Activity 5: *Live exercises.* Field training and training in physical simulators complement the training carried out with *Tactical Incident Commander*.

Activity 6: *Examination.* Summative assessment is carried out by a combination of activities, such as oral and written reports and practical applications of course content. In its current form, *Tactical Incident Commander* does not support overall examination, but can be used as part of an examination unit. For instance, the instructor can use the assessment tool to analyse and assess the learners' performance.

Activity 7: *Class discussion.* At the end of the course, the instructor can lead a class discussion, based on a selection of the learners' scenarios. Some scenarios can also be saved for future use in forthcoming courses, in order to build up a body of relevant knowledge for the community.

The final version of *Tactical Incident Commander* comprises three modules: a scenario player, a scenario authoring tool and an assessment tool (see Figure 10.3). The scenario player (Figure 10.4a) contains functionality for the player to enact a previously specified scenario and take on the role of the incident commander. The session starts when the incident commander trainee is on his/her way to answer an alarm call. The player receives some initial information from the call that will make it possible to start planning the mission. Planning should be conducted from a tactical point of view, in order to secure resources necessary to solve the problem. Throughout the game, the player has access to a continuous news feed with information about the status of the accident. As the scenario unfolds, it is possible to monitor and adjust resources. There is an underlying model for how fire spreads; although crude, it means that the same scenario can be enacted in different ways.

The pedagogical idea behind the scenario player is to train higher order planning as-

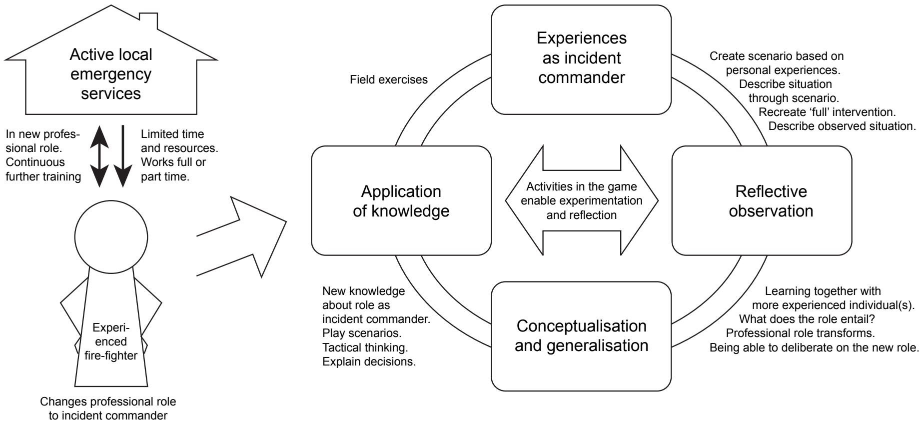


FIGURE 10.2: The pedagogical model of the *Tactical Incident Commander* game. Adapted from Alklind Taylor, Backlund, Bergman, et al. (2012, Appendix 7).

sociated with the role of incident commander. It is important to point out that this is not a tool for training exact procedures at an operational level, such as how to extinguish a fire. Tactical decisions instead concern the short to medium term coordination of activities and the deployment of resources needed to reach a particular goal. Some examples of tactical decisions to take into account are the ability to plan ahead in resource management, the ability to collect and organise information from the scene of the accident, the ability to set up and work towards a specific (sub-) goal, and the ability to deploy resources for operations. The scenario player follows the experiential learning paradigm in that the player has to carry out these tactical decisions and react to their consequences. The player can also replay the same scenarios, in order to experiment with different tactical approaches.

The scenario player is instructor-less, since the learners are encouraged to play in their own time. The instructor role is passive, apart from instructing the learners to play the game and providing support when needed (by answering questions posted on the course forum, via email or similar communication channels). Thus, the instructor role is that of off-game facilitator. Of course, the instructors should also acquaint themselves with the game, and then have a player role as preparation for facilitation.

Next, the scenario authoring tool (Figure 10.4b) provides a stepwise procedure to create a playable scenario. In most SGs, which include a scenario authoring tool, the scenario authoring is done by the instructor. However, the *Tactical Incident Commander* game introduces a novel concept in which the learners create scenarios on their own and share them within their player community. The instructor role here is either as technical support or coach, depending on whether the learner has problems navigating the user interface or needs guidance on how to create a good scenario. In addition, the instructor can also create scenarios and, then, has the role of scenario author. This role differs slightly from the corresponding learner role, since the goal is a pedagogical one instead of experimental. That is, while the learner uses the scenario authoring tool to experiment with the concepts relating to incident commanders, the instructors create scenarios that relate to specific learning goals, for example, creating situations that are known to lead to erroneous judgements and therefore need more training and reflective thinking.

The first step in the scenario authoring tool is to select the facing of the target building. There is a standard selection of buildings, but it is also possible to upload photos. The second step is to select a site for the accident (i.e. localisation) via Google Maps. The

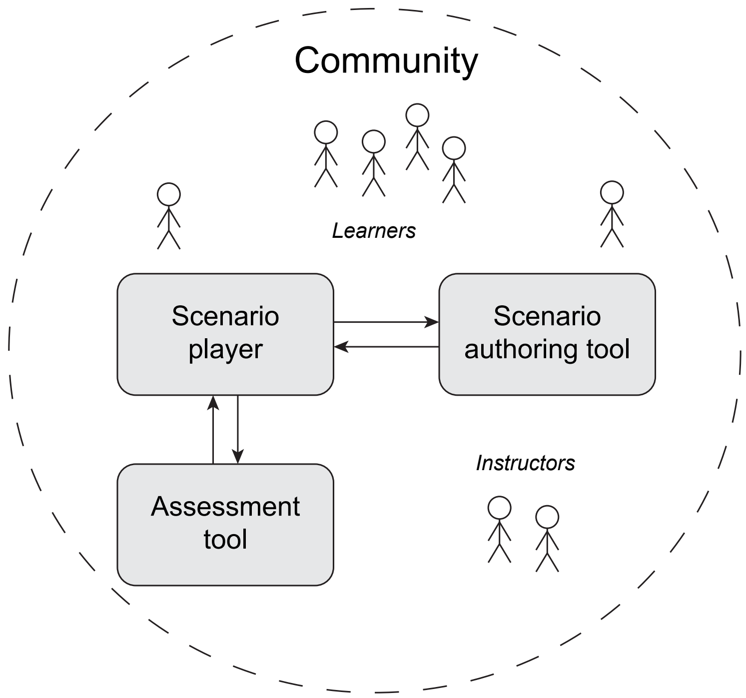
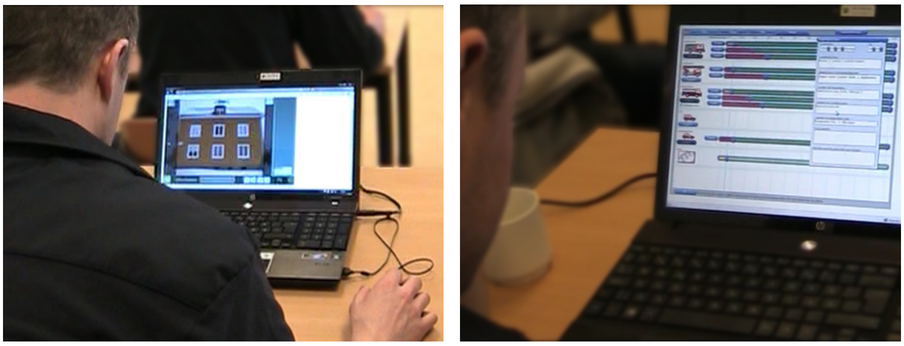


FIGURE 10.3: Overview of the *Tactical Incident Commander* game. Both learners and instructors are active in scenario authoring and, by sharing scenarios within the community, they establish a shared repertoire.

scenario author selects a building where the fire takes place and plans the surroundings with respect to the type of existing buildings (e.g. residential, or shopping area, etc.) and their specific properties. The third step involves adjusting the facing for all four sides of the target building. This includes adjusting the size and position of the windows with which the scenario player can interact. The fourth step involves creating the plan arrangement and locating victims. The scenario author should also estimate the amount of combustible material (by choosing from a pre-selection of standard rooms) and prepare items of information which will be distributed to the player, depending on how the scenario unfolds. It is also possible to place hazardous materials and explosives in the building. Finally, the available resources should be defined and distributed over a timeline. The author of a scenario decides when resources should be available and how long it will take to access them at the scene of the accident, by adjusting the slide bar. It is also possible to place additional items of information on the timeline. All scenarios are stored on the server for access to other users. Thus, the instructors can, for instance, create a scenario and ask the learners to play through it as preparation for a seminar or lecture.

Scenario authoring and sharing by learners corresponds well to the social constructivist theory of learning (see Chapter 6.2.1). Thus, *Tactical Incident Commander* can be said to be a situated SG (see Table 6.1, page 66). According to Razak et al. (2012), constructing a meaningful product, such as a game, will allow for more effective learning of problem solving skills and creativity. In the process of creating a game, the learners have to reflect on the relationships between different aspects of the game, instead of merely taking part of the 'lessons' embedded within games (Razak et al., 2012). Alessi (2000) calls this



(a) Learner playing a scenario (b) Learner creating a scenario

FIGURE 10.4: The *Tactical Incident Commander* game in use by a learner.

a glass-box approach, since it entails that the underlying game model is transparent to the learner. This, of course, requires that the game is designed in such a way that the concepts used for scenario authoring are closely linked to the learning objectives. For procedural training, a glass-box approach might not be relevant (Alessi, 2000). When learning how to drive a car, for instance, the inner workings of a car or a car simulator are, by and large, irrelevant to the task of driving it. In the *Tactical Incident Commander* case, however, we wanted the trainees to use the scenario authoring as a basis for discussion and knowledge sharing (Backlund, Alklind Taylor, Carlén, et al., 2011). Thus, the concepts and terminology presented in both the scenario player and in the scenario authoring tool are highly relevant for incident commander professionals. Consequently, the instructor acts as a more experienced peer, who contributes with his or her experiences to encourage reflection and discussion.

A source of inspiration for the concept of scenario authoring in this model is modding. Creating mods can be viewed as meta-gaming (Salen & Zimmerman, 2004; Scacchi, 2010) and involves modifications, such as customisations to the user interface, creating new missions or creating completely new games from existing game engines. Thus, modding is a broader activity than scenario authoring, although the latter could be said to be a type of modding in certain circumstances (e.g. when scenario creation involves scripting or other types of changes to the structure of the game). Modding and similar creative activity around a game can be viewed from a learning perspective (Hedberg & Brudvik, 2008; Monterrat, Lavoué, & George, 2012). Learners and instructors can construct and tailor different aspects of a game and, in effect, take a more active part in the learning situation and create a mutual engagement within their CoP. As Squire (2008) has shown, even learners with low technical skill can move from being mere players to becoming experts and eventually taking on the role as designers.

A third component of *Tactical Incident Commander* is the assessment tool (see Figure 10.5). It is only accessible to the instructors and provides an overview of decisions made during the scenario enactment. It can display different aspects of the scenario and is useful for both individual walkthroughs and debriefing sessions under the supervision of an instructor. Since the game is intended to be used in a distance learning course, in which the learners can play whenever and wherever they like, the instructor cannot follow gameplay as it is taking place. Thus, in-game facilitation in real-time is not possible. The design of the assessment tool was based on information gathered during workshops with the subject matter experts. It provides support for professional discussions about the decisions made during a session. All sessions of play may be stored to form a library

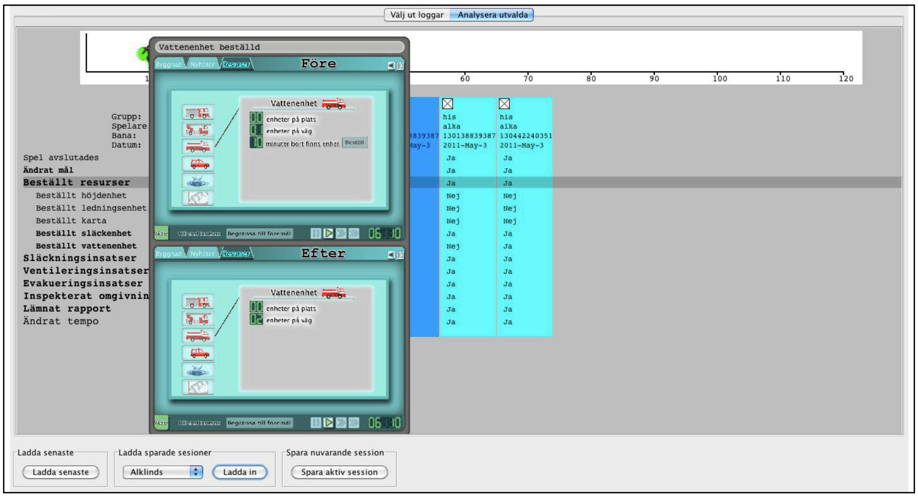


FIGURE 10.5: Screenshot of the assessment tool in *Tactical Incident Commander*. In this instance, the instructor has chosen to upload several playthroughs of the same scenario and compares different actions taken (background table). A specific scenario is chosen (dark blue column). The instructor has also chosen a moment on the timeline (at the top of the screen) in which the learner has ordered resources. The tool states which resources were ordered (left hand side of screen) and also what was shown on the learner's screen at the time (the overlaid window).

of scenario enactments. The instructors can select sessions, compare them with respect to different actions taken and make notes in preparation for the debriefing. As all actions are time-stamped, it is also possible to examine them more carefully, in order to analyse the actual sequence in more detail. In using the assessment tool, the instructor takes on the roles of assessor and debriefer.

Lastly, we also discussed the possibility of using *Tactical Incident Commander* as a replacement for one of the examination procedures that the instructors had developed during a previous course. This procedure was based on a slideshow[1] in which the instructor had developed a scenario with predetermined events. Interaction was made possible by the instructor, who responded to the learner's decisions in each slide by showing a new slide based on a rudimentary action tree. The scenario player in *Tactical Incident Commander* mimics this situation, but with added interactivity and some randomness to account for the unpredictability of fires. The idea was also that the game would add more realism and empathy compared to the slideshow. In this, the instructor would fill in contextual information and act as an opponent.

Since the instructor wanted to run the examination in real-time, we suggested that the game could be played by the instructor within a web conferencing tool, which is how the original slideshow was used. This procedure allows the instructor to share his or her desktop with an individual learner and pause the game at critical events, asking the learner what he or she would do and the reasons for their decision. The procedure also minimises the instructors' workload in learning the pedagogical model, since it makes use of existing practices.

[1]The slideshow included screenshots from *Fire Studio* (Digital Combustion, n.d.), a visualisation program used by the SCCA in on-site lectures and examinations.

10.2.3 CASE STUDY EVALUATION

Tactical Incident Commander was evaluated as a case study, where the game was implemented as part of an introductory course for incident commanders, which was held during the autumn term of 2011 by the SCCA in Sandö, Sweden. The course had 24 enrolled students and two instructors, one of which had participated as subject matter expert during the development of *Tactical Incident Commander*. To support the instructors, we developed a written guide on how the game was to be used. We also included instructions on how to present the game to the learners. In addition, we held a half-day workshop where the instructors tried out the different modules and were presented with the pedagogical model. Data collection was then conducted within the context of use, by logging user activities. After the course was completed, we asked the learners to fill in a web-based questionnaire, conducted telephone interviews with learners and instructors, as well as collected essays that the learners had written about the gaming assignment. The questions in the questionnaire and interviews concerned how the learners and instructors had experienced the use of *Tactical Incident Commander*, in terms of its usability, engagement and pedagogical value. The instructors were also asked about their views on their roles in the course segments in which the game was used, as well as what kind of support they needed in order to use the game within the course.

10.2.4 ANALYSIS

Once the data had been collected, we analysed how the game had been used by both learners and instructors and whether it had been used in the intended way. The overall analysis had a broad scope and is described in more detail in Alklind Taylor, Backlund, Bergman, et al. (2012). The analysis of the instructors' roles and their experiences of using *Tactical Incident Commander* is mainly based on the telephone interviews, since the logs showed limited activity by the instructors in the scenario player and authoring tool. One of the instructors had played the game once and the other had played it twice. None of them had used the scenario authoring tool or the assessment tool. The analysis was carried out in accordance with Objective 2, that is, utterances regarding instructor roles were marked and categorised into the contexts in which they are applied. Other issues related to the instructors' experiences and attitudes were also noted, since they can contribute to the overall research question.

10.3 RESULTS AND CASE CONTRIBUTIONS

The results presented in this section are the results of the analysis that concern the instructors, such as their roles in using *Tactical Incident Commander*, their role as subject matter expert during game development, as well as other aspects related to instructor-led serious gaming. Since some of the analysis of the instructors' experiences can only be understood in the context of the overall results, involving the learner perspective, some of these results are also presented.

10.3.1 EVALUATION OF THE PEDAGOGICAL MODEL

In the current case, the game was developed to be used as a basis for discussions among the learners and among the instructor and the learners. However, the instructors did not engage in discussions with the learners in relation to experiences of playing the game or creating scenarios. Based on their answers in the interview, this was due to the fact that they had not been given sufficient time to familiarise themselves with the game and the activities in the pedagogical model. One instructor explains:

> *A bit more preparation would have been better for the whole game project. We didn't*

> *have time to try out the game and reflect and then have an extra half-day [workshop] or something. It turned out to be one week left before the course began and by then we had our hands full in preparing that stuff. Then when [the learners] started to play and create [scenarios], questions started to pop up, such as 'what was this thing again?' and then you have to sit down and point and click yourself instead of talking about it in a different manner.*
> (Translated from Swedish)

Thus, the instructors felt like novices in handling the game, which also led to a superficial use of it; they were more concerned about how to do something in the game than discussing concepts presented during gameplay. In this case, both the instructor and the learners were expected to build and share scenarios. However, creating good scenarios is far from trivial; it requires both domain knowledge and knowledge about the capabilities of the scenario authoring tool. Participants found it difficult to reuse someone else's material, especially if there were no clear notes about the educational purpose of the scenario. They also did not perceive scenario authoring and sharing within *Tactical Incident Commander* as a means to share experiences. As a consequence, there is a risk that the same scenarios will not be reused in different exercises. If the scenario authoring tool is easy to use, it is often faster to build a new scenario from scratch, instead of figuring out the pedagogical purpose of a specific scenario.

Furthermore, the examination procedure was never implemented due to the fact that the game lagged as a result of poor broadband connections. To deal with this problem, the instructors decided to use the original slideshow for the examination instead.

Due to these deviations from the original case design, the pedagogical model was never fully implemented. Thus, it is difficult to adequately evaluate it. We still believe that the model is sound, but instructors need more resources and guidance, in order to take active part in the learning activities (Alklind Taylor, Backlund, Bergman, et al., 2012).

In the following sections, instructor roles and issues extracted from the interviews with the instructors are presented. These issues give some insights into why the pedagogical model failed to be implemented and how the instructors viewed their own role in relation to *Tactical Incident Commander*.

10.3.2 SERIOUS GAMING PRACTICES USING *TACTICAL INCIDENT COMMANDER*

As mentioned in the previous section, the instructors took on a passive role in relation to *Tactical Incident Commander*. On the question how the game has changed his work practices, one instructor answered:

> *It hasn't really been that different since they [the learners] have worked pretty autonomously. What was different was that they had one more task to do and a little bit more to reflect upon. That has probably been a positive contribution — even if it hasn't worked to a hundred percent in the game, they've had to think things through when making their own games.*
> (Translated from Swedish)

One possible interpretation of this quote is that the instructors do not see their role as important for the learning process. However, both instructors mention giving feedback and follow-ups as key components of the learning process, which fits with the role of coach, as described in Chapter 8.1. Since the learners worked mostly by themselves, feedback from the instructors was mainly given during the examination. Furthermore, the instructors mentioned that their role is to put the learners into different situations that force them to reflect rather than follow a routine. One instructor said:

> *We put them in different situations. Simulations. Games. Also more theoretical parts. A common problem is that you work from some kind of routine. Then you only focus on the routine rather than the envisioned result you want to achieve.*

(Translated from Swedish)

The other instructor also mentioned that this change in thinking is gradual and must be accompanied by continuous feedback:

> *In all examinations there is feedback where we try to steer and give advice on what we find. It sorts itself out when we steer the examinations — makes them think more holistic as leaders and especially as incident commanders. Over time, they let it [routine thinking] go more and more. Different cases and representative examples of incidents during their journey makes them develop this [tactical thinking] overall.*
> (Translated from Swedish)

The instructors' reasoning accords with the concepts of routine and adaptive expertise, described in Chapter 6.2.2. In other words, the instructors see their main roles as (i) finding a broad set of cases and (ii) coaching learners to develop adaptive expertise. In addition, both instructors mention counterplay[2] as an important part of coaching. One of the instructors describes counterplay as such:

> *We use the slideshows in the examination and then we can pose counter-questions and check what they mean by different things. Then we control the speed, so to speak. [...] One can pause and discuss.*
> (Translated from Swedish)

The other instructor suggests how this might work using the game:

> *It would of course be desirable to be able to get all these factors by the press of a button. 'Okay, now he makes this decision that is based on an understanding of something' — so I only press a button and get the desired effect. Now, you have to do the counterplay yourself and assess their decision. But you have to get at how counterplay could be handled automatically. That's the crux of the matter. What I have done now is to make an action tree — that you have a number of alternatives depending on what the learner decides to do. You always have to assess the decision; what is possible and not.*
> (Translated from Swedish)

In short, the instructors want to be able to control the turn of events, based on their assessment of the learners *understanding* of the situation and not solely on their actions. They also do not believe that this should be achieved automatically:

> *This aspect of posing these questions — that, I think, the learners themselves experience as good. I don't know how to change that and I also don't understand why one couldn't have a person doing the counterplay.*
> (Translated from Swedish)

This reluctance of letting the game do the counterplay also seems to stem from the instructors' own positive experiences of doing this task, which they feel is threatened by the introduction of the game into their instructional practices. As put by one of the instructors:

> *I really don't have a need for [counterplay] to be so automated. I think this dialogue that you have with the learner, and listen to [answers to the questions]: 'How do you reason?' 'On what do you base your decision?' 'What do you actually see?' I think it is really fun to pose these questions. I think it would a shame to exclude that aspect, because you realise that it is most often when you debrief that most [learning] occurs.*
> (Translated from Swedish)

A further instructor role suggested by the pedagogical model is that of introducer, since the learners might need help in using the scenario player and authoring tool. The instructors admitted that they did not feel comfortable enough with the game to take on this role, but recognised its importance. As stated by one of them:

> *When you're not sure how it works and how to create [scenarios] and what possibilities there are, then it is difficult to introduce and run it.*
> (Translated from Swedish)

In sum, the instructors see themselves as taking an active part in GBT, but fail to see how

[2] Translated from the Swedish word 'motspel'

this could be achieved within the context of *Tactical Incident Commander*. Instead, they react by becoming passive and fall back on the practices with which they feel comfortable. The instructor roles derived from the interviews are coach, in-game facilitator (to achieve counterplay) and debriefer. A derived role is also introducer.

10.3.3 INSTRUCTORS' EXPECTATIONS AND BUY-IN

Since the instructors had failed to follow the pedagogical model, a large portion of the interviews was spent on what they thought was expected of them, as well as their views on the game and its use in incident commander training. It was clear that the instructor who had not been involved as subject matter expert during game development expected a different type of game:

> *I probably had higher expectations, I think, to be able to build games with a set of events, like in* Fire Studio. *[I] thought this was a bit more bulky. [...] It can also be that I didn't have time to familiarise myself one hundred percent with this game from the start. I didn't have time to familiarise myself with the scenario authoring.*
> (Translated from Swedish)

Thus, not being involved in the development process and not having enough time to acquaint himself with the game and the pedagogical model seem to have led to this instructor's unrealistic expectations of how the game works and is used. Both instructors criticised the game for lacking realism, both in terms of the environment and in the course of events, and that this made the game unsuitable for assessments. As stated by one of the instructors:

> *It becomes very difficult if you don't have this realistic environment and you ask how someone has interpreted a situation — 'What do you actually see and what do you understand?'*
> (Translated from Swedish)

The game certainly had a simple fire simulation model, but was never meant to be used as a stand-alone product or a fully-fledged simulation. The game's low degree of both physical and functional fidelity was a conscious design decision, since fire suppression is highly unpredictable and, thus, difficult to simulate. Instead, the game focused on psychological fidelity. The instructors' assertion seems surprising in light of the fact that they used a slideshow with still images for the examination and that the design of *Tactical Incident Commander* was, to a large extent, based on that slideshow.

In the *Elinor* case, we had learned that working with inexperienced subject matter experts is challenging. Thus, in this case we made a more explicit effort to acknowledge the design process as a mutual learning process in which the designers learn about the domain and, more importantly, the subject matter experts learn about the possibilities of serious gaming. Despite these efforts, we found it challenging to get subject matter experts who are inexperienced with games to understand the difference between games and the simulation and visualisation systems currently in use in their organisation. A further complication within this project was that the teaching staff varied, which led to a lack of continuity in the design process.

Another issue related to instructor roles in GBT is technical competence. Although the instructors involved in this project did not explicitly mention their own level of competence, some statements indicate that they were not comfortable enough with the game and unsure about their own technical ability to use it efficiently in the course. More specifically, in our discussion with the participants from the SCCA, we noticed that the instructors were concerned with the technical competence among the learners. According to them, most incident commander learners have limited IT and gaming experience. Therefore, GBT might be too alien for them to be effective. Our study showed that this was not the case. The usability was good enough for the learners to quickly advance in the game and they rarely complained about not understanding its goal (Alklind Taylor, Backlund, Bergman, et al., 2012). Rather, the problem was that the game never became an integrated part of the course – contrary to what we had intended from the beginning.

One possible reason why the instructors showed a low degree of acceptance for *Tactical Incident Commander* was that it was difficult for them to see the game's possibilities as a learning tool. One of the instructors suggested that the game might be useful in other parts of the course, but that it is difficult to pinpoint which parts, due to his lack of familiarity with the game:

> *And that's my limitation — what you can actually do — I've no clue. And perhaps it should be used for other aspects, for example resource planning, that we discussed. One should take a holistic view of the course and pick out — 'these aspects could be good and we could do it this way' — and just redo certain aspects altogether. What is imperative is that we meet the course objectives.*
> (Translated from Swedish)

This instructor's realisation is interesting, since, from the beginning, we had argued that serious gaming should be seamlessly integrated into a course and not used as a standalone activity. However, the quote indicates that we failed to communicate this to the instructors.

In sum, not being involved in the development process of *Tactical Incident Commander* and, more importantly, not having sufficient time to familiarise themselves with the game, led to an inefficient integration of the game into the course and a low user acceptance of the game as a useful training tool. The instructors felt unsure about the game and their own ability in facilitating gameplay and scenario authoring. The fact that at least one of the two instructors also expected the game to be similar to the visualisation programme already in use also shows the importance of explaining the difference between games and simulators and different types of fidelity (see Chapter 4), as well as how games can complement simulation training rather than using them in the same manner. For instance, *Tactical Incident Commander* was not intended to be used as a simulation, but as a basis for discussion about the role of incident commander.

A lesson learned from this is that instructors need support, in terms of resources, to acquaint themselves with the game and guidance on how to use it in a specific setting.

10.4 CHAPTER SUMMARY

This chapter has outlined a study exploring the use of games for training incident commanders. As part of reaching Objective 2, the chapter aims to identify and describe instructor roles related to the use of the game *Tactical Incident Commander*. It also presents a pedagogical model in which the instructors take part in the learning activities as experienced participants of a developing CoP. What differentiates *Tactical Incident Commander* from many other SGs is that a main component is for the learners to create scenarios of their own that can be shared and played by others (Alklind Taylor & Backlund, 2011). The project offers an example of the development of a SG that is explicitly based on specific learning theories, namely, social constructivism and experiential learning. It aimed at having explicit and dedicated instructional design activities during development, such as working towards a solution in which specific learning theories guide the development of the game and its intended use, as well as exploring the concept of scenario authoring.

The instructor roles identified in this project, both from the pedagogical model and the empirical material, were subject matter expert (during game development), introducer (at the start of the course), game player, scenario author, in-game facilitator, technical support, coach and debriefer. In practice, the roles of in-game facilitator, coach and debriefer overlapped, since the instructors mainly gave feedback to the learners during the examination. During gameplay and scenario authoring, the learners were left to their own devices, mainly due to the instructors' uncertainty about the game and their own competence to facilitate it.

Evaluation of the pedagogical model turned out to be challenging, because the instructors did not follow our instructions, they did not create their own scenarios and failed to engage in discussions with the learners about the scenarios. Consequently, an important result from this project is that instructors need extensive support to familiarise themselves with the game, in order to use it efficiently within an educational context. This includes resources in terms of time and availability of other, more experienced peers (e.g. through organised workshops or more informally, as in the *Elinor* case). They also need guidance on how to implement the game in a specific setting. These aspects of the project constitute a step towards reaching Objective 4, that is, identify and describe challenges for instructor-led GBT.

The project also provides some insights into methodological issues when using case studies to evaluate a serious gaming concept. The user tests that we performed focused mainly on the scenario player and scenario authoring tool, but the assessment tool was never tested in a naturalistic situation before being implemented within the course. In hindsight, this was a mistake, since a large portion of the instructors' tasks, that is, analysis of learners' activities within the game, was, in effect, ignored. Although the instructors base most of their assessments on how the learners answer specific questions about how and why they made their decisions, the assessment tool should be designed to guide instructors in finding game events to ask questions about. Unfortunately, the case study did not collect data that could be used to evaluate the assessment tool's usefulness in this regard. However, the insights could be used in reaching Objective 4.

Both this and the *Elinor* project represent cases in which my interest in the facilitatory aspects of serious gaming took form. The reactions from the healthcare professionals in the *Elinor* project and the instructors in this project contributed to understanding the challenges facilitators face and the different roles that they take on when SGs are implemented into their work practices. The next step in reaching Objective 2 is studying instructor-led serious gaming practices in an organisation which already has SGs implemented and the instructors have experience in using games for training.

CHAPTER 11

GAME-BASED TRAINING PRACTICES AT THE SWEDISH LAND WARFARE CENTRE

In the previous case studies, I have investigated instructor roles in settings where the facilitators were inexperienced in serious gaming. In this chapter, I instead present a case study conducted in an organisation that has used SGs and simulators for many years and, thus, has time to develop a repertoire of how to use games effectively for training. The chosen organisation for this study is the Swedish Land Warfare Centre (SLWC). At the SLWC, simulations and GBT are still, by and large, instructor-led.

The study described in this chapter represents the main case study of my PhD work. It differs considerably from the projects described in Chapters 9 and 10 in that it does not involve the development of a SG and I alone carried out the data collection and analysis. In the following sections, I describe the aim of the project in more detail, the methods used for eliciting instructor roles and GBT practices, and results that are of interest for this thesis. The results of this study have been reported in Alklind Taylor (2010), Alklind Taylor and Backlund (2011), Alklind Taylor and Backlund (2012), Alklind Taylor, Backlund, and Niklasson (2012), and Alklind Taylor and Backlund (submitted).

11.1 THE SWEDISH LAND WARFARE CENTRE

The SLWC educates cadets and response units in ground warfare for national and international missions (forsvarsmakten.se). Specifically, they are devoted to the command and tactical training of individual soldiers, squads and platoons, as well as command and control training at the battalion and company levels for army units (Dessne, 2012). They utilise a number of simulation systems as part of their curricula, including:

- the virtual platoon trainer for tanks and combat vehicles (BTA),
- the virtual command and situation trainer (StriSimPC), equipped with SGs such as *VBS2* (Bohemia Interactive, n.d.) and *Steel Beasts Pro* (eSim Games, n.d.),
- the mobile combat training centre (STA), and
- the command and control training facility (LTA).

Training is conducted at different unit levels: individual (1 soldier), squad (4–8 soldiers), platoon (3–4 squads), company (100–300 soldiers) and battalion (500–1500 soldiers). Normally, training is concentrated to one or two of these levels, that is, when training battalions, focus is on strategic thinking in commanders and the training system simulates individual soldiers.

Training is a mix of physical training, theoretical coursework, field exercises and simulation training. How much of the individual cadets' education that is carried out in a simulation- and game-based training environment very much depends on their unit instructor's buy-in of the concept of GBT and, consequently, differs from group to group and year to year. A unit instructor is responsible for a unit's military education and plans their curriculum based on the organisation's current needs. For this type of organisation, simulator- and PC-based training is considerably more cost-effective than field exercises (Chatham, 2009) and is therefore encouraged by managers. Simulations also differ in terms of the technology used. The SLWC has a wide range of training practices, from live role-playing to high-end simulation facilities. PC-based SGs, which are my main focus, fall somewhere in the middle of that range. Each training facility employs a number of system operators and technical staff. A system operator is an administrative role given to an instructor, which, for instance, entails creating new scenarios and running the system during simulation. System operators and technicians assist the unit instructor in preparing and running the game- or simulation-based exercises.

11.2 AIM

The overall aim of the project was to identify and describe instructor roles and GBT practices at the SLWC. As such, it constitutes a considerable step towards reaching Objective 2. Issues pertaining to challenges and advantages for instructor-led serious gaming were also noted, thus contributing to reaching Objectives 4 and 5. Furthermore, insights gained in this study have contributed considerably to the development of a framework for instructor-led serious gaming (described in Chapter 14). Thus, this study also represents a step towards reaching Objective 3.

11.3 METHODS

The project was initiated at the start of 2009 and ended formally in December 2013. Apart from theoretical work, it involved documentation and characterisation of current work practices pertaining to GBT at the SLWC. The methods chosen for this study were those commonly used for interpretive research, such as participant and non-participant observations, informal interviews, and questionnaires. Figure 11.1 presents an overview of the steps taken to understand instructor-led GBT practices at the SLWC. The funnel shape represents scope or focus during each step, and the 7-shaped literature study activity, running parallel to the empirical fieldwork, represents the abductive approach, where established theories are used as both initial background knowledge and as a guide to understand phenomena encountered in the field (see Chapter 3). At the same time, empirical data are used as a selection tool in finding relevant literature (Dubois & Gadde, 2002).

Initial visits and participant observations were used to delimit the research problem. Thereafter, more focused data gathering techniques were needed. Video recordings of training sessions complemented by interviews with instructors were chosen as appropriate. More thorough observations provided contextual data on training practices and the interviews served as further insight into the instructors' reasoning regarding GBT.

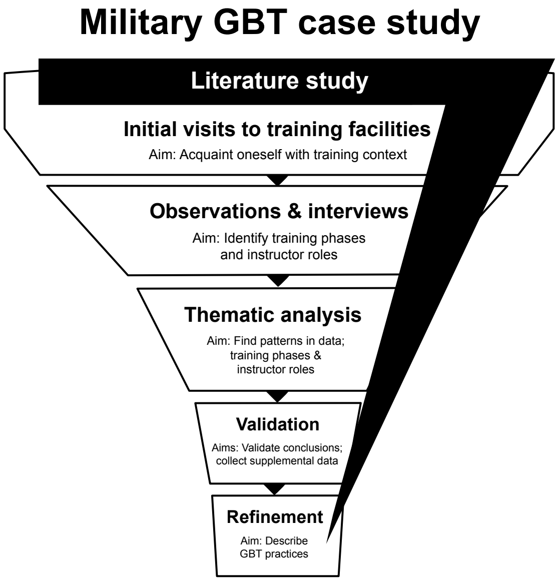


FIGURE 11.1: Research approach in the SLWC project.

11.3.1 OBSERVATIONS AND INTERVIEWS

The purpose of the initial visits to the training facilities was to become acquainted with the SLWC in general and the simulation facilities, including their training practices, in specific. Initially, I did not focus on a specific area, instead I kept an open mind and looked for aspects and clues that seemed interesting and/or important. I strove to become familiar with the 'culture' (thus being able to spot distortions within that culture), as well as establish trust between myself and the people studied, in order to increase the credibility value of later findings, as recommended by Lincoln and Guba (1985). I especially looked for aspects that were either confirmatory or contradictory when comparing field notes to the theoretical knowledge obtained through literature. This is similar to the work of the ethnographer, when he or she looks for 'rich points' (Agar, 2008), that is, unexpected occurrences that lead to a deeper understanding of the phenomena. During the visits, I took field notes and talked to the participants. Dialogues mainly occurred with the instructors, due to the fact that cadets were deeply involved with the simulation and, thus, inaccessible during actual training. For instance, at the BTA, cadets were mostly inside a simulator cabin and, at the STA, they were out in the field, only visible to the instructors as symbols on a virtual map. This probably influenced my inclination to study the instructors instead of the cadets.

Table 11.1 provides a summary of the training facilities visited. I spent approximately one day at each facility, slightly more at the BTA and slightly less at the STA. Training was carried out most of the time during these visits, with the exception of a second visit to the LTA, which was part of a demonstration of the facility.

Once acquainted with the training facilities, an understanding of the training practices emerged from more observations. As the SLWC has many training facilities with different types of simulations and games, the study needed to be delimited to a select few. Since the focus was on serious gaming rather than simulation-based training, two facilities were chosen for further inquiry: the BTA and the StriSimPC. These were selected due to their apparent connection to computer games and gaming, including game tech-

TABLE 11.1: Training facilities at the SLWC.

TRAINING FACILITY (LOCATION)	SWEDISH NAME (ABBREVIATION)	GROUP SIZE	SIMULATION TECHNOLOGY
Virtual platoon trainer for tanks and combat vehicles (Skövde)	Besättnings-träningsanläggning (BTA)	Small groups (tank crew/cadre and platoon levels)	High-end armed vehicles and tank simulators and PC-based simulators
Virtual command and situation trainer (Kvarn)	StridssimuleringPC (StriSimPC)	Varying (squads, platoon and company levels)	PC-based SGs (*VBS2* and *Steel Beasts Pro*)
Mobile combat training centre (Skövde)	Stridsträningsan-läggning (STA)	Varying (squads, platoon, company and battalion levels)	Laser-based direct fire weapons effect simulator
Command and control training facility (Skövde)	Ledningsträningsanläggning (LTA)	Large groups (battalion level)	A mix of live action simulation and low-end simulators

nology. According to Agar (2008), this is sampling based on events. The selection of facilities does not imply that no game characteristics are incorporated into the training at the STA and LTA. However, gameplay is restricted to role-playing and the simulators mainly serve to monitor and control the simulation (e.g. monitoring where groups are on the map, calculating damage during battle, and so on). Furthermore, both STA and LTA conduct large-scale simulations, making data collection difficult for a lone researcher. Thus, convenience sampling (Lincoln & Guba, 1985) was also employed.

The most obvious delimitation is the choice of StriSimPC as a setting of interest, since they use PC-based SGs for training. Furthermore, BTA was chosen as a result of the training activities observed during the first visits to the facility. Although BTA constitutes a more 'traditional' simulator, characteristics of play emerge in the way training is carried out. For instance, the instructors may include elements of competition and scoring as part of certain training scenarios, in which the cadets play against each other instead of, or in parallel to, the AI-controlled enemy. The two facilities also constitute two different types of instructor-led GBT. At StriSimPC, training is conducted in a classroom setting, where the trainees are observable by the instructors. At the BTA, the trainees are instead situated within simulator cabins and instructors have to rely on information from the system to gain a sense of what the cadets are doing.

Participant observations are especially useful for understanding practices. In a participant observation, the researcher not only observes the situation from afar, but also partakes in (parts of) it (Agar, 2008). This enables the researcher to gain access to knowledge only available to those that actually act within the setting. For instance, Williams (2005) points out that game researchers should actually play games themselves. Furthermore, Walsham (1995, 2006) stresses the importance of making a conscious choice between researcher roles, as either outside observer or involved researcher. Although participant observations have been used extensively in this study, it should be noted that the observations were participatory in the sense that I took part in some of the practices myself (tried some of the training scenarios) and also actively put questions to the participants during observations (Agar, 2008). Since I have no military background, I cannot step into the role of instructor or cadet without disrupting the training session. Thus, there is little doubt that I was there as an 'outsider' and not as a member of the training staff or learners. This had several strengths and drawbacks. First, the members of the community being observed did not see me as someone having a personal stake in the interpretations and outcomes of the observations. This is an advantage, since participants tend to be more open in expressing their views when trust and rapport have been established between them and the researcher (Walsham, 1995). A drawback of this researcher role is that it will only gain access to a limited part of the field, both in the sense of time spent on site and access to high-security and confidential resources (Walsham, 1995). Thus, the insights gained from my participant observations will be lacking an 'inside perspective' of the practices observed.

There were several opportunities to participate in activities related to GBT. First, I was asked to step in as driver during one of the training sessions at the BTA. Then I was invited to join an event arranged annually at the SLWC, in which Nordic military personnel and civilians (e.g. politicians, journalists, etc.) meet to learn more about the SLWC organisation and to train in the simulator at the BTA. During this event, I had the chance to play several scenarios as crew commander and gunner. The last participant observation was during a two-day training-course (in which I participated for one day) for system operators going to Afghanistan to train soldiers on-site using *VBS2* (Bohemia Interactive, n.d.). None of the system operators had played *VBS2* before, which gave me an opportunity to learn how to play the game, how to create a few simple scenarios, and how to set up a training session.

Interview material was gathered both formally and informally, in order to gain a deeper understanding of the observations. The informal interviews were conducted in connection with the observations, either before or during training, or during breaks. The latter was most common. Not all of these interviews were recorded, but notes were taken instead, as soon as possible thereafter. Taking notes during the informal interviews disrupted the flow of the conversation, so only key words (e.g. specific military terms) were noted at the same time. Some interesting aspects were also brought up during times when note taking was not possible, such as during lunch or walks to and from the mess hall. Questions asked were those that emerged from the immediate context, such as what was happening and why. Instructors were also asked to voice their opinion on GBT in general and instructor roles in particular. A formal interview (approximately 2.5 hours) was also conducted with the two heads of the BTA, with whom I had gained rapport. One is mainly responsible for the tank combat simulator and the other mainly for the combat vehicle crew trainer. They both have the roles of instructor and system operator during training sessions. The interview was unstructured; I steered the respondents toward a topic and then let them express their views. The main topics were: training practices relating to simulation training, their roles in relation to simulation- and game-based training, their views of the instructor's role, their views on feedback during training (both from instructors and automated), and their view of artificial intelligence in games. During the interview, the respondents also provided me with examples of previous training plans to give me more insight into the kind of material system operators base their scenarios on. As a consequence, part of the data collection also included documentation.

11.3.2 ANALYSIS

A total of 11 hours and 42 minutes of video material was collected during three observations (two at the BTA and one at the StriSimPC). Before every observation, I would write down key words and goals that would help me focus recordings on those details of main concern for the research problem. These 'sensitising concepts' (Patton, 2002) are needed, because it is not possible to observe and record everything going on in the situation. Examples of the sensitising concepts used in this study are: instructor roles, training procedures and routines, training phases, and gaming behaviours. Occasionally, situations arose that I had not anticipated when writing my list, but still found recording them valuable.

A thematic analysis (Patton, 2002) of instructor roles and training practices was carried out using *Transana 2*, an open source software to transcribe, analyse and categorise data from audio and video recordings (Woods, n.d.). Not all recorded material was transcribed, only those parts that contained verbal information of direct interest for the research question. Interesting scenes and utterances concerning aspects related to training phases and instructor roles were sorted into categories. Once a clip had been identified, it was allocated to one or more 'collections' that group together clips that have some common theme. These themes arose from the analysis, but were similar to the sensitising concepts.

Training phase categories that emerged were preparation, renegotiation, briefing, training ('offline' and 'in-game'), break and debriefing (in whole group and in separate groups). The emerging themes for instructor roles were lecturer, observer, scenario author, in-game player or puckster, live role-player, technical support and debriefer.

11.3.3 VALIDATION AND REFINEMENT

The conclusions made from the observations and interviews were validated in several ways. First, the material was discussed with several case study participants, as well as other researchers, resulting in ideas being both refined and validated. Furthermore, the conclusions have been validated through an extensive questionnaire. The data from the validation were used to iteratively refine the conclusions drawn. They were also a valuable input into the developing framework for instructor-led serious gaming (Objective 3).

The validation questionnaire was web-based (requiring a password to access) and available online for a five month period. A complete list of the questions used in the validation questionnaire is presented in Appendix D. As can be deduced from the list, the questionnaire included both structured and unstructured questions about the respondent's experience with and attitudes towards GBT, divided into eight categories:

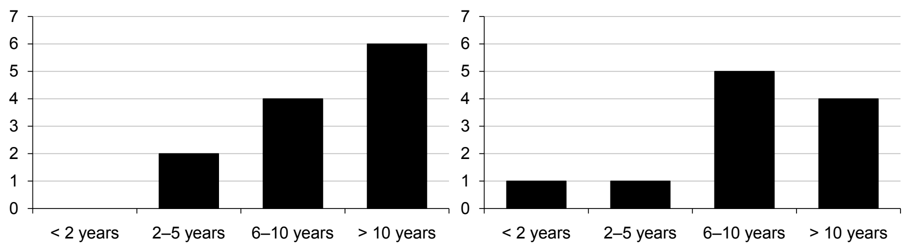
1. Experiences as instructor in the context of gaming and simulation exercises
2. The instructor role
3. Scenario authoring
4. Briefing/information before the exercise
5. Aspects of the ongoing exercise
6. Evaluation/after-action review (AAR)
7. General information about game- and simulator-based training
8. Other information

More specifically, the questions were selected to (i) validate assumptions made from the observations at the SLWC, and (ii) gather demographic data about SLWC instructors' attitudes towards using games for training, as the observations indicated that there is no coherent view on this issue among them.

Most questions were presented as statements using a 7-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (7) and also included a 'don't know' option. This type of question was chosen because it allows the respondent to give a nuanced response without having to give a lengthy answer in free text. However, some questions also had a follow-up question that asked the respondents to explicate the answer using their own words. For instance, the question 'I often use scenarios created by other instructors', which was answered using the 7-point Likert scale, was followed by the question 'Why/why not?', which was answered in free text. This option was given for those questions to which the answer was assumed to be difficult to interpret, or where a statement would be considered a leading question (e.g. 'I use scenarios created by other instructors because [presumed reason]').

A challenge in creating a validation questionnaire such as this is to make it concise, that is, not so many questions that respondents are deterred from answering, but still exhaustive enough to be able to validate as much of the framework as possible. Therefore, the number of questions that required free text answers was kept to a minimum.

The questionnaire was answered by military personnel with experience in teaching with simulations and/or games. Respondents were found using snowball sampling, that is, one respondent with which we have good rapport was asked to encourage his instructor colleagues to answer the questionnaire and to encourage other instructors to do the same. Approximately 20 instructors were invited to participate in the questionnaire and a total of twelve instructors answered it. All respondents have been instructors for at least 2 years and half of them for more than ten years. The majority (n = 9) has been using simulators/games as training tools for more than six years (see Figure 11.2). Thus, the respondents were well familiar with simulation-based training. Four of them stated that they use *VBS2* and/or *Steel Beasts Pro*, and three respondents reported utilising BFT90, a PC-based platoon trainer for combat vehicles used at the BTA.



(a) Q 1.1: How long have you been an instructor?

(b) Q 1.2: How long have you been using simulations/games as training tools?

FIGURE 11.2: Questionnaire respondents' experience with being an instructor and using games/simulations for training. Note that only 11 of 12 respondents answered Question 1.2.

11.4 SERIOUS GAMING PRACTICES AT THE SLWC

The following section describes the training practices at the BTA and StriSimPC that were extracted from the analysis and validation procedure. Overall, the practices can be distilled into five phases or themes:

1. *Preparation and scenario creation*. About one hour before cadets arrive, instructors familiarise themselves with the basics of running the system (e.g. zooming and using audio). The instructors' computer skills vary a great deal, from not wanting to handle the game at all to being able to take over the system operator's role completely. This affects how the roles are divided up between participating instructors.
2. *Re-negotiation of goals or objectives*. Although the training objective should be decided well in advance, the observations show that the learning goals are sometimes

re-prioritised or re-negotiated on the day of practice. The re-negotiation is a result of training progress, that is, instructors might assess that more time is needed to train a specific task or role, or that trainees have reached the learning objectives quicker than anticipated. Another aspect of training that might be negotiated is the difficulty level. In all cases observed, instructors discussed the level of challenges that the simulation would provide, based on the cadets' prior experiences and skills. The results from the validation questionnaire confirm this conclusion.

3. *Lesson and briefing*. Training usually starts with a lesson in a classroom setting. What is included in that assembly seems to depend on the trainees' previous experience with that particular facility, as well as on the individual instructors' involvement. Unsurprisingly, if it is the trainees' first occasion, more time is spent explaining rules and regulations for that facility (including safety issues), plus allowing the trainees to become acquainted with the game or simulator. The results from the questionnaire (Question 4.3) indicate that instructors consider it most important to convey the training goal, as well as current policies and procedures, during the briefing (see Figure 11.3). Interestingly, they consider communicating how the performance will be assessed (Question 4.4) to be least important.
4. *Simulation/gameplay*. Training is achieved through simulation or gameplay. First, trainees are allowed to acquaint themselves with the system before the actual gaming commences. The gameplay phase is complex; many things are happening at the same time. Often several instructors are involved so that responsibilities can be distributed and less stressful for the individual instructor. Formative feedback is given continuously. According to the validation questionnaire (Questions 5.1–5.9), instructors are actively and dynamically changing the conditions in the simulation as it progresses and most of them prefer to control virtual objects and avatars themselves, instead of leaving it to the preprogrammed AI. Thus, the role of puckster seems to be common practice among the respondents. Furthermore, most of them use a variety of methods to assess learners' performance (Question 5.10), where most listen to what is said over the radio. Using AAR functionality as well as listening and observing what happens in the physical space are also common methods (see Figure 11.4). Some also make use of the assessments made by other instructors. Only a few (n = 2) let the learners complete the exercise on their own, without supervision from instructors (Question 5.18).
5. *Debriefing/AAR*. Debriefings are carried out in different ways depending on the situation and the limitations of the simulation software. Observations included (formative) between-game and summative debriefings, as well as debriefings with individuals, groups and in the whole class. According to the questionnaire (Question 6.6), the instructors (n = 10) consider the participants' performance and the training objective as the most important issues to discuss in the debriefing (see Figure 11.5).

A sixth phase could also be included, although it was not part of the unit of analysis: the lessons-learned process (Dessne, 2012). A lessons-learned process, in short, involves the acquirement and analysis of experiences from, for example, training sessions or field missions. The analysis is described in a lessons identified report that is then evaluated, implemented and followed up; resulting in a lessons-learned report (Dessne, 2012).

11.4.1 SERIOUS GAMING AT THE BTA

The following section presents an account of the GBT practices at the BTA facility. In general, two types of training scenarios were identified. The first type involved regular simulation training without any gaming characteristics, such as victory scores and competition. Enemy units were either controlled by the AI or one of the facilitators. On the

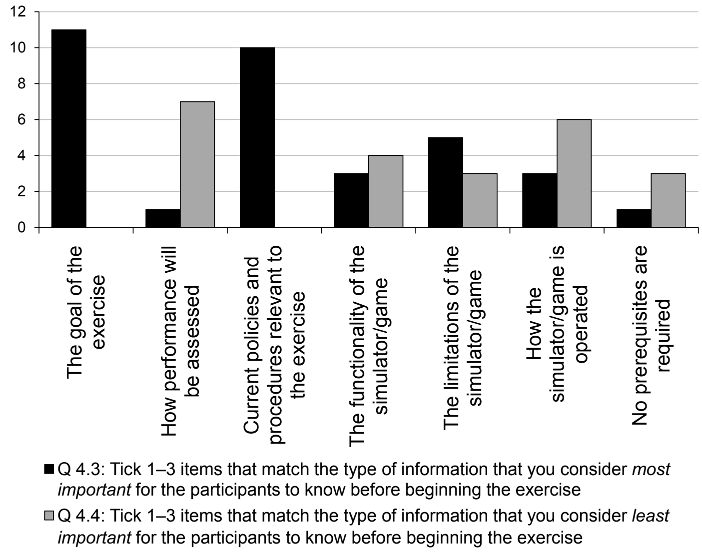


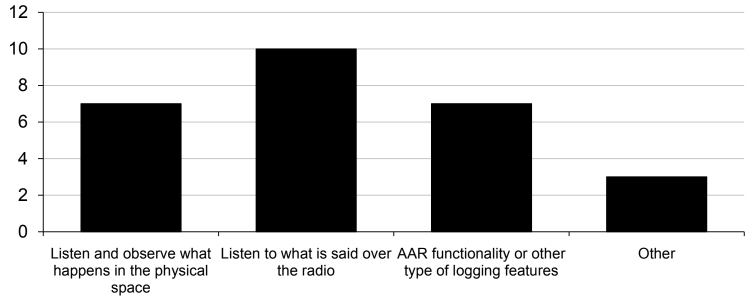
FIGURE 11.3: Questionnaire results (Questions 4.3 and 4.4, see Appendix D): What respondents consider most and least important for the trainees to know before beginning the exercise.

other hand, the second type involved scenarios in which trainees were pitted against each other, revealing clear winners and losers at the end. This second type of scenario thus falls under the category of serious gaming. The instructors add game characteristics, not just by adding a narrative and adapting the difficulty level, but also by incorporating a score system. The scores serve as a way to increase the level of stress and attention that the trainees experience during the simulation. Being pitted against one's peers also adds to this extra tension. One scenario observed is called the The King of the Hill (KOTH), which is often played towards the end of the day, when the cadets are starting to show signs of fatigue and/or boredom. In short, the idea of KOTH is to defend a village (or 'hill') and be the last tank crew standing (see Figure 11.6). The first challenge is to reach the hill intact (worth 10 points) and then to conquer all other enemies (including the other participants and AI units). Winning the game (defeated all enemies) equals 20 points, neutralising an AI controlled unit is worth less (5 points) than conquering one of the other participants' tanks (10 points), while being defeated results in negative points (minus 10 points). It is also possible (but extremely difficult) to win the game by receiving infinite points (e.g. shooting down a bird).

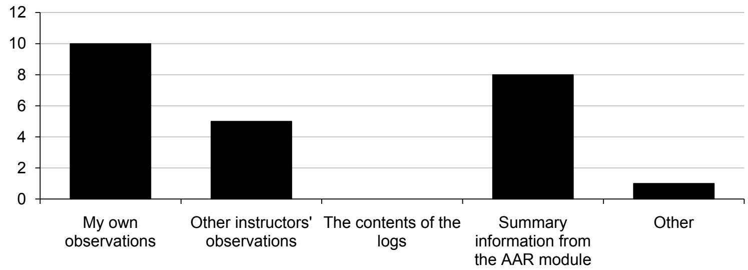
From an observer perspective, the social atmosphere changes dramatically when training proceeds from traditional simulation to one with aspects of competition. In the former, participants are generally calm and quiet, while in the latter they seem more excited, as if attending a sporting event. What follows is a description of the different training phases of GBT at the BTA. Since the overall structure of the training was essentially the same for both simulation and gaming scenarios, they have not been differentiated in the description.

PREPARATION AND RE-NEGOTIATION OF GOALS

Training at the BTA usually extends over several consecutive days (up to a week) of simulation training, interspersed with field practice, theory and physical training. The days are planned in advance, but last-minute changes are not uncommon. Preparation before



(a) Q 5.10: Select which methods you *mostly* use to assess participants' performance during the exercise



(b) Q 5.12: Tick 1–2 items that match the type of information you make *the greatest* use of when you assess the participants' performance

FIGURE 11.4: Questionnaire results (Questions 5.10 and 5.12, see Appendix D): What respondents base their performance assessment on during gameplay.

training is done in several steps. First, about two weeks in advance, the unit instructor sends a training plan or order to the system operator at the simulation facility. The training plan usually includes information about the extent, aim, objective and requirements of the training. The system operator at the facility then prepares scenarios based on the material.

What struck me as interesting about the planning phase was that, although training objectives were decided in advance, changes to goals in the individual scenarios could be re-negotiated at any time before or during the days in which training occurred. For instance, Figure 11.7 shows a situation in which two of the instructors are concerned that the system operator has prepared a scenario which is too difficult for the current trainees. However, it was a misunderstanding based on different expectations about the aim of the training; the instructors agreed that while the difficulty level should be low, it should not be non-existent.

Furthermore, preparing a scenario in the BTA system entails either choosing a scenario from the system library and modifying it as needed, or creating one from scratch. According to one of the instructors, it is usually quicker to create a scenario from an empty map than trying to modify someone else's scenario, since interpreting its pedagogical aim is difficult. Of course, the usability of the authoring tool also plays an important part. In this case, the instructor found the tool easy to use, which also explains his reasoning. Moreover, creating a scenario mostly entails choosing a virtual map or terrain and, to some extent, adding entities such as buildings, units, and so on. However, most of these entities are created moment-by-moment during gameplay, to produce a dynamic

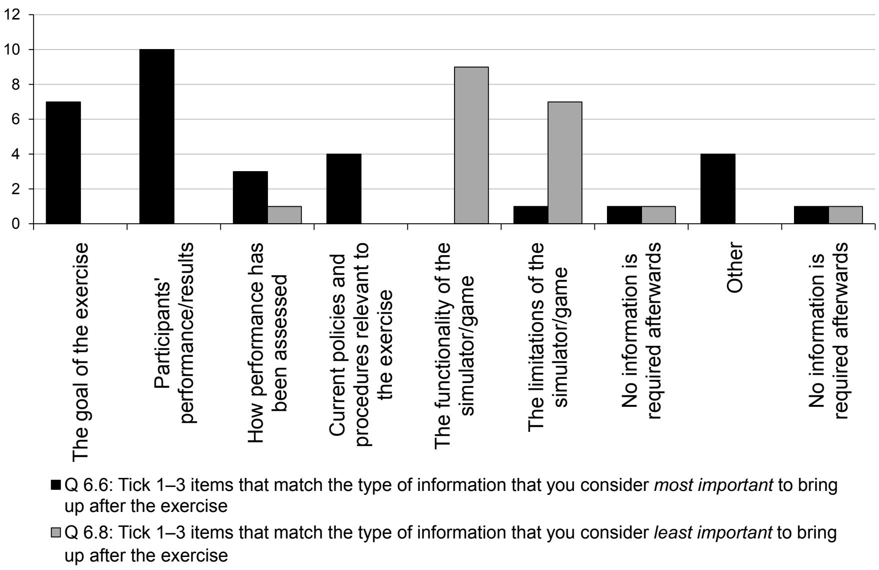


FIGURE 11.5: Questionnaire results (Questions 6.6 and 6.8, see Appendix D): What respondents consider most and least important for the trainees to know after the exercise. The most common stated reasons for picking 'other' as an alternative were 'lessons learned' (n = 3) and 'what to improve until next time' (n = 2). Note that some respondents mentioned both.

environment. Thus, the BTA system supports in-game facilitation, as described in Chapter 8.

One difficulty when creating a scenario, as voiced by one of the system operators interviewed, is to anticipate how the trainees will interpret it. This calls for a skilled instructor who is proficient in both the technical system and the domain of the profession and can create a scenario that is flexible enough to be played in different ways. Hence, a military scenario should not be designed by a civilian, nor should it be created by a military professional who is a novice in using the authoring tool.

According to the results from the validation questionnaire, the respondents would like to dedicate more time to scenario authoring and gameplay (Question 7.1), but one respondent also points out that it depends on the complexity of the exercise. Most of them do not believe that they dedicate too much time on any phase (Question 7.3), although three respondents answer scenario authoring. One respondent, utilising the BFT90 system, gives an explanation for this:

> *Too much time is put on preparing an exercise. It is difficult to adapt a scenario in real-time. For example, quickly add or move an opponent. Therefore, a scenario must be well tested and thought-through before a training session. A whole scenario, as the system is right now, is time consuming to build and it is rare to get the time you need to make a good exercise. The problem as I see it is that today it is too complicated to place and assign tasks in real-time during a simulation, which means that you have to put a lot of time in preparation if one is inexperienced as an instructor.*
> (Translated from Swedish)

Furthermore, in the questionnaire, one of the respondents at the BTA stresses the importance of being able to include explanatory text in the scenarios:

> *I use the scenarios that I know are good regardless of who created them. It is important that the scenarios are tested and documented with any type of exercise PM/description, so you know how it works.*
> (Translated from Swedish)

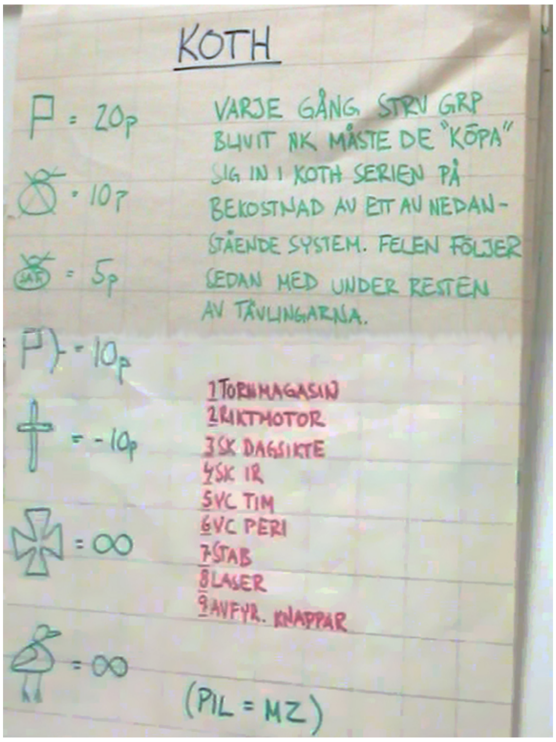


FIGURE 11.6: Rules for the King of the Hill (KOTH) scenario at the BTA. Note the humorous side of scoring where proof of marksmanship, such as shooting down a bird, gives infinite points. The green text reads (translated from Swedish to English): *Every time a tank squad has been destroyed, they must "buy" into the KOTH series at the expense of the following systems. The errors are persistent during the remainder of the competition.*

```
Frank:   ( We're thinking that it ) slowly becomes too difficult
Eddie:   That is, it should be characterised by plenty of time (.)
         It shouldn't be so hard an opponent
David:   (.hhh) (hhh) Have you (.)  ever been involved with this process?
         Is this how it's supposed to be Frank?
Frank:   We see it as an experi=
Eddie:   =See it as a gunner-and-loader [week]
David:                                  [Ha!]
Eddie:   =but eh: [little more]
David:            [It's gunner and tank commander]
Frank:   Yes but I [think that]
Eddie:             [Yes but-]
Frank:   =we have been able to step up [more-]
Eddie:                                 [Yes we might be able to do that]
David:   Yes I promise [I] won't=
Eddie:                 [Yes]
Frank:   David won't even be here
Eddie:   No it's not you I'm worried about
David:   [But you're looking at me and=]
Frank:   [( inaudible ) to check up on us ] (( laughs ))
(( All three laugh ))
```

FIGURE 11.7: Excerpt from one of the observations at the BTA. Example of a negotiation of the level of challenges given to the trainees. *Translated from Swedish. Names of instructors are fabricated.*

FIGURE 11.8: Snapshot of a lecture situation at the BTA.

George: There you have a clear-felled area with stumps on the right picture.
David: That's marsh, there you will get stuck. Most often it's in the vicinity of streams and so on too. There are three types of diff= stream sizes. You won't see the difference on the map. And that's almost as in reality then, on the map. There are three different sizes. The largest stream it's the one we're looking at now. You will notice that when you arrive (that) this one is big. You will get stuck there. The other two you can pass. That's streams. Water is not possible to drive into either (.) by the way. By the streams there is vegetation. So you should be able to look in the terrain and be able to read the terrain that damn, there it is a row of bushes. Winding away. Then it's a stream.
((David points with his laser pointer on a tank in the stream))
Yes that's how you will end up. Then it's also simulated, collision simulation, here. If you drive too fast, down a causeway or somewhere it will be simulated (inaudible) damage outcome on the tank. If you (inaudible).
((The right screen shows a tank driving in high speed straight through the stream))
Yes.
((David turns to the other instructors by the controls))
That's good. How pedagogical (that) is ((Everyone laughs)) presented here.
Frank: Just to have something to document.
David: Yes. ((clears his throat)) Exactly.
Frank: But it did break.
((The screen shows the tank in the middle of a marsh.))
David: Yes he did get stuck there anyway. That's nice.

FIGURE 11.9: Excerpt from one of the briefings observed at the BTA. The instructors show how the virtual world works and how the graphics look. *Translated from Swedish. Names of instructors are fabricated.*

(a) Intermediate self-assessment by the cabins (b) Coaching

(c) Classroom AAR

FIGURE 11.10: Three different debriefing situations at the BTA.

Thus, a scenario in itself is not useful for other instructors, unless it is accompanied by a description of its objective and use.

LESSON AND BRIEFING

Before cadets are allowed to enter the BTA simulator cabins, they are introduced to the facility and the simulation system, and given a lecture related to the training objectives. This lesson takes place in a room adjacent to the one with the simulator cabins. It is equipped with a whiteboard, a flip board and two projectors connected to the instructor station, which is also situated in the same room (see Figure 11.8).

During one of the observations at the BTA, in which the trainees were entirely new to the simulator, the system operator spent a large amount of time explaining the graphics in the simulator (an example is shown in Figure 11.9). While he explained how different terrain and objects in the terrain looked and worked, the other instructors steered the camera and, on occasion, vehicles in the virtual environment. The result was projected onto two screens above the whiteboard. One of the respondents to the questionnaire (Question 5.16) gives a reason for this practice:

> *The graphics are an obstacle, as it is difficult for the practising group to interpret the terrain in front of them and hence implement the right measures.*
> (Translated from Swedish)

Whether or not time should be spent explaining how the simulation works is an opinion that varies between instructors (see Figure 11.3). One alternative solution to doing this in a lecture setting is to create a few short scenarios that allow learners to discover key simulation mechanics on their own. However, the case data are inconclusive with regard to whether or not this is done on other occasions.

GAMEPLAY

At the BTA, the cadets step into simulation cabins during simulation/gameplay. Thus, the instructors cannot directly observe the trainees, but have to rely on information presented on the screens at the instructor station and communications over the radio. The instructor station also allows for in-game facilitation, in terms of changing the scenario during runtime, by, for instance, adding new entities and triggers, steering enemy units (puckstering), and giving orders and feedback to the cadets over the radio.

Up to three instructors can be actively involved at the same time. The station includes two main instructor seats from which everything can be reached, and a third seat with limited features. For instance, the third instructor can glance at the screens and control the radio communication, but not reach the scenario editor. Most often, only one or two instructors are active during gameplay, but a third can be added for more advanced training scenarios. At the BTA, all instructors share responsibility for the in-game facilitation and everyone has the same role. The workload is instead distributed by allocating responsibility for different groups of trainees. For instance, one instructor might follow the progress of the *Echo Alpha* crew, while another follows *Foxtrot Alpha*. As the day progresses, the instructors may switch the team they follow. It is therefore important for all the instructors to learn the assessment and feedback interface of the BTA system. To the question 'What do you think facilitates/prevents you from getting an overview' (Question 5.16), one respondent from the BTA answers:

> *If more than one exercise should be monitored simultaneously it may be too much information. Having a good overall monitoring, such as communication monitoring between different exercises, is important so that the instructor becomes aware that it may be appropriate to change monitoring focus to another exercise. Ability to configure and quickly put up a monitoring of the most important data for the intended purpose is important, such as quick start monitoring for three ongoing simple shoot-*

> *ing practice without too much clicking.*
> (Translated from Swedish)

Another one writes:

> *The ability to have several "flying cameras" at the same time is limiting when not enough information is displayed on the overview map. The ability to easily control/place new enemy units during the simulation. Give enemy units new information and be able to follow the "what do the AI do/see right now" in real-time, e.g. an information box in the overview map when selecting the unit. So I do not need to drop the monitoring of the exercising vehicle and locate the unit using the "flying camera" to see the unit.*
> (Translated from Swedish)

Thus, the instructors have a need for easy-to-use monitoring tools, in order to identify and follow the progress of specific groups or events. Furthermore, in contrast to the previous case studies, in which the facilitators were inexperienced with serious gaming, the above quotes show that experienced instructors are able to pinpoint specific features that could make their tasks more efficient and enjoyable. This is unsurprising, given their familiarity with the system, although this familiarity might hypothetically lead to them missing the obvious flaws in the system.

When playing the KOTH scenario, the instructors are, apart from the above mentioned tasks, also responsible for keeping track of the scores, which are then presented on the whiteboard during debriefing. As a high-end simulator and not a SG in the strict sense, the BTA system does not include automatic scoring or points.

DEBRIEFING

During and directly after training, instructors take notes about what to put emphasis on during the debriefing. They usually only have a few minutes to prepare between gameplay and debriefing, so the notes are usually brief and written by hand. A 'trick' they use to allow themselves more time is to give the trainees a routine task to perform that does not need the instructors' attention.

The BTA system logs everything, from every button that is pressed to the communication within each simulator. The instructors have the opportunity to use these during debriefing, to highlight issues both visually and auditory, by replaying events. This does not mean, however, that all logged data are used; in the sessions I observed, only a small amount of the logs was used actively during the debriefing. In the BFT90 system, the trainees have access to the logged data and, to a large extent, assess their own performance. However, one of the respondents to the questionnaire (Questions 7.4 and 6.4, respectively) points out that learners need training in understanding the AAR module in order to self-assess their performance:

> *The AAR program should be made easier for trainees to understand. For example, that the objectives are presented in the order they have been defeated and not in alphabetical order. [...] The graph of the gunner's targeting performance is difficult to understand if you're not used to using the program. Hence, the instructor must put a lot of time in the beginning to educate trainees to be able to evaluate themselves.*
> (Translated from Swedish)

The BTF90 is, however, more of a gunner trainer than anything else, making assessment (e.g. accuracy of aim) easy to automate. For the larger simulator system, assessment is more complex (e.g. measuring communicative skills) and, as a consequence, only available via the instructors.

Several different types of debriefing activities were observed at the BTA (see Figure 11.10). For shorter scenarios, the instructors employed between-game debriefings, where the cadets were encouraged to assess their own performance in smaller groups. This was usually done near the simulator cabins (Figure 11.10a). At other times, a cadet might ask one of the instructors for individual coaching (Figure 11.10b). On all occasions observed, the session also included a classroom AAR in which everyone participated together (Figure 11.10b). The focus of the classroom AAR is to give summative feedback as well as to discuss specific events and how they could have been solved differently.

11.4.2 SERIOUS GAMING AT THE STRISIMPC

The following section presents an account of the GBT practices at the StriSimPC facility. In contrast to the BTA, the StriSimPC utilises PC-based SGs instead of high-end simulators, more specifically *VBS2* (Bohemia Interactive, n.d.) and *Steel Beasts Pro* (eSim Games, n.d.). In the training sessions observed, only *VBS2* was used. Figure 11.11 shows a cadet playing *VBS2* at the StriSimPC.

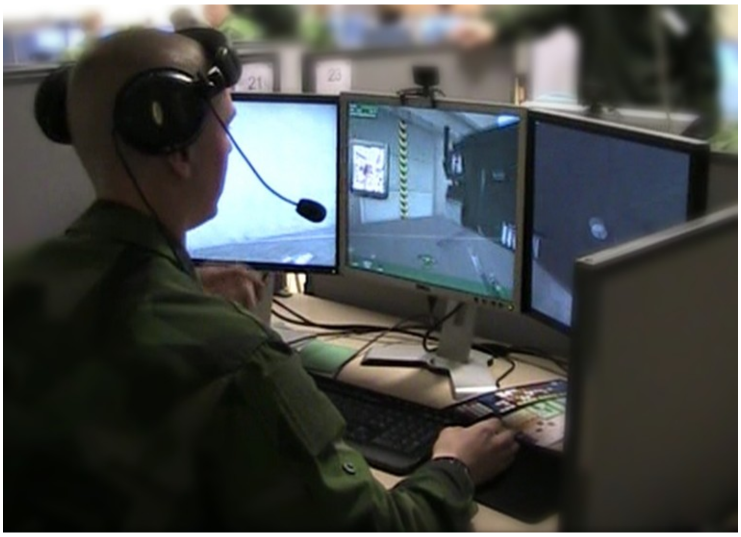


FIGURE 11.11: Snapshot from a training session at the StriSimPC facility, which shows a trainee playing *VBS2*.

```
Adam:   It will be about one session tomorrow too= We have (.)  we don't
        have more time. So we have decided to train assault tomorrow. So=
        the upstart will be damn easy. We will run with the same scenario
        as we've run (.) today. And we'll run assault tomorrow too then.
        And then we'll have time to run more scenarios and more platoon
        commanders get to train (.) like the role of platoon commanders.
Bob:    The order is already written= They will recognise the order= It's
        like= We'll take the same as= as yesterday= the scenario= we'll
        run the exact same thing.
```

FIGURE 11.12: Excerpt from one of the observations at the StriSimPC. The group of instructors uses one of the breaks to plan the next day's training. *Translated from Swedish. Names of instructors are fabricated.*

PREPARATION AND RE-NEGOTIATION OF GOALS

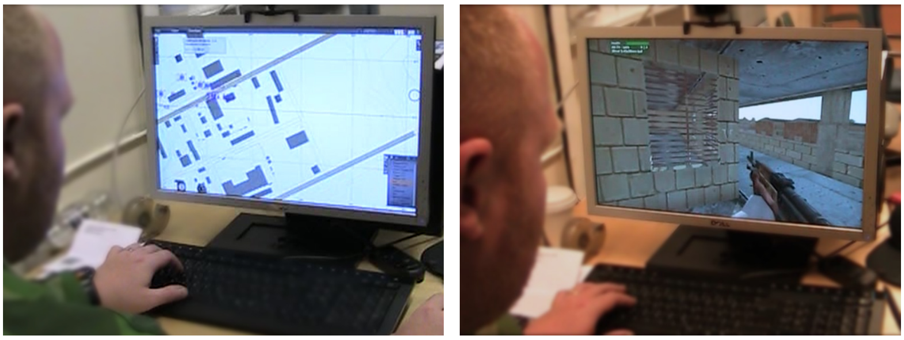
According to one of the respondents to the questionnaire, scenario authoring and sharing at StriSimPC depend on the specific needs of the unit to be trained:

FIGURE 11.13: Snapshot from a *VBS2* training session at the StriSimPC facility, which shows briefing by an instructor acting as a superior officer giving mission orders. To the left is a map used in the scenario and to the right are the written orders and background information for the same scenario.

(a) Direct assessment by an instructor (foreground), who takes notes on the trainees' performance and plans (background)

(b) Direct communication between an instructor (left) and a trainee (middle)

FIGURE 11.14: Snapshot from a *VBS2* training session at the StriSimPC facility, which shows an instructor in action during gameplay, both when the trainees leave their computers and when they are in-game.



(a) System operator changing the scenario during gameplay

(b) System operator controlling an enemy avatar (puckstering)

FIGURE 11.15: Snapshot from a *VBS2* training session at the StriSimPC facility, which shows two examples of in-game facilitation.

> *Recently, StriSimPC has not been utilised on a regular basis in officer training, which is a shortcoming in my opinion. Those who used the StriSimPC have been "widely diverse" units which have had different needs of scenarios which, as a consequence, made it difficult to reuse them to any great extent. Previously, however, we reused much more frequently. When StriSimPC is introduced as an "official" facility in 2013, the opportunities and need for reuse/sharing of scenarios is deemed to increase.*
> (Translated from Swedish)

Another respondent, who also utilises *VBS2*, reflects upon this from the perspective of knowledge sharing:

> *Because we are not particularly good at sharing scenarios, but we're working on it and it gets better. BUT, we would need to meet for two or three days each year, to exchange experiences, scenarios and questions. This must be controlled from above, otherwise it will all come to nothing.*
> (Translated from Swedish)

Similar to the practices at the BTA, training objectives and scenarios are prepared in advance of the actual training session, but can be re-negotiated on site. For example, Figure 11.12 shows a situation in which the instructors have realised that the current scenario has taken longer to play than expected. This was problematic because all the cadets did not have the opportunity to play the role of platoon commander (one of the main objectives for that day's training). During one of the breaks, the instructors decided to change their plans for the next day's training and, instead, continue with the same scenario one more day. This sort of re-negotiation and prioritising is, according to the instructors interviewed, common practice, mainly due to time constraints. Thus, although the instructors might have some idea about what the general training objective will be, the precise details might not be formulated until the day of training. It complicates the issue of reusing and sharing scenarios, fostering a practice of creating general scenarios that can be used for multiple training objectives, but may be difficult to apply for specific and limited training objectives.

LESSON AND BRIEFING

The briefing at the StriSimPC was conducted by two of the instructors in the same room as the game was played. First, the system operator presented the conditions for the sessions. For example, in order to communicate, the cadets must move their avatar in close proximity to the one they want to talk to, even if they are physically seated next to another. Next, another instructor who played the role of company commander used a considerable part of the briefing to relay the objective and the orders for the different platoons (see Figure 11.13). Most of this was done in the role of commander and the trainees assigned to play the role of platoon commander answered him as they would if the communication had been transmitted via radio. Plenty of time was given for the cadets to make notes and ask questions.

GAMEPLAY

The setting at StriSimPC was different from the one at the BTA in several ways, which also affected how the training was realised. First, because the game is PC-based, the cadets were directly observable, which allowed for another type of assessment and feedback than merely relying on information mediated through digital means and over the radio. Second, the workload was distributed by assigning different roles to the instructors involved during training. Many of the technical issues and in-game facilitation were left to the system operator, while the rest of the instructors did their tasks off-game, such as direct observation and live role-play (see Figure 11.14). One of the system operators interviewed mentioned that some unit instructors do not feel comfortable with computers and prefer to observe the cadets directly. Thus, distributing roles over several individuals allows instructors with less computer and gaming experience to still be involved in serious gaming. It also affords monitoring off-game gameplay. For instance, at some points during training, some of the cadets would leave their computer to huddle together in one of the corners of the room. One of the off-game facilitators would then stay close to the group and make handwritten notes on their deliberations (see Figure 11.14a). The off-game facilitators would also communicate directly with the trainees as they were playing *VBS2*, by asking questions and coaching them (see Figure 11.14b).

VBS2 incorporates tools for in-game facilitation during gameplay. For instance, the system operator can make changes to the scenario, revive fallen cadets, and act as a puckster (see Figure 11.15). An example of puckstering was observed when one of the platoons decided to move quickly through a neighbourhood, without searching the houses for enemy soldiers. The system operator reacted to this by creating an enemy avatar on top of one of the buildings and started to take down the platoon soldiers (Figure 11.15b). As they re-spawned outside the village, the cadets quickly learned their lesson and developed a new strategy.

According to one of the respondents to the questionnaire (Question 5.16), *VBS2* facilitates "*following the situation in the simulation from the instructor station. Sticking to the trainee who is the commander*" (Translated from Swedish). Thus, the game facilitates instructors' real-time overview of what is happening in the game. However, the same respondent also writes that getting an overview is prevented "*if technical problems arise that need to be overcome and you are alone or too few*" (Translated from Swedish). Another respondent expresses similar frustration with *VBS2*:

> *Hassles and illogical bugs in the system. Frustrating when a computer freezes or a player is thrown out. Then you lose focus directly on the learning.*
> (Translated from Swedish)

Thus, apart from acting as a puckster, the system operator also had to deal with technical problems that arose during training. As hinted at in the above quotes, sometimes these two roles can be in conflict with one another. For instance, during the observation at StriSimPC, the system operator was seated in the same room as the trainees. His position was in one of the corners, with the screen turned away from the rest of the room. This makes it difficult for cadets to sneak a peek at where the enemies are located. Yet, whenever there is a bug in the system or a cadet's avatar needs reviving, one of the trainees has to go to the system operator to report the problem. The system operator must then quickly discontinue what he was doing to help the trainee, who now has full view of the screen. The system operator was often observed changing screen mode whenever a cadet came close, most likely to prevent peeking.

As a side note, I also asked one of the facilitators whether the cadets' previous experience with entertainment games made a difference to how the game was played. While most SG literature points out that experience with games is advantageous for serious gaming, the instructor at the StriSimPC indicated that trainees with experience of entertainment FPS games often performed worse than those with less experience. The problem is that entertainment FPS games do not convey correct behaviours, and playing *VBS2* in the same manner as an entertainment game will result in severe errors of judgement. One example given was that many experienced gamers do not stay close to building walls, but run in the middle of streets, which would instantly get you killed in a real war situation. Thus, *VBS2* differs from most entertainment games in that it is less forgiving of avatar spatial position, in relation to other objects and agents, which is due to a training goal requirement.

DEBRIEFING

Debriefing at the StriSimPC followed a similar scheme as at the BTA; debriefings were conducted with all trainees at the same time or in smaller groups. Sometimes specific individuals were singled out, to receive more coaching. For instance, one of the instructors asked two of the cadets to remain after the conclusion of the main debriefing. The cadets were asked to reflect upon their assigned roles, how communication had or had not worked between them and how it could be improved.

During the training sessions that I observed, the AAR module in *VBS2* was not used. When asked about this, one of the facilitators explained that they had problems using and recording the sound from the headsets. The main problem was that the microphones picked up sound from the neighbouring trainees, which made in-game communication confusing. Instead, the microphones were turned off during gameplay, but this also meant that communications were not recorded in the AAR.[1] According to the facilitator, showing replays of in-game events without sound is not very useful, therefore only snapshots from the game were used instead. However, he also pointed out that being able to make full use of the AAR module would improve the debriefing.

11.5 CHAPTER SUMMARY

The previous sections have described GBT practices and instructor roles at the Swedish Land Warfare Centre (SLWC), specifically at two of their facilities. Several training phases were identified and found to be consistent in different settings, such as preparation and re-negotiation of goals, lesson and briefing, simulation/gameplay, and debriefing. A few differences between the conditions for instructor-led serious gaming were also identified, such as being able to directly observe and communicate with the trainees or not, and the division of work between several instructors. Most of the instructor roles outlined in Chapter 8 were observed, with the exception for those roles related to buy-in at the workplace (champion) and SG development (subject matter expert). It was also found that off-game facilitators do not have to take on a passive role during gameplay, but can actively provide guidance and assessment, as well as role-play. Thus, the line between in-game and off-game facilitation becomes blurred, when GBT is conducted synchronously and at the same place, and part of the gameplay occurs off-game.

When I first began my observations, I was coloured by my experiences with the facili-

[1] I was later informed that this problem had been fixed.

tators and instructors in the previous case studies (see Chapters 9 and 10). As a consequence, I was first surprised to see how active the instructors were in real-time facilitation of the serious gaming event. My preconceptions of a military organisation led me to expect a practice driven by efficiency and automation, albeit still instructor-led. Instead, the need for dynamic simulations has resulted in a complex GBT practice which involves several instructors who either share responsibility for facilitating the event or divide the various roles between them, in order to reduce cognitive workload.

Another important point to make is that serious gaming at the SLWC is not *one* practice, but a variety of practices which differ in number of instructors involved, physical setting, technology used, division of roles, just to mention a few factors. In this chapter, I have distilled these practices into their common denominators (i.e. the training phases), in order to describe the different roles that instructors take on. As these GBT practices are seldom documented, a more general description will benefit a larger SG community. As a consequence, a framework for instructor-led serious gaming cannot be too detailed, but rather allows for flexibility in its practical application.

Another consequence of this research is that SG developers can be benefited by considering the whole context of GBT. Descriptions of current training practices can be used to infer requirements for how such a system should support both learners and instructors in their tasks. The setting in which a SG is played will affect how player performance is assessed and how feedback is conveyed. It will also affect how roles and tasks are distributed among instructors, if more than one is involved as facilitator. For instance, not being able to directly observe and communicate with the learner will make instructors dependant on computer-mediated data and communication. Furthermore, a SG for soft skill training needs several components of subsystems, such as an authoring tool and an AAR module. Instructors are a specific user group with different needs compared to trainees. To give a concrete example: trainees playing a game need challenges related to learning goals. Instructors, on the other hand, need to be able to play the same game without those challenges. An instructor who is 'stuck' on a problem will not be able to coach his or her trainees in an efficient and relevant way. Therefore, challenges related to coaching should not be linked to learning goals. The system should instead support, not hinder, the task of creating a dynamic learning experience, because that is a challenge in itself.

CHAPTER 12

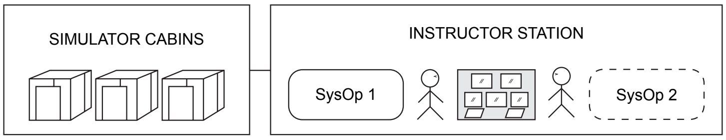
SUPPORTING IN-GAME FACILITATION

In the SLWC study described in the previous chapter, I identified a need for instructors to have system support before, during and after a GBT session. This chapter describes a follow-up case study at the virtual platoon trainer for tanks and combat vehicles (BTA), in which specific aspects of in-game facilitation were studied in more detail. More specifically, it examines in-game facilitation from the perspective of instructors' situation awareness (SA) and presents a set of guidelines for the design of support systems for this type of awareness in instructor-led GBT systems. As such, this study represents a step towards reaching Objective 4.

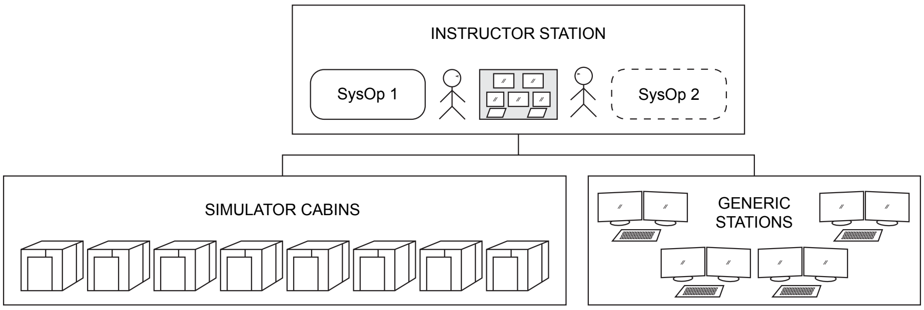
12.1 AIM OF STUDY

In late 2011, the BTA initiated a project to expand their facility from three tank simulator cabins to eight. Another aim of the project was to add a number of generic (PC) stations that could be used for puckstering during gameplay, that is, instructors or trainees who control one or several avatars in the game/simulator, in order to create a large-scale and dynamic environment (see Figure 12.1). The BTA staff speculated that these upgrades would extend their training repertoire, from squad and platoon levels to company and battalion levels, since a larger group of cadets could run a simulation at the same time and pucksters could control larger units of avatars, which simulate several squads or platoons. As a consequence of this expansion, training sessions involving company and battalion level training require a larger number of facilitators (system operators and pucksters) or more effective system support for the current ones.

A fourth simulator cabin was added in early 2012, but the remaining additions required more extensive modifications to the physical environment (the facilities needed an expansion that allowed for four more cabins), the internal structure of the system, and the user interface of the information displays of the instructor stations (see Figure 12.2). However, when the fourth cabin was added to the BTA facility, it became clear that the previous way of displaying information did not scale well to more training stations. Since the system operators need to have an overview of what is happening within the simulation, the monitors had to be upgraded to wide-screen ones. Considering that the number of cabins was soon to be doubled, this was only a temporary solution, and a more drastic one had to be found. During discussions with the SLWC on how to proceed with



(a) Before 2012



(b) Vision at the start of 2014

FIGURE 12.1: Model of the simulation concept at the BTA, before, with three simulator cabins, and after, with eight simulator cabins and four generic (PC) stations. The instructor station is designed for two system operators, but a third can also be involved in limited in-game facilitation (i.e. view screens and oversee radio communication, but not control the flying camera or act as a puckster). At the generic stations, instructors (acting as pucksters) or trainees can access the simulation in a similar fashion as playing a FPS game. The simulator cabins house the tank crews currently in training.

FIGURE 12.2: Instructor station at the SLWC's tank crew training facility (BTA). The top screens display the virtual environment from one of the squad members' perspective or the virtual camera. The bottom screens display the scenario map (left and right screens) and the status information panel (SIP) (middle screen). The small touch screens below the displays control communication.

the PhD project, I was given the opportunity to be involved in the procurement process of this system. Considering my background in human-computer interaction (HCI) and GUI design, and an interest in the facilitators' role(s) during GBT, it was decided that I would be involved in making prototypes for one of the main screens at the instructor station, namely the SIP.

The aim of the study was to identify and describe challenges for in-game facilitation and instructors' SA at the BTA. A further aim of the study was to synthesise a set of guidelines for the design of system support for instructor-led GBT that enhances instructors' SA. Thus, it contributes to the research question in terms of Objective 4.

A secondary aim was also to examine the applicability of the SA concept to in-game facilitation.

12.2 METHODS

The methods chosen for this case study were prototyping development, analysis and descriptive evaluation (see Figure 12.3). According to Hevner et al. (2004), the creation of design artefacts as part of research is intended to solve some identified organisational problems. In this case, the identified problem was the lack of an effective user interface for the SIP, leading to inefficient facilitation during simulations. Since the research problem pertains to the application of a technological solution in a specific context, developing an artefact and then evaluating it in that context is an appropriate research approach (Hevner et al., 2004). However, these methods can be implemented in various ways and the implementation procedure will affect the output and possible interpretations that can be made from the study. For instance, the choice of development process and evaluation method is dependent on resources such as time, design competencies among the researchers, and the availability of subject matter experts and end users from the client organisation.

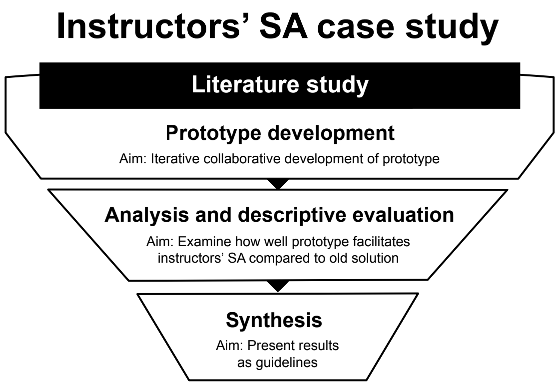


FIGURE 12.3: Research approach in the instructors' SA case study.

In this case, I was the sole researcher working together with two subject matter experts (one facilitator at the BTA and one consultant that had formerly been involved in training at the facility), who in turn were in regular contact with the developers of the BTA system, a company situated in Germany. At the beginning of the study, the idea was that the developers would implement my design ideas into the system, which could then be evaluated in its proper context. Due to complications outside my control, this was never realised. Instead, a number of lo-fi prototypes were iteratively developed and evaluated by descriptive evaluation.

12.2.1 PROTOTYPE DEVELOPMENT

The SIP prototype was developed from May 2012 to May 2013. The ideal model for developing a GUI is to work iteratively, by performing as many iterations as possible (Hartson & Pyla, 2012). The fact that I was working with a limited user base made full user testing in each iteration problematic. As each testing makes the users more and more familiar with the GUI, and only a few users were available, user testing was not a suitable option. Instead, the sketches and prototypes were shown to the subject matter experts, who commented on the ideas and suggested improvements, which then informed further development of the next generation of prototypes. A total of three iterations were carried out in this manner. The final user meeting included a novice system operator who had not seen the previous designs, which was beneficial for the evaluation.

As indicated in section 12.1, a main goal of the prototyping task was to reduce complexity in the SIP interface. In order to reduce the number of design elements, the subject matter experts were given the task of picking out the indispensable ones given both training scenarios (i.e. platoon and company level). To do this, they ran a number of test scenarios, together with a third facilitator, and consolidated their conclusions. Thus, as a basis for my prototyping, I was given a list of items to be included in the interface, their labels, states and, if applicable, colour coding. In addition, I also had access to an early version of the user manual for the new BTA system.

For all designs and revisions, established design principles from HCI and visualisation literature were used (e.g. Cooper, Reimann, & Cronin, 2007; Mullet & Sano, 1995; Ware, 2013). Tools used to create the prototypes were pen-and-paper, the *Pencil* prototyping tool (Evolus Co., 2012), and *Microsoft PowerPoint* (Microsoft Corporation, 2010). The latter was chosen because *Pencil* and other similar prototyping tools available as freeware did not have animation functionality and parts of the prototype required visualisations through movement. In *Microsoft PowerPoint*, it is possible to achieve animations, with little effort and programming skills.

12.2.2 ANALYSIS AND DESCRIPTIVE EVALUATION

In order to analyse the challenges to in-game facilitation and instructors' SA, both the final prototype of the SIP interface and the original SIP interface were analysed using the eight threats to SA (presented in section 12.3.2). In doing so, the applicability of SA as a concept to describe in-game facilitation was also evaluated. A descriptive evaluation is based on the concept of informed argument, that is, information from the knowledge base (e.g. relevant research) or scenarios is used to build a convincing argument for the artefact's utility (Hevner et al., 2004). Thus, by comparing the prototype to the original SIP's user interface with regard to how well they meet the requirements for supporting instructors' SA (or fail to hinder threats to SA), something can be said about both the prototype's and the SA concept's utility in this specific context.

12.2.3 SYNTHESIS

The challenges and proposed design solutions generated by the prototyping process and the descriptive evaluation were synthesised into guidelines for the design of support systems for in-game facilitation. The synthesis was done by categorising the challenges and design solutions into themes and reformulating them into guidelines.

12.3 RELATED RESEARCH

Research within this area is limited, especially from the perspective of UXD and instructors' tasks in simulation- and game-based training. However, there are a few relevant studies that can be mentioned in this context.

12.3.1 DESIGN OF USER INTERFACES IN SIMULATORS AND INSTRUCTOR STATIONS

In one study, Hubal (2005) describes usability issues in simulation training systems for Army ground tracked vehicles. While most of the study concerns usability from the trainees' perspective, Hubal (2005) also interviewed instructors and concluded that instructors "perceived that simulator training teaches students adequately, allows instructors to have full interaction with students, and teaches maintenance and repair effectively. However, instructors felt that simulation does not allow for communication with students in the same way as instructor-based methods" (p. 2113). Interestingly, Hubal (2005) does not explain the difference between 'full interaction' and 'communication', but the quote indicates that the instructors felt hindered by the system in performing some of their facilitatory tasks.

Another interesting and relevant study is by Stiso et al. (2004), whose 'Common Instructor Operator System (C-IOS)' is designed to "provide support for instructors to carry out their training responsibilities in a pedagogically sound manner across all phases of the simulation-based training process" (p. 103). The paper particularly look into the issue of scenario authoring from a distributed perspective (see Chapter 8.2), but they also recognise the importance of designing for scenario execution and AAR from an instructor perspective. More specifically, they find that using virtual worlds and games as inspiration for the system design benefits facilitating collaboration among instructors.

A more recent study is presented by Branaghan, Covas-Smith, Jackson, and Eidman (2011), who redesigned the interface of an instructor-operator station for a military pilot simulator. They claim that "the usability of these products can take a back seat to functionality. Often this is because programmers with little training in human factors are responsible for the user interface design" (Branaghan et al., 2011, p. 939). In my own work with the SLWC, I have made similar observations. Furthermore, they found that while changes to the organisation of the user interface may frustrate users who have become accustomed to the original design, benefits in making the design coherent with the user's knowledge structure will outweigh the benefit of keeping a poor design in order to retain familiarity. This calls for a bold design strategy which dares to make substantial changes to systems or part of systems that have been found to be ineffective or otherwise less usable.

12.3.2 INSTRUCTORS' SITUATION AWARENESS

One way of studying the challenges for in-game facilitation is through the lens of *SA* (see Chapter 5.1.2). SA is a well-known concept within the military community, but is mainly used from the perspective of the individual soldier, pilot or team. Endsley and Jones (2012) describe SA as "being aware of what is happening around you and understanding what that information means to you now and in the future" (p. 13). They also divide SA into three levels:

- Level 1: *Perception* of the elements in the environment
- Level 2: *Comprehension* of the current situation
- Level 3: *Projection* of future status

In my literature studies, I found no sources that use the concept in the context of instructors or teaching. However, being aware of and grasping a situation is a central task for the in-game facilitator. Otherwise, he or she will not be able to assess learner performance within the context of the particular situation and infer the consequences of their actions, nor make interventions and give meaningful feedback (see Chapter 8). I have termed this type of SA *instructors' situation awareness*. A related concept is 'professional vision', that is, the way that professionals or experts within a community view and make sense of things in their environment (Goodwin, 1994, see also Chapters 6.2.2 and 7.3.2). As such, professional vision seems to relate to levels 1 and 2 SA.[1] Thus, by having a professional vision, an instructor can more easily acquire SA and more efficiently take on the role of in-game facilitator.

In order to facilitate instructors' SA, it is useful to study what supports or hinders SA in general. Endsley and Jones (2012) summarise eight threats[2] to SA:

1. Attentional tunnelling
2. Requisite memory trap
3. Workload, anxiety, fatigue and other stressors
4. Data overload
5. Misplaced salience
6. Complexity creep
7. Errant mental models
8. Out-of-the-loop syndrome

Attentional tunnelling, or attentional narrowing, occurs when the user is trying to attend to multiple, but separate, stimuli at the same time. Since human attentional resources are limited, the user runs a risk of only attending to part of relevant information and missing information critical to understanding a situation or making a decision (Endsley & Jones, 2012). At the BTA, attentional tunnelling can occur when an instructor tries to follow a crew's progress on the map screen, while at the same time interpreting the information on the SIP and listening to the radio communication.

Requisite memory trap occurs because of limitations to human working memory, both in terms of the amount of information that needs to be retained in the memory and the amount of time that elapses between two related chunks of information pieces (Endsley & Jones, 2012). At the BTA, this can occur when an instructor tries to remember one crew's current status information while searching for information about another crew's status, in order to compare them (e.g. when one crew has attacked another during a KOTH scenario, see Chapter 11.4.1).

Workload, anxiety, fatigue and other stressors are common in situations characterised by a physical or mental workload, such as high noise levels, poor lightning, physical exertion, time pressure, high-consequence events and uncertainty. This in turn leads to less systematic ways of searching for and understanding information, as well as more errors of judgement (Endsley & Jones, 2012). At the BTA, simulations and GBT sessions often run for several hours and involve a high degree of cognitive workload for the instructors (see Chapter 11.4.1). Even if instructors distribute the workload among themselves, their roles are challenging and likely to be even more so with the new, more complex system (S. Lindquist, personal communication, March 12, 2014).

[1] I am aware that the two models might be incommensurable due to them adhering to different paradigms (cognitivism and constructivism, respectively). However, I am not trying to explain the processes behind these phenomena, but rather use the theories in a pragmatic manner.

[2] Endsley and Jones (2012) actually use the terms 'demons' and 'nemeses', but I have chosen to use the less dramatic term 'threat' instead.

Data overload occurs when a user is presented with more information than he or she is able to handle, cognitively. Although this can be due to the sheer amount of information, it is more often an issue of jumbled and disorganised information that makes the task too difficult (Endsley & Jones, 2012). At the BTA, the instructors have to handle a large amount of information from various displays and modalities. Thus, they most likely experience data overload at one point or another. Inexperienced instructors, who have yet to develop a professional vision for these tasks, are likely to experience this to a higher degree than more experienced ones.

Misplaced salience refers to properties of design elements that inadvertently draw the user's attention to them and, as a consequence, distract him or her from important information (Endsley & Jones, 2012). Salience is largely determined by physical properties, such as the colour red, movement, flashing lights, loud noises and larger shapes. Misplaced salience is a highly contextual issue, since the same information can be important in one situation and unimportant in another. At the BTA, many of the above mentioned properties are used to code different types of information. These can either help, or hinder, the instructor in attending to relevant information.

Complexity creep is related to data overload and refers to the complexity that arises from new features being added to a system without considering how they affect the system as a whole. Complexity can refer to the number of items included in a system, the degree of interaction between them, overall system dynamics, or the predictability of changes to the system dynamics (Endsley & Jones, 2012). According to Endsley and Jones (2012), complexity creep is subtle and "primarily works to undermine [people's] ability to correctly interpret the information presented and to project what is likely to happen" (p. 39). At the BTA, complexity creep occurs when new features are added onto the current simulation system, leading to misinterpreted information, such as not recognising a symbol on the map or not knowing how to add a trigger to the scenario.

Errant mental models refer to situations in which the user is unable to understand a situation or predict its outcome (i.e. levels 2 and 3 SA). This leads to errors. A common error is mode error, that is, when information is misinterpreted because the user believes that the system is in one mode, when it really is in another (Endsley & Jones, 2012). Mode errors can occur at the BTA, especially when several instructors are allowed to control the information displays at the same time. If one instructor is distracted elsewhere while another one changes the SIP mode or the flying camera, the first instructor might not notice the change and interpret the information as if it was in the previous state.

Out-of-the-loop syndrome only affects systems with automation. Automation can help SA by eliminating excessive workload, but can also act to lower SA. As put by Endsley and Jones (2012, p. 170):

> While some people falsely believe that automation reduces the operator's need for SA, it turns out that SA is not only important for human performance when operating alone, it is just as important when people work to operate systems where they must interact with or oversee automation. In most systems that include even high levels of automation, people still retain important roles as overall system monitors and operators.

Out-of-the-loop syndrome occurs when the user cannot perceive how the automation is performing or the state of the components that the automation is supposed to control. From a serious gaming perspective, out-of-the-loop syndrome would occur if the instructor is unable to follow gameplay in real-time (which was the case for both the *Elinor* console, Chapter 9, and the *Tactical Incident Commander* game, Chapter 10) or unable to detect whether the game reacts inappropriately to the learners' actions. As a consequence, out-of-the-loop syndrome directly hinders in-game facilitation.

12.4 SIP PROTOTYPE

This section aims to describe the SIP, such as its purpose, its original user interface (as of May 2012) and the final prototype. First, the SIP is only one type of information display at the BTA instructor station (see Figure 12.2). The purpose of the information displays is to facilitate instructors during different states of the ongoing simulation. The map gives the location of individual cadets and vehicles, including their direction and heading. The top screens, which show the virtual environment either from one of the squad members' sights or from a 'God mode' perspective, provide a sense of what the trainees are seeing and what kind of landscape they are in (e.g. woodland, marsh, rural or urban area). The SIP presents information about ammunition, shots fired, communication channels open, vehicle speed, and other data that can be gathered about the simulation. Together with the other information displays, the SIP gives the instructors a basis for assessing trainee performance before, during and after the training session. Although distributing information on separate screens can increase the workload for the operator (Brickman, Hettinger, & Haas, 2000), it is preferable before having to manually switch between modes on a single screen. As a complement to the visual information, instructors also listen in on the trainees' communications, both over the radio and within the vehicles. Using a mix of sensory modalities reduces cognitive workload on the operator (Brickman et al., 2000).

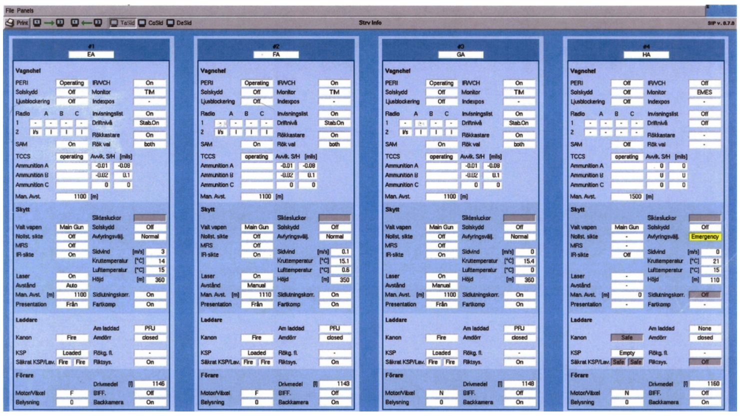
Figure 12.4 shows the SIP as it was designed by the developers of the simulator system used at the BTA after the fourth cabin was added. This was the main basis for my design task and I henceforth refer to it as the original SIP interface. Essentially, the original SIP is based on a tabbed interface paradigm and consists of three tabs: (i) start-up mode (Figure 12.4a), which is mainly used before or at the beginning of the simulation, in order to check that all controls are set properly, (ii) combat mode (Figure 12.4b), which is the main tab active during the training session, and (iii) detail mode (Figure 12.4c), which gives more information on the latest shots made. All this information is grouped according to the simulation cabins.

The final SIP prototype is presented in Figure 12.5. In short, the prototyping followed three core design goals:

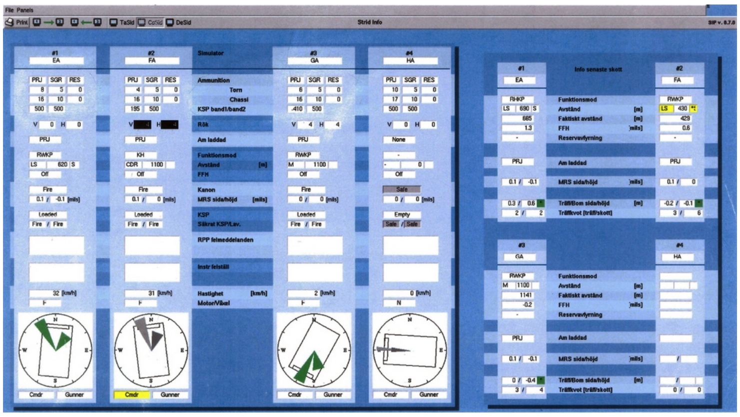
- Reduce the number of design elements, in order to fit all relevant information onto one display.
- Redesign individual design elements to facilitate at-a-glance assessment.
- Redesign the SIP for platoon level and company level exercises, respectively.

Reducing the number of design elements was necessary, because the subject matter expert involved in the project wanted to reduce the need to interact with the display (e.g. pointing and clicking). Thus, information from all three tabs had to be thoroughly examined and reduced to the most critical data needed for instructors' SA, as well as displayed on a single screen. Moreover, in order to make assessments of the situation and the trainees' performance more effective and reduce the instructors' cognitive workload, the individual design elements had to be redesigned to allow quick identification of simulation states. Lastly, since the type of training exercises was to be expanded, the SIP needed to reflect this. In essence, company level exercises need that a different set of data is presented on the SIP, compared to platoon level exercises. Furthermore, company level exercises can be played as one-sided or two-sided training, that is, either with all trainees playing on the same side (with AI- or puckster-controlled enemies), or in teams playing against each other (so-called force-on-force). Thus, two different user interfaces for the SIP prototypes were created.

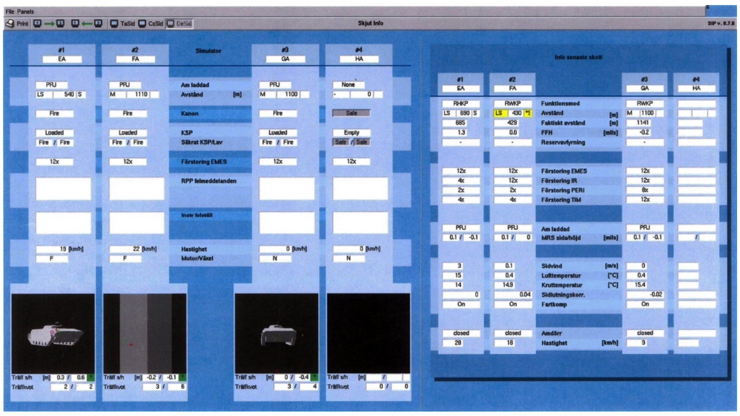
Several attempts to present information from eight cabins on one screen were made, but even with the reduced number of design elements, all design solutions were rejected due



(a) SIP start-up mode tab



(b) SIP combat mode tab



(c) SIP detail mode tab

FIGURE 12.4: The original SIP interface.

to their inefficiency. The final solution assumes the SIP is divided into two screens with each showing four cabins.

12.5 RESULTS FROM ANALYSIS

This section presents how well the original SIP and the final SIP prototype manage to reduce the threats to SA and, in essence, how well both design solutions support the instructors during in-game facilitation. Overall, the SIP prototype offers design solutions that theoretically improve the instructors' SA. Although the prototype has not been implemented and tested in a natural setting, the reactions from the subject matter experts have been positive. For instance, one of my contacts at the BTA, who was not directly involved in this study, used the prototype, on his own accord, as a good example of how to improve one of the BTA's other simulation systems. Furthermore, the subject matter experts involved in the design process have expressed a wish to continue the collaboration in a new study (outside the scope of this thesis work), in order to further improve and implement my designs.

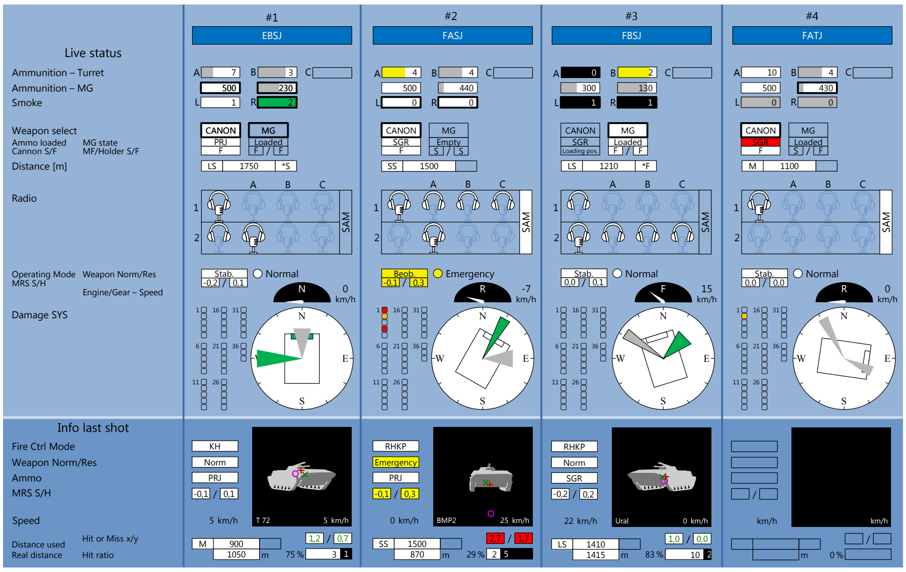
12.5.1 ATTENTIONAL TUNNELLING

As mentioned in section 12.3.2, attentional tunnelling occurs when the instructor fails to attend to several stimuli at the same time. According to Endsley and Jones (2012), this can be prevented by careful design, such as making critical cues salient, presenting information through different modalities, and allowing the user to filter information. In the original SIP, colour coding is used to draw the instructor's attention to critical events. For instance, white denotes a neutral or good state, yellow means that something might need to be attended to, and red signifies a serious error. In certain instances, grey and black are also used to draw the instructor's attention. Gray means that something is in 'off' or 'safe' mode, while black means 'empty' (e.g. empty ammunition clip).

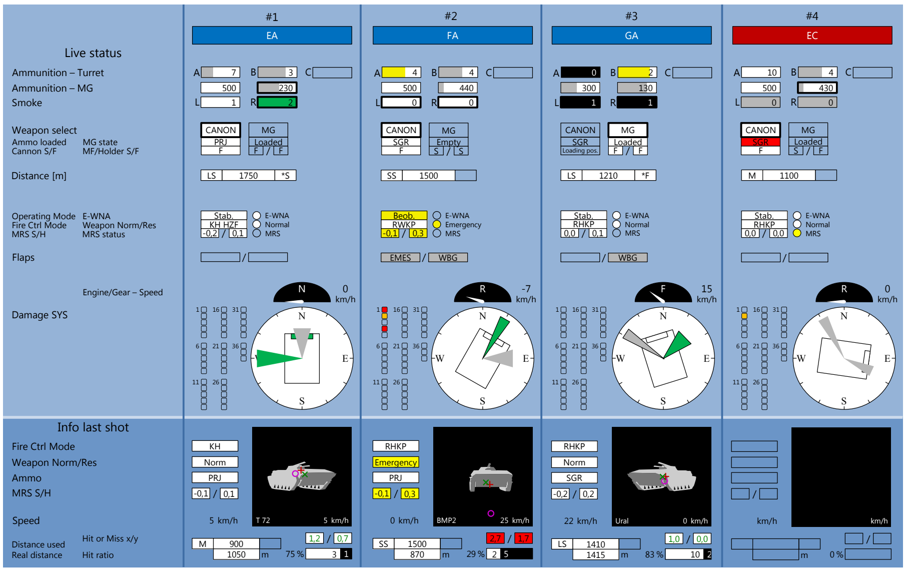
The final SIP prototype made use of the same colour coding, but added background colour for inactive elements. By doing so, the instructors' attention is more effectively directed towards the more important elements, which means that an assessment of a particular crew's status can be made at a glance and then the instructors can attend to information from the other screens. For instance, the radio communication element was redesigned to use icons, instead of textual information, to relay information about which channels are open (white) or closed (background colour), and who is sending, receiving, or both (see Figure 12.6). The icons were designed to be distinct, simple and easily recognised, in order to promote a quick interpretation of their meaning. Text requires conscious attention, which takes longer and needs more cognitive resources (Endsley & Jones, 2012). As a result, the instructor has to scan and interpret the details instead of merely absorbing the information at a glance. This is particularly problematic in displays with large amounts of text (Ware, 2013). Text boxes also signal that the contents can be edited, which was not the case in the SIP. Thus, the original design forced the instructors to focus all their attention on the radio communication element, which increases the risk of attentional tunnelling.

12.5.2 REQUISITE MEMORY TRAP

An information display can be designed in such a way that it does not put unnecessary workload on the instructor's working memory. For instance, Endsley and Jones (2012) suggest that information should be organised according to goals, that is, instead of presenting information on the basis of the order in which the panel receives data from the cabins, information should be organised according to the goals and tasks of the instruc-

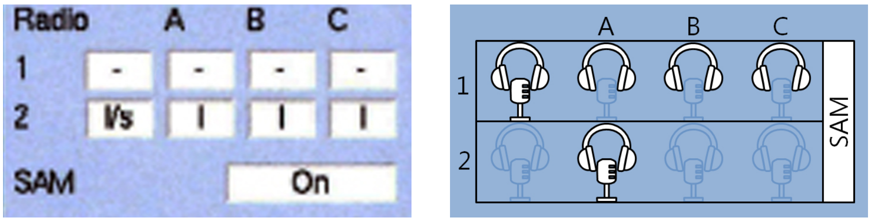


(a) User interface for company level exercises (single-sided training)



(b) User interface for company level exercises (double sided/force-on-force training)

FIGURE 12.5: The final SIP prototype, which makes use of a tabular design to organise design elements into columns and rows. This allows for quick cross comparisons of different crew performances.



(a) Original design (l/s = listen/send)

(b) Prototype design

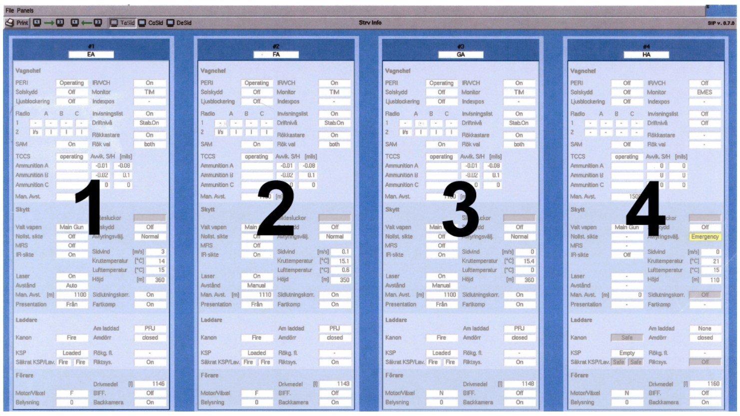
FIGURE 12.6: Comparison between the original SIP's radio communication design and the prototype's. Note that the text boxes have been replaced by icons, in order to allow for at-a-glance assessment and reduce cognitive workload. Inactive communication channels have been colour coded to blend in with the background colour, to reduce the design elements' salience.

tors, such as finding and comparing different sets of data. Another principle is to support comprehension, by presenting level 2 information directly, for instance by presenting a calculated value rather than requiring the instructor to do a mental calculation. Additionally, trend displays and other visualisation techniques help alleviate cognitive workload for level 3 SA, projection of future states. Overall, reducing complexity is beneficial to overcoming the threat of requisite memory trap, since a simpler design will put less strain on working memory (Endsley & Jones, 2012).

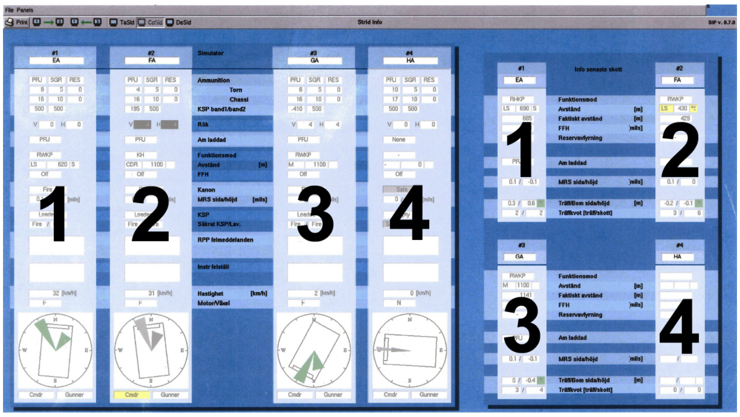
In the original SIP, the layout was not consistent in terms of how blocks of information relate to one another, which makes finding and comparing different sets of data challenging for the instructor. Figure 12.7 aims to visualise this inconsistency by highlighting blocks related to the respective cabins. For instance, in combat mode (Figure 12.7b), the facilitator's attention has to switch back and forth between the left and the right side of the screen, in order to obtain an overview of one tank crew's performance. The same problem exists in detail mode (Figure 12.7c), with the additional problem of the grouping being spatially different from the other displays. Maintaining consistency over several displays is a well-known and important interaction design principle that allows the user to maintain his or her bearings between context shifts (Cooper et al., 2007). In the prototype, the main interface paradigm implemented for the layout was to arrange items in a tabular manner, which is common in AAR interfaces (Meliza et al., 2007). Thus, the instructors can scan the interface either vertically, to find information from the same cabin, or horizontally, to compare the same type of information from different cabins.

Another design solution that helps unburden the instructors' working memory is the redesign of the hit ratio. In the original SIP, the hit ratio is shown as two text boxes, where the left shows the number of hits and the right shows the number of shots fired (see Figure 12.8a). While this representation facilitates instructors in reading the hit ratio as 'two hits of two shots fired', it does not support level 2 SA. The final prototype makes use of dual coding of hit ratio information; it is shown visually, by two bars of relative percentages of hits versus misses, and textually (see Figure 12.8b). The bars allow for quick assessment of a crew's performance, while the numbers can be used in preparation for the debriefing or during less stressful periods of the simulation, where more time and cognitive resources can be spent on details. Both representations support level 2 SA.

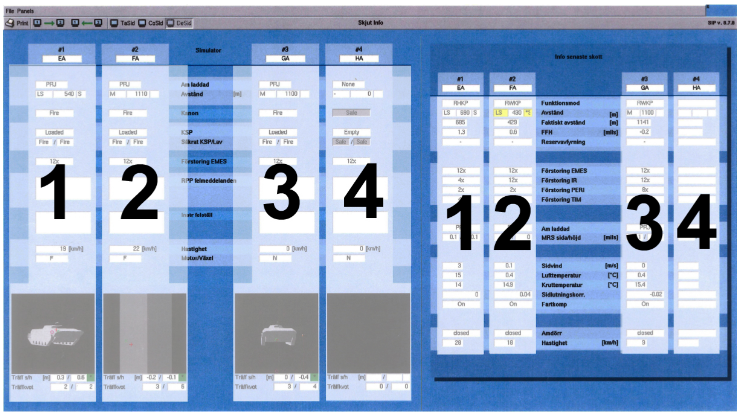
Neither the original SIP nor the prototype shows level 3 information, which would further support the instructors in gaining SA. Additional studies have to be conducted, in order to analyse the instructors' need for such features, whether or not these should be



(a) SIP start-up mode tab



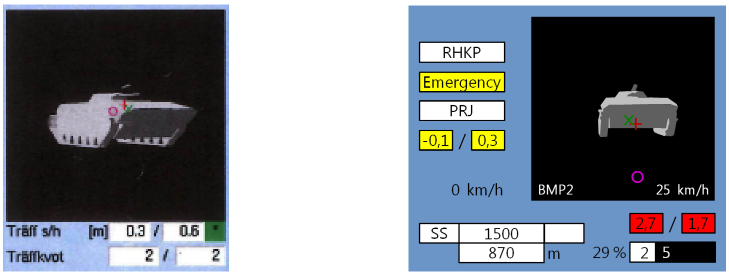
(b) SIP combat mode tab



(c) SIP detail mode tab

FIGURE 12.7: The layout of the original SIP interface shows clear inconsistencies which make overview and at-a-glance assessment difficult. The numbers and white rectangles represent blocks of information related to the respective cabins (1 = cabin 1; 2 = cabin 2; and so on).

shown in the SIP or on another display, and whether or not new features would lead to complexity creep.



(a) Original design

(b) Prototype design

FIGURE 12.8: Comparison between the original SIP's last shot design and the prototype's. Notice specifically how the hit ratio has been redesigned to provide level 2 information; instead of showing 'two hits of two shots fired', the prototype shows the percentage, both in numbers and as a visualisation. The above hit ratio in the prototype design would thus read as 'two hits and five misses', where white is used for hits and black for misses. Consequently, a full white bar would indicate a hit ratio of 100 percent, and a full black bar would represent zero percent.

12.5.3 WORKLOAD, ANXIETY, FATIGUE AND OTHER STRESSORS

According to Endsley and Jones (2012), the same design principles used to reduce attentional tunnelling can also be used to overcome the physical and mental workload. Thus, the design solutions presented in the previous sections also act as solutions for this threat to SA. Furthermore, this is a threat that works on a larger scale and needs to be dealt with from a holistic perspective. For instance, the BTA utilises different modalities (visual and auditory) to transmit information from the cabins to the instructors, consequently, the combination of information displays at the instructor station can either increase or decrease the level of stress that the instructors experience, depending on interdependencies between the displays and between the instructor station and its practices of use. Additional studies must examine the design of the BTA system, in relation to training practices, on a wider scale than the one permitted by the scope of this case study.

12.5.4 DATA OVERLOAD

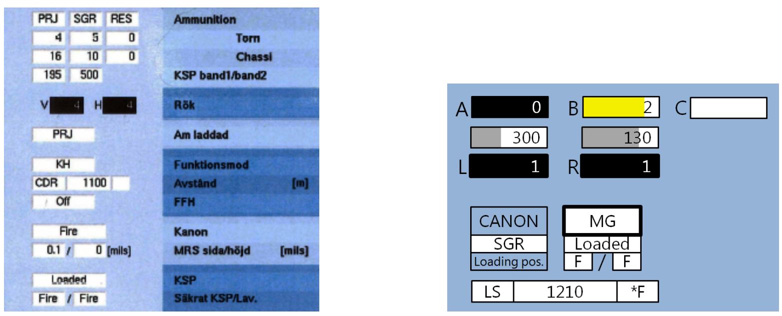
One of the most obvious threats to SA when analysing the original SIP is data overload. The subject matter experts involved in the design process all agreed that the user interface is too cluttered and disorganised. Although the final SIP prototype has reduced screen density and information is ordered according to the subject matter experts' needs, it is still regarded as cluttered. Thus, while the prototype can be said to be an improvement, compared to the original design, the instructors still run the risk of experiencing data overload. Further analyses and possibly a complete redesign of the SIP concept are needed to overcome this threat to SA.

12.5.5 MISPLACED SALIENCE

Another apparent threat in the SIP interface is misplaced salience. One of the subject matter experts used the phrase “Christmas tree effect” and said that both the original SIP and the prototype run the risk of displaying too many colours and blinking items at the same time. In essence, both interfaces make use of colour and movement to catch the instructor’s attention. If too many elements are active at the same time, the instructor runs the risk of attending to elements of less importance for the current task. As already discussed in section 12.5.1, the final prototype is designed to tone down this effect by using the background colour rather than white to represent inactive or neutral states. Although this decreases the risk of misplaced salience, the Christmas tree effect can still occur in extreme conditions, due to the fact that most states are still active ones.

12.5.6 COMPLEXITY CREEP

In order to avoid complexity creep, all features should be examined on the basis of their necessity. Existing ones should then be prioritised and organised to minimise “the impact of infrequently used features” (Endsley & Jones, 2012, p. 292). As mentioned in section 12.2.1, the prototyping process included a phase in which the subject matter experts examined the original SIP and prioritised the parts most essential for in-game facilitation of company level training. Since no new features were added to the final SIP prototype, the risk of complexity creep is small. However, some existing design elements were redesigned in such a way that instructors will have to go through a learning process to be able to interpret them efficiently. One such example is the redesign of the radio communication elements presented earlier (see Figure 12.6).



(a) Original design

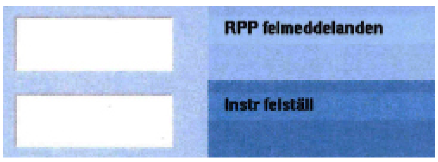
(b) Final version

FIGURE 12.9: Comparison between the original SIP’s design for weapon and ammunition states and the prototype’s. The colour coding was kept, but bars were added to allow for at-a-glance assessment of different states.

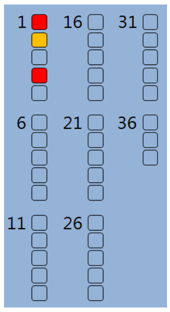
Another example is the design elements showing information about which weapon is currently selected, whether it is in safe mode or not, whether it is loaded or not, and what kind of ammunition is loaded (see Figure 12.9). The prototype’s solution is to graphically, and not only numerically, show how much ammunition is left. Many games make use of status bars to represent, for example, the level of health, mana or stamina, remaining. Normally, the bars are shown as full or 100 percent when the character or item is at its full potential. However, since the instructors are used to white indicating that everything is okay and other colours that something needs attention, the bars in my final version of the prototype fill the white box (showing the amount of ammunition) until there is no ammunition left. The bars are coloured grey, turn yellow when the ammunition has almost been expended and turn black when the amount reaches zero. Ideally, the instructors intuitively perceive how much ammunition a squad has left just by reading the amount of grey shown in the ammunition part of the interface, since they do not have to actively attend to the numbers shown, unless the exact amount is needed for some pedagogical purpose. During the last user meeting with the subject matter experts, they agreed that the design was an improvement compared to the original SIP, but admitted that the new design would “take some time getting used to” (paraphrased and translated from notes taken in Swedish during the meeting). Consequently, the new design might initially lead to decreased SA, but considering the results reported by Branaghan et al. (2011, see section 12.3.1), familiarity should not be used as a design principle when the previous design is poor.

12.5.7 ERRANT MENTAL MODELS

People have trouble understanding the underlying processes behind a system if it behaves inconsistently (Cooper et al., 2007). Thus, providing consistency and standardisation throughout the system is important to ensure that the user will not form errant mental models (Endsley & Jones, 2012). However, consistency must be made in accordance with the intended task. In the original SIP, text boxes are used to convey most of the status information, but as already discussed in section 12.5.1, textual information requires more cognitive resources and text boxes signal editable content. As the boxes are standardised, identifying and attending to a specific one also becomes more strenuous. In the SIP prototype, icons and items with less salience are used instead to allow for quick identification of an item and its current state (see e.g. Figure 12.6), which theoretically would minimize the risk of instructors forming errant mental models.



(a) Original design



(b) Prototype design

FIGURE 12.10: Comparison between the original SIP’s design for cabin errors and the prototype’s. The original design shows the error messages as abbreviated strings (up to eight characters long) such as VNA HÄCK, TIM KYL and VBG. Since the instructor is more focused on whether or not a virtual tank is damaged and less interested in the nature of the problem, the prototype’s solution involves coloured boxes. However, while this solution is better suited to the instructors’ need, it can also hinder instructors’ SA, since the coloured boxes can be difficult to interpret without a quick reference guide.

On a critical note, there is one design solution in the SIP prototype that could potentially be more difficult to interpret than the corresponding design in the original SIP; the cabin error messages. The BTA simulator systems include two types of cabin error messages, of which both relate to simulated damage on the tank. First, the virtual tank can be damaged due to an event in the simulation, such as being fired at or driving into a solid object, for example, a large tree or building. If the vehicle is damaged, the tank commander will receive an error message on his or her display. Second, the instructor can produce error messages even without a simulated event to cause it. From the trainees' point of view, there is no difference between these messages, and only the instructor knows which is which. Figure 12.10 shows the original design and the prototype's design solution of the error messages item. Instead of having short-hand descriptions of the error messages in large text boxes, coloured squares, identified by their spatial position and number, are used. As with the ammunition selected, the fact that an error has occurred is more interesting for the instructor than the actual error itself. However, a possible drawback of the final solution is that less experienced instructors may have difficulty interpreting the coloured squares, form errant mental models, and might spend more time consulting the quick reference guide instead of focusing on the in-game facilitation. In sum, some design solutions in the SIP prototype assist the instructor in acquiring level 2 SA, while others may hinder it.

12.5.8 OUT-OF-THE-LOOP SYNDROME

As mentioned in section 12.3.2, out-of-the-loop syndrome only occurs in systems where all or parts of the operator's tasks have been replaced by automation. While the current BTA system includes some automation in terms of system interface feedback and system-controlled feedback (see Table 7.1, p. 86) that are inherit in most computer-based simulation systems, it leaves much of the in-game facilitation to the instructors. The SIP itself merely conveys information from the cabins, but does not automate any of the instructors' tasks in interpreting and acting on the information. Thus, out-of-the-loop syndrome is not an issue when designing the SIP user interface.

12.6 GUIDELINES FOR SUPPORTING INSTRUCTORS' SA

The aim of the prototyping process and subsequent analysis was to gain further understanding of the issues involved in in-game facilitation and instructors' SA. The following guidelines are derived from insights gained from the analysis. They are divided into three overall goals related to in-game facilitation: enhancing instructors' SA, providing at-a-glance assessment of in-game events, and reducing cognitive workload during in-game facilitation. The guidelines are summarised in Table 12.1.

First, to enhance instructors' SA, a system should be designed to *support perception of critical items*. In the case study, this entailed making critical cues salient, which works to minimise the risks of attentional tunnelling, unnecessary cognitive workload and misplaced salience. Additionally, it also implies avoiding the Christmas tree effect, where too many items clamour for the instructors' attention at the same time. The second guideline to enhance instructors' SA is *support comprehension of critical items*. This was realised in the case study by adding visual coding, such as percentage bars, in combination with numerical information (see, for example, Figures 12.8 and 12.9). The third guideline to enhance instructors' SA, *support prediction of future events*, was never realised in the case study. However, adding visualisations that support instructors in predicting the direction of an ongoing scenario, based on players' previous actions, would theoretically make in-game facilitation more efficient and dynamic, in that the instructors can more quickly react to changes in the scenario.

Second, related to the goal of enhancing instructors' SA is to provide at-a-glance assessment of in-game events. In order to achieve this, the instructors must have good SA, since they must interpret the current flow of information in relation to their understanding of the situation. Thus, generally *supporting instructors' SA* will improve at-a-glance

TABLE 12.1: Guidelines for the design of support systems for in-game facilitation.

GOAL	GUIDELINES
Enhance instructors' SA	
	Support perception of critical items
	Support comprehension of critical items
	Support prediction of future states
Provide at-a-glance assessment of in-game events	
	Support instructors' SA
	Support efficient use of displays
	Do not rely on familiarity as an excuse not to improve a poor design
Reduce cognitive workload during in-game facilitation	
	Reduce complexity
	Organise information on the basis of instructors' goals and tasks
	Strive for consistency and standardisation

assessments. Furthermore, the analysis also identified the importance of *supporting efficient use of displays*. This could, for instance, be achieved by presenting information through different modalities and supplementing or replacing textual information with other visualisation techniques, such as icons or percentage bars (see, for example, Figures 12.6 and 12.8). Using different modalities to present information will decrease the threats of attentional tunnelling and excessive cognitive workload, while avoiding textual information where possible helps to combat attentional tunnelling, requisite memory trap, excessive workload and errant mental models. Additionally, the synthesis identified *familiarity* as a possible guideline, but also a potential trap for designers. In accordance with Branaghan et al. (2011), familiarity should only be used when a design solution to successfully support instructors in their work has been found. Familiarity should never be used as an excuse to not improve a poor design solution.

Third, a key goal in successful in-game facilitation is to reduce cognitive workload during in-game facilitation. Three guidelines were specifically identified as a result of this case study: reduce complexity, organise information on the basis of instructors' goals and tasks, and strive for consistency and standardisation. By *reducing complexity*, including reducing screen density, less demand is put on instructors' working memory and they are less likely to experience data overload. Additionally, complexity creep can be avoided. *Organising information on the basis of instructors' goals and tasks* entails performing task analyses on representative and critical tasks related to in-game facilitation, as well as prioritising and organising items based on their importance and their connections to different tasks and goals. If done appropriately, this will support instructors by reducing demands on their working memory, reducing data overload and decreasing the risk of errant mental models. Furthermore, the case study also employed the use of tabular interfaces to allow for quick cross comparisons without putting too much strain on instructors' working memory (see Figure 12.5). Lastly, by *striving for consistency and standardisation* in the design, errant mental models are more easily avoided (Endsley & Jones, 2012). Thus, the user interface becomes easier to learn and more efficient to use.

12.7 CONCLUDING REMARKS

This case study explored system support of in-game facilitation by the means of a status information display at the SLWC's BTA facility. Although training at the BTA is synchronous, the instructors are unable to directly perceive the trainees, and have to rely on secondary sources, such as information displays and communications made over the radio, in order to act as in-game facilitators. This places high demands on the system's design to correctly and efficiently convey information about the trainees' performance, progress, and the status of the simulation. This study has identified several areas in which the status information panel (SIP) can be improved. However, only tentative conclusions can be drawn, due to the limited scope of the study. Future work in this area would involve a complete design process, where the prototype is implemented into the BTA system, evaluated in naturalistic conditions and compared to corresponding statistics from the use of the original user interface.

12.8 CHAPTER SUMMARY

This chapter has described a case study at a simulation facility at the SLWC, in which system support for in-game facilitation was studied from the perspective of instructors' situation awareness (SA). By the use of prototyping, several issues concerning the design of user interfaces for displaying status information were identified. For instance, the display should be designed in such a way that allows the instructor to perceive the necessary elements (status, attributes, relations), comprehend the situation based on that information, and make judgements about future events. Furthermore, the information should be presented in an intelligible way that allows for at-a-glance assessment of learner progress and performance. Thus, the assessment should be accomplished with minimal effort, in order for the instructor to quickly react to learner activities and changes in the scenario. A key goal is to reduce cognitive workload, which involves careful selection of what kind of information to display (and not to display), in order to lower perceptual complexity and strive for consistency, as well as placing that information in a logical way, based on the instructors' goals and tasks.

In sum, the project gave some valuable insights into the importance of instructors' SA in relation to in-game assessment and facilitation, and constitutes a step towards reaching Objective 4.

CHAPTER 13

CHALLENGES OF CAPTURING INSTRUCTOR NEEDS

In the previous chapter, I described a case study in which design of system support for in-game facilitation was explored. In parallel to that study, I was also involved in a second case study at the Swedish Land Warfare Centre (SLWC), which examined challenges involved in capturing instructor needs. More specifically, its aim was to identify and describe challenges related to the instructor role of subject matter expert. Thus, this study represents another step towards reaching Objective 4. In the following sections, I describe the aim of the case study, the methods used, and the conclusions drawn.

13.1 AIM OF STUDY

In 2011, the Swedish Armed Forces (SwAF) initiated a project to review simulation technologies used for training. They decided to purchase a licence to a version of *VBS2* (Bohemia Interactive, n.d.) that is adapted to the conditions of the Swedish Army. *VBS2* is a modified off-the shelf (MOTS) gaming and simulation training system, aimed for military and defence training, and is used by organisations all over the world. It is a proprietary system in the sense that users can buy different types of licences to use its different modules. *VBS2* is an interesting study object, because SGs of this scale are rare and it is also designed to be used in instructor-led settings.

Since a Swedish version of *VBS2* did not exist at the time, the developers of *VBS2* were contacted to draw up requirements for additional features needed. The civil organisation Swedish Defence Materiel Administration (FMV) was responsible for this process. By the end of 2012, a requirements specification had been finalised. At the beginning of 2013, I was invited by one of my contacts at SLWC to attend user meetings between Bohemia Interactive Simulations (BISim) and representatives from SLWC, Swedish Armed Forces International Centre (SWEDINT) and FMV. Given my observations at the StriSimPC (see Chapter 11.4.2), I decided that such an opportunity could benefit my continued study of instructor-led GBT.

The aim of this study was to identify and describe challenges for instructors in their role as subject matter expert during a project to adapt a SG to SwAF's GBT practices. Issues of specific interest were those pertaining to the instructor's or administrator's tasks and how they are dealt with during the elicitation of needs. Thus, the study contributes to the research question in terms of Objective 4.

13.2 METHODS

No specific formal methods were used for this study. As I conducted this research by attending meetings, which also meant participating by commenting on issues of interest for the research question, the research approach can be said to be a mix of participant observation and action research (see Figure 13.1). This means that I did not attend as a silent observer, but could, to a certain degree, influence the situation. However, as an outsider researcher meeting new people, from whom I had not yet gained trust and established rapport with, I would claim that my influence was minimal. During the meetings, I also gained access to some of the design documents, which provided the basis for the meetings. The data collected from the meetings were analysed, in order to identify possible challenges for capturing instructor needs.

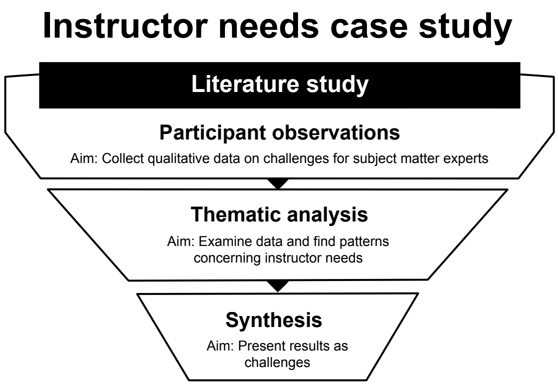


FIGURE 13.1: Research approach in the instructor needs case study.

13.2.1 PARTICIPANT OBSERVATIONS

Most of the meetings spanned over two days and were conducted at the SWEDINT facilities in Kungsängen, north-west of Stockholm, except one, which was held at the BTA facilities in Skövde. The user meetings that I attended served as checkpoints where the developers could present the work in progress, sort out details from the requirements, and discuss different design solutions with the stakeholders. The last meeting was also a critical design review (CDR) meeting, in which FMV was expected to approve the design. Although attendance at the meetings was not constant, in general, there were 1–2 developers (including the lead designer), 1–2 consultants from FMV (including the project leader), and 3–4 subject matter experts from SLWC and SWEDINT who attended the meetings. The subject matter experts had many years of experience with simulations and GBT, working as instructors and/or system operators. Most of them had also used earlier versions of *VBS2* for training (3 out of 4).

During the meetings, I took notes in order to capture what was being discussed and especially noted issues pertaining to instructors' tasks, including suggestions about how *VBS2* was to be used and interface design details. Appendix C presents a few excerpts from my field notes.

To gain more insight into the participants' attitudes and concerns, I also struck up conversations with them during breaks. I was especially interested in the subject matter experts' perspective of the meetings, but also tried to obtain a broader view by talking to the others.

13.2.2 THEMATIC ANALYSIS AND SYNTHESIS

A thematic analysis was conducted on the field notes. Issues pertaining to instructor needs and instructor support tools were isolated from other, less relevant issues and clustered into themes. It should be noted that most the meeting time was spent discussing details of the simulation (e.g. look and behaviour of snow, armour, vehicles, damage and injuries) and while these visualisation aspects are interesting in themselves, they do not notably affect the instructor's task. The issues identified by the analysis were then synthesised into challenges for capturing instructor needs and requirements during SG development.

13.3 CHALLENGES IN NEED ELICITATION

This section presents the results from the thematic analysis conducted on the field notes. Three challenges were found:

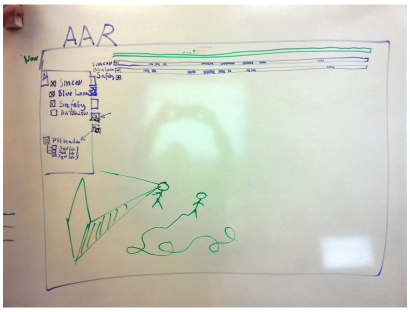
1. Balancing instructor needs against system constraints
2. Evaluating pedagogical benefits of novel features
3. Technical competence and GBT expertise

In the next sections, I describe these themes and related issues in more detail.

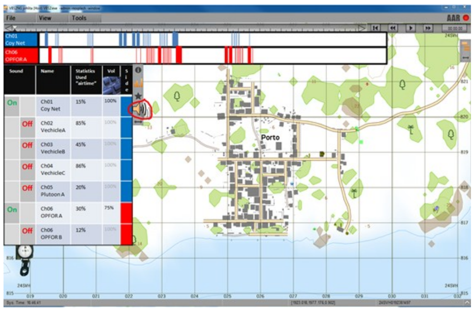
13.3.1 CHALLENGE 1: BALANCING INSTRUCTOR NEEDS AGAINST SYSTEM CONSTRAINTS

Often, when discussing simulated events and features, the question of computational constraints and lag was brought to the participants' attention. More realistic simulations require more computational resources and will result in lag, especially when a scenario has been played for some time. The solution to this problem was usually to either accept a simpler simulation or request an extra feature where a specific aspect of the simulation could be turned on or off. For instance, when discussing snow behaviour, the subject matter experts requested that vehicles and avatars leave tracks in the snow, something that can quickly slow down the server, especially for large-scale scenarios. To solve this issue, the subject matter experts suggested that they should be able to choose a specific area of the map where tracks would be shown, but not elsewhere. Making such adjustments was often requested as a feature in the mission designer module, that is, the real-time editor in which the instructor or system operator can, for instance, place objects or repair damaged vehicles, during runtime.

The design of the AAR module was the topic of a lively discussion among the participants. The subject matter experts wanted a more intuitive and flexible user interface for selecting and replaying sound from the combat network radio (CNR), since communication is one of the main learning objectives. They specifically wanted to be able to select the channel to listen to (thus muting others), to see the same user name in the AAR interface as the one used for CNR in the game, to filter out surrounding sound, and time stamp voice commands, in order to triangulate with other events. One of the subject matter experts became so engaged in this issue that he drew several sketches on the whiteboard and later also a digital sketch as an overlay to the current AAR interface (see Figure 13.2). As it transpired, the request proved problematic for two reasons: (i) it required substantial remodelling and reprogramming of the AAR module, and (ii) issues related to AAR were not prioritised in the project. However, the lead designer was responsive to the users' wishes and promised to look into the issue, even if a solution would not be implemented within the scope of this project.



(a) First sketch (drawn in Jan. 2013)



(b) Second sketch (drawn in Sep. 2013)

FIGURE 13.2: A subject matter expert's sketch of an improved AAR interface for *VBS2*. The second sketch was based on the current AAR interface.

Another requirement that was discussed involved the export and import of game data. From the beginning, the issue was limited to unit hierarchies, which the subject matter experts wanted to be able to export to a spreadsheet. The stakeholders also wanted to export data from the AAR module, which could be used for evaluations beyond debriefings (e.g. research). The benefit of this solution was to be able to share scenario information with stakeholders who do not necessarily have *VBS2* installed in their computer. Many of SwAF's personnel are also used to working with spreadsheets. As the discussion continued over the course of several meetings, the issue grew to also include other scenario data. In addition, one of the subject matter experts also wanted to be able to make changes to the exported files and then import them again into *VBS2*. However, another subject matter expert thought this would be too cumbersome and prone to error (e.g. risk of typos), given that the spreadsheets would involve large amounts of data and parameter names. Although the issue was never resolved during the meetings that I attended, it is clear that exporting and importing features increase the SG's usability and facilitate knowledge sharing and evaluations of training effectiveness.

A more straightforward issue was the availability of online user communities (e.g. forums) in which practitioners can, for instance, share stories, ask questions and give advice. Apart from conventional support (e.g. phone support), the developers also maintain their own user forums and allow sub-forums that are managed by a specific user group, such as the SwAF.

It should also be mentioned that the different stakeholders involved in this project had their own agenda. For instance, while the game developers are responsive to the client's requests, they are also unsurprisingly inclined to prioritise those features that will be of interest to a larger user group (e.g. being first on the market with a good simulation of snow) than just a subgroup of the clients (e.g. Swedish vehicles).

To summarise, instructors involved in the project as subject matter experts care and argue for features that will support their roles as scenario authors, in-game facilitators and debriefers. Computational resources and constraints can impede subject matter experts, whose main objective is to be able to facilitate serious gaming as easily and efficiently as possible. In the examples mentioned above, the ideal solution was often too difficult or costly to warrant implementation. Furthermore, differences in training practices at different branches of the organisation can lead to disagreements that cannot be easily resolved. A feature that would support one instructor in his or her practices can be seen as an encumbrance from another instructor's perspective. Resolving these issues involves making trade-offs and aiming for a good-enough solution.

13.3.2 CHALLENGE 2: EVALUATING PEDAGOGICAL BENEFITS OF NOVEL FEATURES

As mentioned in the previous section, a large proportion of the user meetings' time was spent discussing issues pertaining to fidelity. For instance, as a result of this project, a major upgrade to *VBS2* was snow behaviour simulation. Other areas, where fidelity was discussed, were vehicle appearance and behaviour, as well as combat gear and armour. Great care was taken to make all objects as similar to their real counterparts as possible. For example, vehicles, weapons and armour were photographed to capture as much detail as possible. One of the instructors commented that it was important for the trainees to learn how everything looks, in order to avoid confusion once they are out in the field. While the simulation fidelity discussions dealt with different types of fidelity (see Chapter 4.1.3), the subject matter experts often became preoccupied with physical fidelity specifically. Sometimes this led to a point where the developers had to remind them of the cost (high computational demand) versus the pedagogical benefit. There were occasions, however, where the subject matter experts saw pedagogical values of physical fidelity that had not been considered by the developers. For instance, when discussing snow on trees, the subject matter experts wanted it to interact with gun shots, so that snow would fall from tree branches if a gun was fired in the vicinity. The lead designer tried to argue against this, but one of the subject matter experts explained that it was important for tactical training, since one can pinpoint the location of an enemy by recognising bare patches in a forest's foliage. Nonetheless, the suggestion was not followed through, due to the increase in developmental time.

Even if fidelity was rated high in importance, the stakeholders were less impressed by beautiful graphics that served no other purpose than looking good (e.g. the colour of shadows on snow). For instance, one of the subject matter experts claimed to prioritise issues such as performance and system stability (e.g. being able to run the game on a 64-bit system) rather than nice graphics.

Another issue was AI and NPC behaviour. The AI is used in training, either to play the enemy side or to add more soldiers in training settings involving company or battalion level scenarios. Furthermore, NPCs are used for civilian or other non-military people. The developers have built randomness into their AI agents, in order to make NPC behaviour somewhat unpredictable, which they claim adds to the game's fun and replay value. However, one of the developers revealed that, due to customer demand, AI agents are becoming more predictable. This trade-off between replay value and need for control of the learning situation is a well-known phenomenon in SGs and not unique to this particular game (see e.g. Coleman, Menaker, & Hussain, 2010).

A related issue was conversations with NPCs. The new version of *VBS2* uses a conversational system similar to the one used in the entertainment game *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, n.d.), that is, it consists of a set of question-answer options or multiple options and branches, of which each may depend on external data. The subject matter experts also wanted to include simulations of the spreading of rumours and lying, but this issue was too complex to solve within the scope of this project.[1] Instead, since the game is based on open architectures, facilitators can edit conversation

[1] These types of avatar behaviours are known to be challenging for HBM and game developers (see e.g. Brusk, 2014).

files and create new conversations from scratch. Localised files with Swedish characters and fonts also enable text-based conversations in Swedish. Furthermore, subject matter experts were interested in being able to take over some conversations during gameplay. A suggested procedure was to have two actors (role-playing instructors) on stand-by for conversation requests from players. When receiving such a request, the actor takes over the NPC (acting as a puckster) and communicates with the player in real-time, either by text messages in a chat window or by voice in the CNR. Such live conversations would add more flexibility to the training sessions than only relying on pre-scripted conversations.

One of the subject matter experts expressed concerns that the mix of pre-scripted and live conversations may lead to different responses from the trainees. For instance, they might become more suspicious about the intelligence received from instructor-controlled avatars than the game-controlled ones. The developers also wanted to add an icon on top of the NPCs who have intelligence to share. This would constitute the kind of scaffolding that Linderoth (2012) advises against (see Chapter 7.1), since it would allow players to recognise important individuals without talking to them or reading their body language (which would be the real-world equivalent). Here, however, it was seen as a method to speed up gameplay, although subject matter experts requested to be able to toggle it on and off.

Another concern for the live conversational system was the delay that would occur if the actor was not immediately available when a conversation request was sent. The developers suggested a solution where the NPC is given a set of control options: (i) 'with timeout', that is, a notification is sent, but if the actor does not take over the NPC within a set time frame, the AI conversation starts instead, (ii) 'never', that is, no notification is sent and NPC is not available for instructor control, and (iii) 'admin conversation only', that is, the players have to wait until the actor takes over the NPC and no AI conversation is available. The subject matter experts were satisfied with this solution, given that the trainee would receive some kind of indication that the game is waiting for a response from the facilitator.

To summarise, the subject matter experts involved in this project put great value into high levels of simulation fidelity and advanced AI features. Discussions often centred on physical fidelity. However, they ultimately deemed physical fidelity less important when its pedagogical benefit was questioned by the lead designer. This seemingly contradictory behaviour may be due to the fact that physical fidelity is more tangible and therefore easier to discuss and criticise. Moreover, issues related to AI often lead to trade-off situations, such as predictability versus replayability or automation versus flexibility. Thus, a challenge for both subject matter experts and SG developers is to identify and prioritise pedagogical needs in relation to ideas of future serious gaming practices. While subject matter experts should be encouraged to explore possible uses of SGs, they also need support in evaluating the pedagogical benefits of a particular new feature compared to current practices. At the same time, developers must be responsive to the subject matter experts' ideas and needs, even if they seem superfluous at first.

13.3.3 CHALLENGE 3: TECHNICAL COMPETENCE AND GBT EXPERTISE

As mentioned earlier, *VBS2* is based on an open architecture, which means that even if it is a proprietary system, the user can view the source code and even make modifications to parts of it. The subject matter experts involved in this project had learned the scripting language and readily made modifications to objects and NPC behaviour. One subject matter expert even expressed excitement at doing this and claimed to spend his leisure time scripting 'just for fun'. This is in line with Ardito, Buono, Costabile, Lanzilotti, and Piccinno (2012), who show that end users are increasingly involved in creating and modifying software, as opposed to merely using it. Thus, basing SGs on open source code allows expert users (so-called champions) to modify parts of the game to fit specific training needs. However, since not all instructors have scripting skills or are interested in spending time on modding, some features require more easy-to-use ways to modify the game. One such feature was the conversational system mentioned in the previous section.

It was also evident from the observations that champions are also valuable assets in the development process. As power-users with previous experience of the game to be upgraded or similar games, they offer unique insights into the merits and shortcomings of the current system and can offer concrete solutions. One example of this is the AAR sketches drawn by one of the subject matter experts (see Figure 13.2) and another is the live conversation procedure described in the previous section. This was in stark contrast to the subject matter experts involved in the *Elinor* case (Chapter 9) and the *Tactical Incident Commander* project (Chapter 10), who did not have previous experience with SGs and struggled to see the possibilities that SGs offer.

To summarise, having sufficient technical competence allows instructors to be more involved in both SG development and serious gaming practices. Conversely, lacking sufficient technical skills may make instructors' tasks more challenging, both as facilitators and as subject matter experts. Similarly, having experience of serious gaming is beneficial for subject matter experts. Their experiences allow them to explore more alternative uses of games and to articulate more elaborate needs and requirements. This is especially apparent when compared to the less experienced subject matter experts involved in the development of the *Elinor* console and the *Tactical Incident Commander* game (Chapters 9 and 10, respectively). However, experienced subject matter experts may have difficulty understanding how less experienced instructors perceive the game, as well as the possible usability and UX problems that may arise. Therefore, less experienced instructors should also be involved in the development process, for instance, during user tests.

13.4 CONCLUDING REMARKS

Although this was a limited study, it complements previous ones, since it studied instructors who are experienced in serious gaming and act as subject matter experts during SG development. The list of challenges described in this chapter is by no means exhaustive and more studies are needed. Future works could add in-depth interviews with all stakeholders, including SG developers, in order to gain a broad view of the issues involved in developing and improving SGs to support instructor-led activities.

13.5 CHAPTER SUMMARY

This chapter reports on the insights gained from being involved in user meetings during a project to purchase a Swedish version of *VBS2* for the SwAF. Three challenges of capturing instructor needs have been identified and described (Objective 4). First, in their role as subject matter experts, instructors struggle with balancing system constraints against needs for system support when planning scenarios, facilitating gameplay, and running debriefings. Second, a related challenge is evaluating pedagogical benefits of novel features, such as higher degrees of simulation fidelity and more advanced game AI. These features often have technical constraints that make them difficult or costly to implement. Thus, subject matter experts have to use their knowledge and experience of serious gaming, in order to argue their case. Third, the study found that high technical competence and a more in-depth understanding of GBT is beneficial for instructors when conveying their needs to SG developers. This is consistent with the previous case studies, which found that a lack of these skills had a negative effect on instructors' experiences as subject matter experts. Consequently, not all subject matter experts can be expected to be knowledgeable in serious gaming practices and overcoming this disadvantage constitutes a challenge in itself.

PART IV

RESULTS AND KNOWLEDGE CONTRIBUTIONS

CHAPTER 14
THE COACHING CYCLE FRAMEWORK

After analysing the training practices observed at the SCCA and the SLWC, an overall pattern of training phases emerged. These phases were identified as (i) preparation, (ii) lesson or briefing, (iii) exercise (including gameplay and formative assessment), (iv) summative assessment, and (v) debriefing/AAR. This structure was sometimes repeated in a cyclic fashion, where a short debriefing session was followed by new directives, that is, briefing, and further gameplay. After one or several iterations, a more thorough debriefing session would follow.

Identifying and formalising these patterns was the first step towards reaching Objective 3, that is, building a framework for instructor-led GBT. It is important for a framework to be grounded in real-world practices, in order to be usable for practitioners. The next step was to compare observations with theoretical models of training and learning in general and serious gaming in specific. The result was the *coaching cycle* framework (Alklind Taylor, Backlund, & Niklasson, 2012). This chapter presents the core ideas and assumptions behind the framework, relates it to other similar frameworks, and discusses how they differ from the coaching cycle.

The three main phases of the coaching cycle are: scenario authoring, gameplay, and debriefing (see Figure 14.1). Apart from these, I also touch upon briefing and preparation of debriefing as vital but shorter phases of the cycle.

14.1 SCENARIO AUTHORING

In Chapter 7.2, I describe scenarios as a game element that sets the game in motion. Scenarios play an important role in GBT practices and so also in the coaching cycle. Depending on how the game has been designed, a scenario is (i) created from scratch, (ii) elaborated on from an already existing scenario, or (iii) simply chosen from a list of available ready-built scenarios. From an instructor's perspective, creating a scenario from scratch requires a high level of skill in scenario authoring, whereas the last option is usually more efficient but also less flexible. In the case studies described in Part III, my colleagues and I have explored scenario authoring from two perspectives: as something that the instructor does as part of the preparation and as part of the learning experience when it is performed by learners. Either way, if a SG allows tweaking, or even creation of completely new scenarios, serious gaming becomes more flexible and dynamic, since

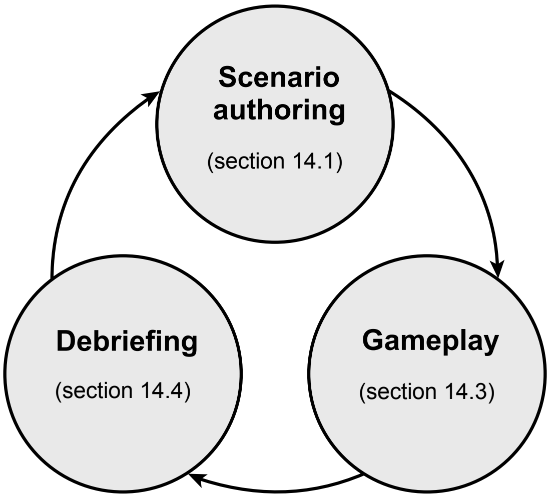


FIGURE 14.1: Simplified model of the coaching cycle.

it affords a broader set of learning goals to be met using the game. It also puts the locus of control onto the individual instructor, as opposed to the developer or the subject matter experts who happen to be involved in the development process. Instead, active scenario authoring increases the degrees of freedom that instructors have in adapting a game to their pedagogical aims. For instance, as described in Chapter 13, some of the instructors at the SLWC, who use *VBS2* in their training, have learned to modify the game through scripting. This involves, for example, creating conditional statements to alter the behaviour of certain NPCs, who will act differently than their hard-coded counterparts. This allows a wider range of behaviours from NPCs than in the basic version of the game.

Scenario authoring at this level must, evidently, be carried out before the game has begun. However, a less self-contained scenario will have to enable the instructor to change certain parameters or conditions in-game, although these alterations should not require interactions that take too much time (e.g. scripting) or make rebooting the game a necessity. For open-ended or baseline scenarios, pre-authoring might only involve setting the initial scene (e.g. the virtual environment with the map, buildings and avatars), while leaving the rest open to whatever the learners and pucksters want to do. Scenario authoring then spills over into the gameplay phase of the cycle, which is dealt with in section 14.3.

There are a number of possible challenges related to scenario authoring. Certain instructors might not be motivated to create new scenarios, might feel they lack the necessary technical skills in order to realise their ideas, or they might not have enough time to develop a scenario from scratch. In the *Tactical Incident Commander* case (Chapter 10), for instance, we noticed that the instructors did not try out the scenario editor. During the interview, they admitted to not having enough time to familiarise themselves with it and also that they found it difficult to see where their role fitted into the serious gaming activities, which affected their motivation negatively. This is consistent with one of the barriers described in Chapter 8.2, which states that instructors can be hesitant about actually becoming involved in game production, due to time restraints and the priorities of their teaching duties. If instructors do not regard scenario authoring as part of their teaching practices, this could pose a real problem to GBL and GBT practices.

Another challenge to scenario authoring can be found in the SLWC case (Chapter 11), which describes situations in which the training goal or difficulty level of a scenario was re-negotiated shortly before a training session. These examples show that scenario authoring software must be flexible enough to deal with last-minute changes, including re-evaluations of the overall goal. Thus, a scenario editor must provide an easy-to-use and effective interface.

While it is usually the instructor who creates the scenario, scenario authoring can also be done by the learners, in order to encourage them to experiment with the game's underlying structure and, in doing so, to learn about work structures, specific terminology, and other aspects of their future tasks that have been built into the game (Alklind Taylor & Backlund, 2011). Scenario authoring by students is a concept that was explored in the pedagogical framework of *Tactical Incident Commander* (Chapter 10). It is up to the instructional designer to decide which approach should be used. The decision will have profound consequences for how the scenario builder will be designed. For instance, in *Tactical Incident Commander*, scenario creation was carried out by adjusting different conditions (e.g. what resources are available at the start of the game) and not by formulating elaborate conditional statements. This solution has the advantage of not requiring the scenario author to predict all actions of the player (which is already constrained by the game itself), and can focus on experimenting with different conditions for the mission. Thus, a scenario authoring system developed for use by students, should not require too much knowledge of the subject matter so that scenario creation becomes too difficult or even impossible.

14.2 BRIEFING

As presented in Chapter 8.1, learners must become acquainted with the idea of serious gaming, before playing a SG for the first time. Once they start playing, they also need to know what is expected of them, for example, the overall goal of the exercise (van Kessel & Datema, 2008). Thus, gameplay is often preceded by some type of introduction or briefing. As mentioned in Chapter 11, more time is spent on briefing, if the learners are novices. It would, however, be possible to minimise this phase, leaving more time for other activities within the coaching cycle. The idea of a short briefing instead of a thorough lesson is consistent with the second type of serious gaming situation outlined by Crookall and Thorngate (2009), in which the game is supposed to elicit new knowledge based on concrete experiences and, thus, needs little pre-teaching (see Chapter 7.4). In essence, by having concrete experiences through gameplay, learners are more likely to grasp abstract concepts related to those experiences, since they give learners concrete exemplars on which to 'latch' abstract knowledge (Kolb & Kolb, 2009). Following this reasoning, briefings should be restricted to only making sure learners are comfortable with the situation and understand the purpose of the game. This is why briefing is not emphasised in the coaching cycle model (see Figure 14.4).

14.3 GAMEPLAY

Once the scenario is built, gameplay can, in theory, begin. As mentioned in Chapter 5.2, gameplay can be viewed as a situated activity; that is, its nature and outcome are dependent on the physical and socio-cultural context in which it takes place. Social interaction can take on a number of forms. It can be direct, as in Figure 11.14b (p. 150), where communication is synchronous and situated in the same physical space, or mediated via avatars or communication networks (e.g. radio, chat, email) which can either be synchronous or asynchronous.

The nature of communication has an effect on gameplay. For instance, direct communication has the advantage of being able to use the full range of natural language: speech, facial expressions, body language and posture. Although some avatars include the opportunity to display emotional and non-verbal signals, they are far from being a natural extension of one's own body (Abshier, 2012; Dormann, Whitson, & Neuvians, 2013). However, although direct communication is an effective way of catching someone's attention, it also results in disrupting the player's sense of immersion and presence. Figure 14.2 illustrates an action-feedback cycle derived from the game cycle outlined in Chapter 7.3.1 (see Figure 7.2, p. 85), but extended to include not only feedback from the (digital) game but also the instructor. System interface feedback (see Chapter 7.3.1) is immediate and should, if possible, resemble real-world feedback, thus constituting functional fidelity (see Chapter 4.1.3). For instance, if a cadet has made an avatar in *VBS2* sprint, the field of view sways as if the avatar is out of breath, making target shooting more difficult. The trainee thus receives the feedback that running before making a shot is inadvisable.

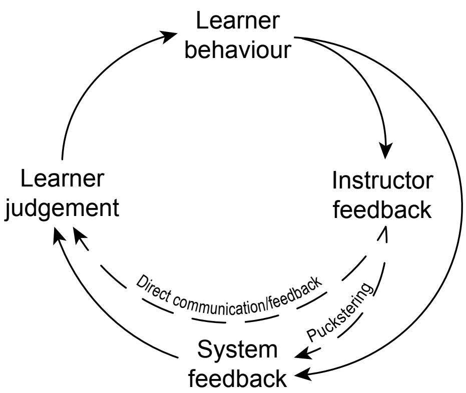


FIGURE 14.2: Action-feedback cycle during gameplay in which a learner receives feedback from the system and the instructor (both directly and indirectly). System feedback refers to both system interface feedback and system-controlled feedback.

System-controlled feedback (see Chapter 7.3.1) requires that performance can be represented in a quantifiable way within the system. Therefore, the instructor can complement or add to system-controlled feedback where more dynamic and flexible feedback is needed. For example, when a learner communicates with an NPC, its speech can be voice-acted in real-time by an instructor. The NPC can then respond to any questions or utterances from the learner and not be limited to pre-scripted communication (see Chapter 13 for an example). Instructor-controlled feedback can be direct, that is, the instructor interacts directly with the learner, or indirect through manipulating the game (e.g. placing an enemy soldier in the vicinity of the trainee or taking over an NPC's avatar) which, in turn, gives feedback to the learner. The result of these action-feedback cycles is a continuous loop or spiral, as depicted in Figure 14.3. Of course, players will probably receive most of the feedback from the game itself and less so from the instructor, since system-controlled feedback is automated and fast, whereas instructor-controlled feedback is manual and requires a high degree of instructor control, effort and technical skills. Ignoring or not allowing instructor-controlled feedback would, however, make the game less flexible and dynamic.

It is obvious why gameplay is a natural ingredient in GBT practices and so also in the coaching cycle. In the following sections, I describe certain issues related to gameplay and also introduce two new concepts related to the coaching cycle: coaching-by-gaming and instructors' situation awareness.

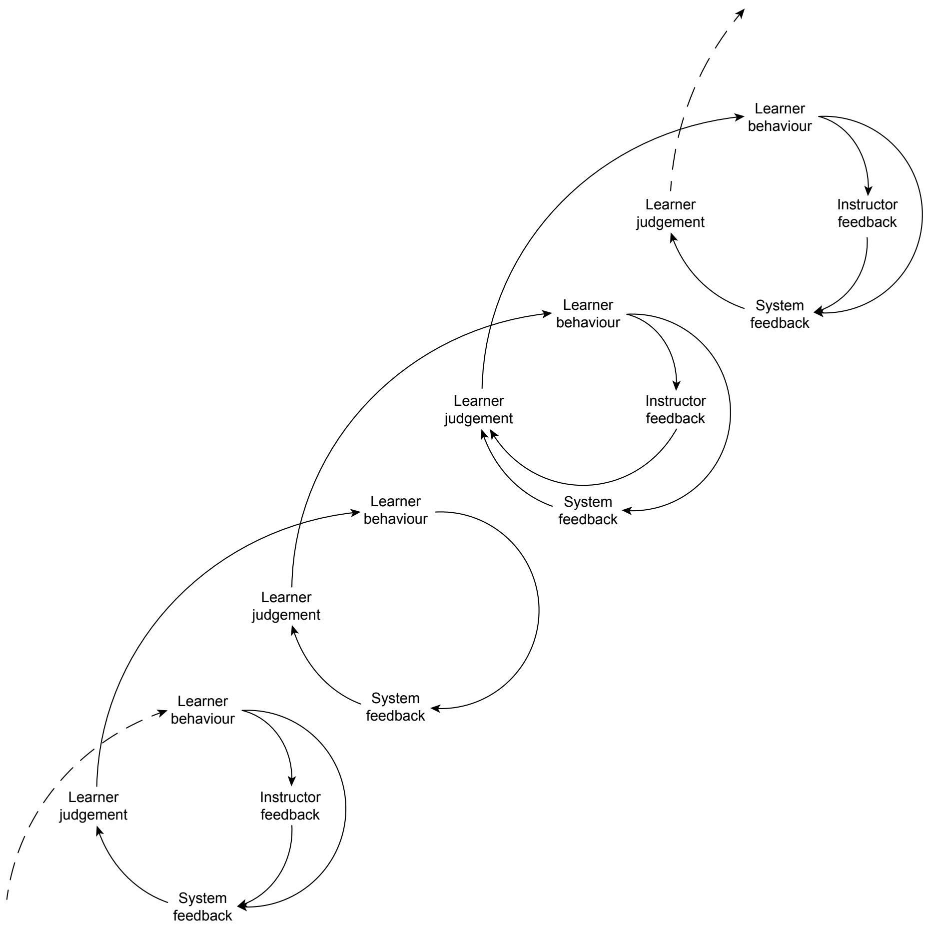


FIGURE 14.3: Action-feedback loops during gameplay. One action leads to another, which in turn leads to another based on feedback received from the system and/or the instructor.

14.3.1 COACHING-BY-GAMING

Earlier, I introduced the idea of instructors indirectly communicating with learners by, for instance, taking control of an NPC, that is, the extreme form of in-game facilitator (as described in Chapter 8.1), or role-playing. Brennecke (2009) argues that gameplay is not exclusive for learners, but can also be applied for instructors. *Coaching-by-gaming* is an instructor-in-the-loop approach, where the instructor actively and dynamically alters the scenario in real-time. I use the term 'coaching' because the role of the instructor is not teaching, but observing the performance of the learners, steering them in the right direction when needed, and adding challenges that are matched to the individual learner's skill level. The goal is to encourage learners to enter a mode of deliberate practice in their endeavours to become experts within their field of work (see Chapter 6.2.2). Severe errors of judgement might warrant the instructor to interrupt gameplay, in order to achieve what Schön (1983) calls reflection-in-action, that is, deliberation during (in this case) gameplay. Here, the coaching-by-gaming is most powerful, since the interruption or call for reflection can be made as if part of the scenario.

As evident from the case study at the SLWC (see Chapter 11), coaching-by-gaming is readily used within the military simulation community. Tied closely to the concept is the term puckstering, that is, coaching-by-gaming which assumes that instructors control the narrative and gameplay by controlling avatars of their own (playing the game themselves; Alklind Taylor & Backlund, 2011). This has several benefits. First, by taking an active part in the learning environment, instructors increase their sense of involvement in the gameplay phase. This should increase user acceptance of GBT practices among instructors. Second, coaching-by-gaming means that feedback can be delivered in a non-intrusive way, where feedback from the instructor is immediate and indistinguishable from system feedback. Thus, the instructor can create a situation in which a message to be learned is conveyed within the context of the game narrative instead of direct communication (Raybourn, 2007). Examples of this can be found in Chapter 11. Third, a human puckster can discern between different actions of the learners, based on contextual information (e.g. a conversation overheard in face-to-face communication), and act according to certain pedagogical principles, while AI solutions are limited to information in the digital game space. This was evident in the SLWC case, where gameplay occurred both in *VBS2* and off-game (see Chapter 11.4.2). Thus, a fully adaptive system has to account for all activities, both 'inside' and 'outside' the virtual game space.

Automation has its advantages, however, and ideally, human and virtual pucksters should work in parallel, especially in large-scale multi-player gaming sessions. For instance, Colonna-Romano et al. (2009) suggest that virtual pucksters could help a single operator control the behaviour of a group of avatars, making them perform coordinated and realistic actions. This would reduce the number of pucksters actively involved in training, but not exclude them completely.

14.3.2 INSTRUCTORS' SITUATION AWARENESS AND ASSESSMENT

In Chapter 7.3, I outlined the importance of assessment and feedback for learning. Embedded, or stealth, assessment helps instructors make ongoing appraisals of their learners, which is highly compatible with the coaching-by-gaming approach to GBT. Here, an instructor who supplements the monitoring system is valuable. However, it is often difficult for an instructor to manually monitor everything that is happening within a game, and some kind of assessment aid or visualisation is therefore needed. Without continuous information about learners' progress and achievements, real-time adjustments to the game become hard, if not impossible.

A prerequisite for coaching-by-gaming and in-game assessment is that the instructor knows what is going on during gameplay, in order to assess the situation. In Chapter 5.1.2, I introduced the concept of situation awareness (SA). While there are many endeavours to improve SA for professionals such as pilots and soldiers (e.g. Livingston, Ai, Karsch, & Gibson, 2011), few have investigated how to increase SA for instructors. The case study outlined in Chapter 12 represents one such endeavour. In that study, I introduced the concept instructors' situation awareness. I define *instructors' situation awareness* as being aware of what is happening in the learning space (both in-game and off-game) and understanding how that information can be used to assess learners' progress in relation to the current and future learning goals. A SG designed in accordance with the coaching cycle should facilitate instructors' SA by incorporating specific GUI components such as HUDs, information panels (see Chapter 12 for an example), and an extended assessment module that can be used in both real-time and during debriefing.

The greatest challenge for facilitating instructors' SA is analysing off-game data and combining it with in-game data in a sensible way. As is evident from the observations at the StriSimPC (see Chapter 11.4.2), collecting off-game data would mean recording speech, monitoring who is talking to whom (and, preferably, what they are talking about), logging pen-and-paper notes taken, and so on. The challenge here is not to gather the data – that can be achieved with well-placed video recorders and microphones, as well as by requiring digital technology equivalent to pen-and-paper (e.g. tablets) – but to synchronise it with in-game data in a way that makes sense for formative and summative assessment. In the case described in Chapter 13, a great concern for the instructors was to get the audio from the trainees' communications through the headsets (which was handled by a separate programme incorporated into *VBS2*) to work in a useful way in the AAR module. A problem here was that the instructors wanted all audio, irrespective of how it was recorded or if it was an in-game sound (e.g. gunshot) or speech, to work in the same manner in the AAR interface. Instead, because of the way sounds from the headsets were recorded, the programme could not process them as other sound objects, which lead to a less optimal solution. By extending this issue to data recorded with equipment that has not been adapted to the SG at hand, the problem should become evident. With today's SGs, instructors can, at most, expect to get the off-game data synchronised with the in-game time-line, but triangulations between in-game and off-game data to assess learners' performance must still be done manually. Herein lies a potential for future research.

14.4 DEBRIEFING

Since most practitioners and researchers view debriefing as essential for GBT in order to achieve reflection-on-action (see Chapter 7.4), it makes sense to include it in the coaching cycle. Since debriefing is carried out after the gaming experience, it is likely to include mostly summative assessments and feedback, although formative feedback could be included, if the coaching cycle is executed through short gaming sessions interspersed with a number of debriefing sessions. Something that is seldom discussed in SG literature is the time and effort required to prepare a debriefing session. In the observations at the SLWC (see Chapter 11), instructors had only a few minutes to prepare the debriefing. This meant they had to (i) use time from in-game facilitation to take notes about what issues to raise later, (ii) require the trainees to perform some extra task, which does not require in-game facilitation, in order to gain more preparation time, or (iii) perform some of the debriefing on-the-fly or in an *ad hoc* fashion. Experienced debriefers handle this without problems; they know what the main issues are and can pick out what constitutes important events in the current training session that need extra attention during the after-action review (AAR). However, less experienced instructors might feel overwhelmed and unsure of how to handle the overflow of information, which leads to an unfocused debriefing that pays too much attention to inconsequential details. While having inexperienced instructors working alongside more experienced ones is a good way to remedy this, there is also great potential in developing and improving debriefing tools that help instructors disregard and structure issues found during training.

Furthermore, if the game includes some type of achievements or game scores (e.g. victory points), these are also reviewed during the debriefing. The instructor should be very clear about the fact that the "the real winners are those who learn from the game" (Hofstede, 2008, p. 76), which is independent from winning the game. A good example of this presented itself during the observations at the BTA (Chapter 11), especially during the King of the Hill scenarios. Here, infinite points are awarded to the crew that manages to hit a bird, making them the immediate winner, regardless of their performance in the rest of the game (see Figure 11.6, p. 144). Although this is not a serious part of the scoring system, it can be argued from a game mechanic perspective that high (or in this case infinite) points for tasks unrelated or counter-productive to the training objectives can result in learners focusing on the wrong aspect of the game in order to win (see Chapter 6.3). This game mechanic at the BTA could easily be translated to a game achievement instead; acknowledging and rewarding the feat of a difficult hit without overshadowing the other game mechanics. Both achievements and scores tell us something about what the players have been doing in the game and, by contextualising them, the instructor can assess overall performance.

Although an instructor-in-the-loop approach is one of the core concepts of the coaching cycle, I also acknowledge that there are benefits to automated assessment and self-assessment. Automation helps alleviate some of the cognitive load of the instructor and can also be more practical, since it leaves more options open to flexibility in terms of when and where playing takes place (see Chapter 8.2). For instance, it is important to be able to detect whether the learners are in an undesirable gamer mode. While a skilled instructor might spot this tendency during gameplay (in-game assessment), it is also important that the AAR interface visualises this in some way and that it is brought up during debriefing. It should be noted, however, that while tools for automated assessment and AAR interfaces "provide an objective viewpoint of the training exercise, they do not provide training feedback or assessment on their own" (Johnson & Gonzalez, 2008, p. 111). Thus, automated assessment should still be supplemented by a human instructor.

Debriefing can also be realised without the instructor, which leads to the concept of self-assessment. Self-assessment has the benefit of a higher degree of learner control which, in turn, benefits learning (Kay, 2001). As mentioned in Chapter 10, *Sidh* included a self-assessment module, where the player, after each mission, enters an in-game debriefing room (Backlund et al., 2009). There are, however, some drawbacks to self-assessment that need more attention in future research. Self-assessment requires that information from the log files is provided to the individual learner. These data may be difficult for the learner to interpret or contextualise and there is a risk that he or she will fixate only on the negative aspects and mistakes. In *Sidh*, the quantitative scores are complemented with an NPC instructor who utters a few encouraging words to summarise the mission performance. While this might be enough during between-game debriefings, I would argue that at some point learners need to also have instructor-led debriefings, mainly to ensure that learners do not focus on low game scores or have trouble reflecting upon the experiences in a nuanced and in-depth manner. This was evident in the *Tactical Incident Commander* case, where the absence of instructor-led activities resulted in learners not understanding the purpose or usefulness of the game (see Chapter 10). Chapter 7.4 also mentions the importance of de-roling and diffusion of tension, which could be hard to accomplish without the presence of a mentor or coach. Thus, for complex training situations and ones that are emotionally disruptive, self-assessment should only be carried out by experienced learners who have reached a high level of self-regulation skills.

Other issues that are seldom explored in SG research are trust and privacy, when data about gameplay and performance is logged. For instance, a possible negative effect of self-assessment is low user acceptance (see Chapter 5.3); if the learners do not trust the ones operating the system or feel that the system logs sensitive or private data, it will ultimately have a negative effect on learning (Malheiros, Jennett, Seager, & Sasse, 2011). The problem of privacy issues obviously becomes even more severe if peer-assessment is employed, or if scores or other potentially embarrassing information is shared among learners. Thus, SG developers must take measures to minimise negative effects related to privacy and integrity, if self- or peer-assessment is to be implemented within the system. Peer-assessment undoubtedly has positive learning effects and can enhance learners' ability to handle critique, but educators should be aware of the potential drawbacks. Malheiros et al. (2011) suggest that players should be in control of the information shown to others and that information logging and sharing within the system should be transparent to the users. Trust and privacy issues are also a concern when debriefings are instructor-led. For instance, in the *Elinor* study (see Chapter 9), one of the participants was uncomfortable sharing information about the gameplay with the facilitator. In this specific case, the participant avoided playing at times she thought were not socially acceptable (in the middle of the night), because she knew that it would show in the logs. Here, both the facilitator and the game developers share responsibility in establishing trust. For instance, playing times can be displayed as duration instead of exact clock time in the AAR/diagnostic interface (see Figure 9.4, p. 113). Additionally, the facilitator should be sensitive to possible social and cultural factors that could affect gameplay and establish rapport with the learner.

14.5 SUMMARY OF THE COACHING CYCLE

The coaching cycle as displayed in Figure 14.4 aims to describe serious gaming practices from an instructor perspective. It consists of three main phases: scenario authoring, gameplay and debriefing, in which the instructor takes on different roles to facilitate learning. Most importantly, the framework highlights the way in which instructors contribute and improve serious gaming, as well as how SGs and SG practices can be improved to support instructors in their tasks.

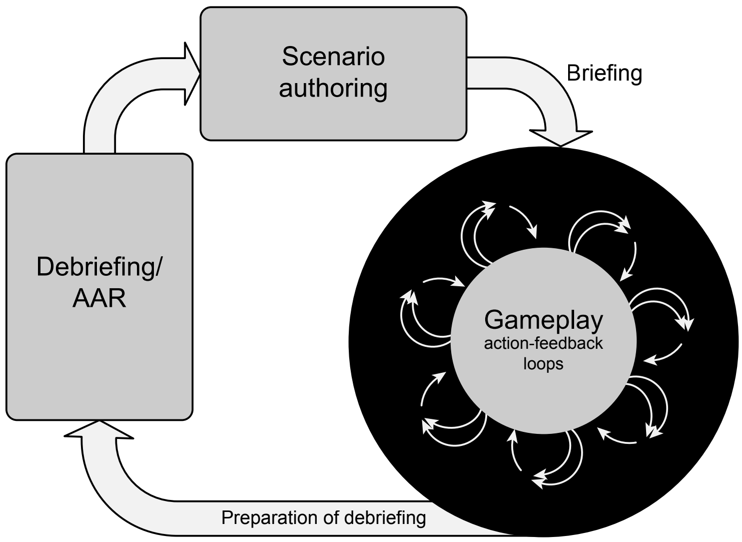


FIGURE 14.4: Model of the coaching cycle.

Furthermore, the matrix in Table 14.1 represents four potential roles in GBT. Most researchers consider the 'learner-player' and the 'instructor-author' roles to be the 'typical' roles that instructors and learners have in GBT, whereas the other two ('learner-author' and 'instructor-player') are less explored and are presented in the framework as being possible role-swaps for further study. The roles of instructor-author and learner-author are described in the scenario authoring stage of the coaching cycle (Chapter 14.1), while the instructor-player role is represented in the coaching-by-gaming concept presented in Chapter 14.3.1.

The main points of the framework are:

- Instructor-led GBT practices can be abstracted down to three core phases: scenario authoring, gameplay and debriefing, which follow each other in a cyclic fashion.

- Scenario authoring can be used as a playing and learning experience.
- Learners should be allowed to gain experiences through gaming before generalising knowledge, which assumes that briefings or introductions are kept short and with minimal theoretical content.
- Coaching-by-gaming is an instructor-in-the-loop approach to serious gaming, where instructors steer and pace the gameplay, by playing the game themselves, which provides embedded, non-disruptive in-game feedback.
- In-game facilitation and coaching-by-gaming require support for instructors' SA and assessment.
- Debriefings should be in-depth and dynamic. Support for debriefing includes preparatory features (e.g. bookmarks), visualisations (e.g. graphs and tables) of in-game and off-game data, and replay functionality.
- Even if a self-assessment scheme is employed, it should be supplemented by instructor-led debriefings.

TABLE 14.1: The player-author matrix; four views on how participants can contribute to serious gaming.

	PLAYER	AUTHOR
LEARNER	Plays the game in order to develop/improve skills	Creates scenarios to learn about work structures
INSTRUCTOR	Plays the game to give context-related and embedded feedback	Creates scenarios for specific learning goals

14.6 CRITICAL APPRAISAL

Frameworks are used in various ways. According to Rogers and Muller (2006), a framework can be used to refer to "a model, an account and a form of prescription" (p. 3). It is typically derived from a theory or a set of assumptions about a phenomenon. As a framework, the coaching cycle is general and applicable in different GBT settings. It describes instructor-led GBT practices derived from both theory and empirical work, but can also be used to inform the design of GBL experiences and the design of SGs (as artefacts that can be used for these experiences).

It is important to bring the underlying assumptions of the coaching cycle to light. First, many of its concepts assume that serious gaming is synchronous and centralised. For instance, coaching-by-gaming would only work in an asynchronous situation, if the game is turn-based and played over a longer period of time (days or weeks). In most formal educational settings this is not practical or desirable. Thus, in the *Tactical Incident Commander* project (Chapter 10), coaching-by-gaming was not implemented, since the stakeholders wanted to use the game as part of a distance course. Similarly, if the participants are allowed to play anywhere, anytime, setting up recording devices to log off-game activities can be cumbersome and perceived by participants as a breach of privacy. Instead, instructors have to rely on in-game logs and specific off-game (digital) tools that participants are directed towards, such as discussions in forums and chat messages. Thus, the coaching cycle is optimised, if implemented in a synchronous and centralised setting, but can be tweaked to work in other conditions as well.

A second assumption is that instructors want to be actively part of GBT. In all case studies but one, instructors expressed a desire to take part in serious gaming. In the *Elinor* project (Chapter 9), the subject matter expert (e.g. the healthcare professionals) made it very clear that the console was not to be used as a stand-alone tool, but should supplement current rehabilitation practices. They also made sure that the console included log features and a diagnostic screen. In the SLWC project (Chapters 11, 12 and 13), instructor-led GBT practices were already in place, and the instructors did not express any intention of changing it. The only case in which the instructors did not actively take part in GBT was for the *Tactical Incident Commander* game. A discussion on why this was the case is presented in Chapter 10.3, where it is posited that the main barriers were time constraints and user acceptance. Thus, more efforts to achieve buy-in from instructors must be made by all stakeholders, including management and developers.

A third assumption is that instructors experience some level of engagement when coaching-by-gaming, that is, they like to play games. This implies that SG developers have to design for good player experience (PX) for instructors, not just learners. An interesting challenge in this regard is whether the instructors should be merely engaged or fully immersed in the gaming situation? For example, should they feel presence, or flow and, if so, to what degree? More research is needed on this issue, but I would argue that instructors should not be as immersed in gameplay as the learners, since this might cause them to lose focus on the pedagogical issues and miss important coaching events. In other words, instructors engaged in coaching-by-gaming might enter gamer mode, which could have negative consequences for the overall learning experience. Thus, a balance between engaging in gameplay and remaining in coaching mode must be found and preferably designed for in SGs.

A fourth assumption is that the games used for training are explicitly designed for instructor-led GBT. The coaching cycle would not work as well with entertainment games, since they lack the appropriate support tools for scenario authoring, coaching-by-gaming, instructors' SA and debriefing. The success of the coaching cycle is also dependent on the quality of such tools and features. If carried out properly, SG developers should be able to use that as a sales argument, when pitching their games to new customers.

In sum, the coaching cycle framework describes an ideal situation that may be impossible to realise in full. Practitioners should instead use it as a base for discussing how serious gaming is best implemented within their organisation. Depending on the specific constraints on the organisation's infrastructure and how firmly ingrained the habits of the current community of practice (CoP) are, the actual implementation of the coaching cycle will differ greatly.

14.7 COMPARISONS WITH SIMILAR FRAMEWORKS

While the theoretical background presented in Part II should account for most of the basis of the framework in current SG theory, it is also relevant to establish a theoretical grounding at a higher abstraction level. Therefore, in this chapter, I compare the coaching cycle to other, similar frameworks. First, I present two cyclic frameworks which also describe serious gaming practices at a similar abstraction level as the coaching cycle. Then, I also present a framework which arrives at similar conclusions to mine, but presents them at a different abstraction level.

14.7.1 CYCLIC FRAMEWORKS OF GBT PRACTICES

Describing learning and training as cyclic processes is very common. For instance, in Chapter 6.2.1, I present the experiential learning cycle, which is a popular learning theory within the GBT community. Describing GBL and GBT practices as cyclic processes or as phases is also common. Thus, the coaching cycle is not unique in the sense that it describes training phases as a cyclic process. There are a number of frameworks that describe GBL and GBT, but for this analysis I have narrowed them down to those that resemble to the coaching cycle. Two frameworks that fit this description are Klabbers' macro and micro cycles (2008), and the iterative five-stage learning cycle by Kirkley et al. (2011).

KLABBERS' MACRO AND MICRO CYCLES

Klabbers (2008) describes his framework as "a typical game session" (p. 54). It consists of two cycles: the macro cycle and the micro cycle (see Figure 14.5). The macro cycle starts with the facilitator sending out invitations to the participants and, as they arrive to play the game, holds a briefing, which involves reading manuals and setting up teams. According to Klabbers (2008), the "purpose of the briefing is to ensure that everyone is mentally ready to step into the magic circle" (p. 55).

Next, the participants enter the micro cycle, which is an iterative set of four activities described by Klabbers (2008) as actions and interactions, sense making and meaning construction, formation and adjustment of schemas, and adjusting the action repertoire. These four activities are not unlike the four events in the experiential learning cycle (concrete experience, reflective observation, abstract conceptualisation, and active experimentation; see Figure 6.3, p. 62). After the game has been played out, the facilitator interrupts for a debriefing, which is divided into two stages. In the first debriefing stage, "focus is on reviewing the gamed process, to allow the players to 'blow off steam', unwind, and metaphorically 'play again and comment on the video of the game'" (Klabbers, 2008, p. 56). During this process, the participants create a shared narrative of the gaming experience, which is necessary before the second stage of the debriefing, the aim of which is "sense making and meaning construction, and agreeing on the vital *schemas* triggered by the game" (emphasis by Klabbers, 2008, p. 56).

The resemblance of the macro and micro cycles to the coaching cycle framework is striking. There are, however, a number of significant differences between them. Most importantly, Klabbers (2008) mainly describes the framework from a learner perspective and only briefly mentions the instructor or facilitator. For instance, preparation of the gaming session is described as selecting a suitable game and sending out invitations, and no mentioning of scenario authoring. Another noteworthy difference is the in-game facilitation, which is described by Klabbers (2008, pp. 55–56) as such:

> As games either evolve in cycles or in an iterative sequence of steps, the facilitator monitors the dynamic process of play, and intervenes only when needed to guide its proper continuation. In a rigid-rule game, the facilitator makes sure that everyone plays by the rules. In a free-form game the players have in principle the freedom to shape their own rules within the constraints of a few "rules of nature". These rules concern, the start and stop rules, use of the physical game space and its facilities, and break out times for meals. Facilitating a free-form game presupposes that the facilitator does not impose rules while the game goes on and only intervenes when participants may get hurt, physically or mentally.

It should be clear from this quote that Klabbers (2008) is far from suggesting a coaching-by-gaming approach to the gameplay phase (the micro cycle). Another final difference between the macro cycle and the coaching cycle is that Klabbers (2008) divides debriefing into two stages, while I have presented it as one phase. The reason for this is that the coaching cycle is described from an instructor perspective, and my concern has mainly

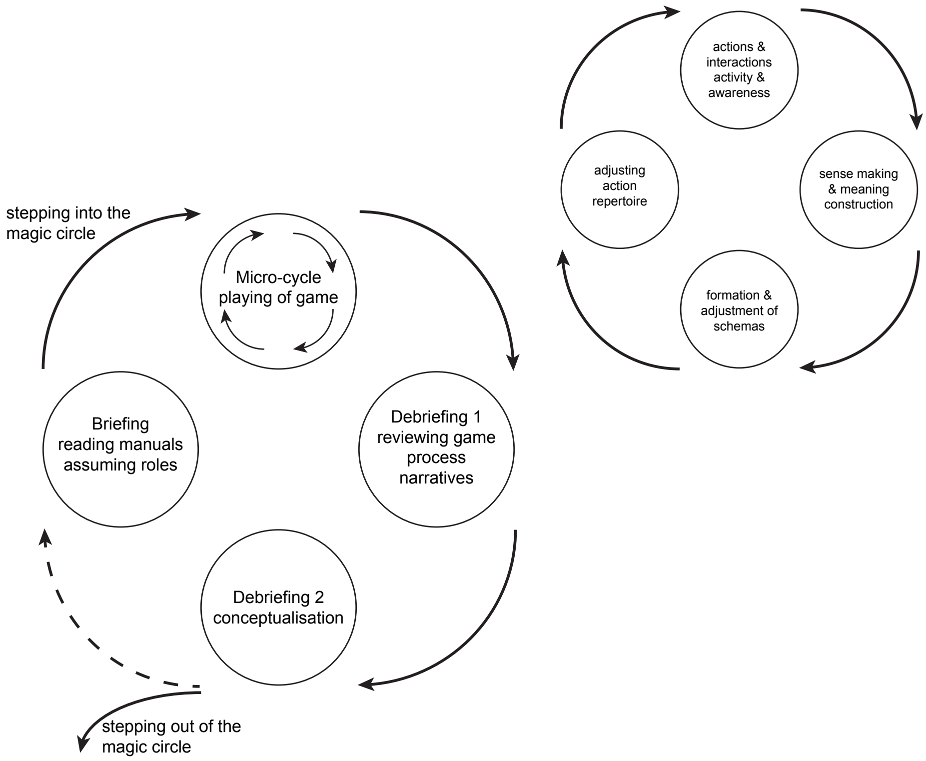


FIGURE 14.5: Klabbers' macro cycle (left) and micro cycle (right). Adapted from Klabbers (2008, pp. 55-57).

been on how debriefers can be facilitated and not on the specific stages therein. From this point of view, it is up to the individual instructor, or the team of instructors, to decide how to best conduct the debriefing.

THE ITERATIVE FIVE-STAGE LEARNING CYCLE

The iterative five-stage learning cycle is described by Kirkley et al. (2011) as a problem- or inquiry-based learning approach to serious gaming. The framework is depicted in Figure 14.6. Its five stages are (Kirkley et al., 2011, pp. 379–380):

- *Stage 1: Situation stage*, in which the central problem (the game's goals and central storyline) is presented to the learner;
- *Stage 2: Issues identification stage*, in which learners analyse the mission, develop hypotheses about how to address it, and identify learning issues to be investigated (e.g. what resources are available);
- *Stage 3: Inquiry stage*, in which learners investigate, often in teams, the learning issues and possible solutions. Facilitators provide learning structure, scaffolding, guidance, and feedback in response to learners' needs;
- *Stage 4: Action stage*, in which learners make recommendations to address the problem, provide rationales for recommendations, and begin to test their hypotheses;
- *Stage 5: Assessment stage*, in which assessment, synthesis, and transfer of learning occur through some kind of debriefing activity.

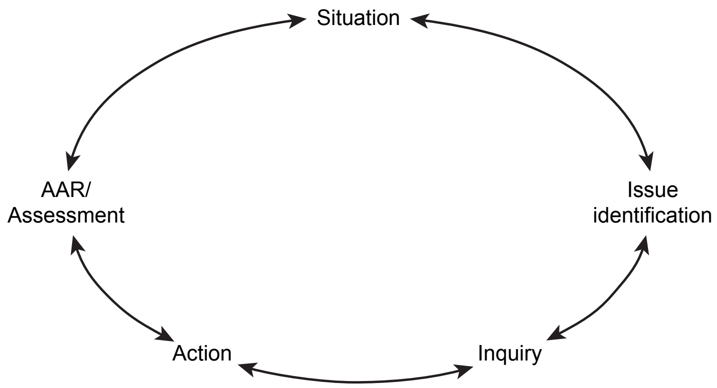


FIGURE 14.6: The iterative five-stage learning cycle. Adapted from Kirkley, Duffy, Kirkley, and Kremer (2011, p. 379).

Comparing the iterative five-stage learning cycle with the coaching cycle, it is clear that stage 1, the situation stage, corresponds to the briefing or introduction part. However, in the example case described by Kirkley et al. (2011), the problem is introduced by a virtual mentor, thus excluding the human instructor from this stage. There is, on the other hand, nothing in the framework that would suggest the problem cannot be presented by the instructor, either directly or by puckstering. Stages 2, 3 and 4 correspond to the gameplay phase of the coaching cycle. Just as with the framework presented by Klabbers (2008), the iterative five-stage learning cycle is described from a learner perspective, although Kirkley et al. (2011) acknowledge the fact that the instructor plays an important and active role during these phases, especially in stage 3, the inquiry stage. However, they do not present any details about how instructors “help learners by providing structure, guidance, and feedback” (p. 383). Lastly, stage 5, the AAR/assessment stage, corresponds to the debriefing stage of the coaching cycle. Kirkley et al. (2011) suggest that the debriefing is facilitated by an instructor, but speculate that even this stage could be incorporated into the game, and facilitated by a virtual mentor.

Both the macro/micro cycle framework and the iterative five-stage learning cycle are frameworks that describe serious gaming practices from a learner or learning perspective. Although they mention the instructor’s role(s), they do not provide any details about the challenges to be met and conditions required for these roles to thrive. In this sense, the coaching cycle differs from both frameworks, even if, superficially, they seem similar. The similarities, on the other hand, show that the coaching cycle is based on sound pedagogical principles, in line with current SG theories and practices.

14.7.2 THE SIMULATION EXPERIENCE DESIGN FRAMEWORK

In Chapter 1.1, I mention that the work of Elaine Raybourn has been one of the inspirations for my own work. While the cyclic frameworks, described in the previous chapter, can be said to be similar in form, but only superficially in content, the simulation experience design framework, presented by Raybourn (2007), can be said to be similar in content, but not in form. A model of the framework is presented in Figure 14.7.

Raybourn (2007) describes the simulation experience design framework as “a process that addresses game design as a *system of experiences that exist within an emergent, adaptive cultural context* that the designer strives to engender throughout game play, as well as before, between, and after game play has concluded” (p. 206). Thus, the

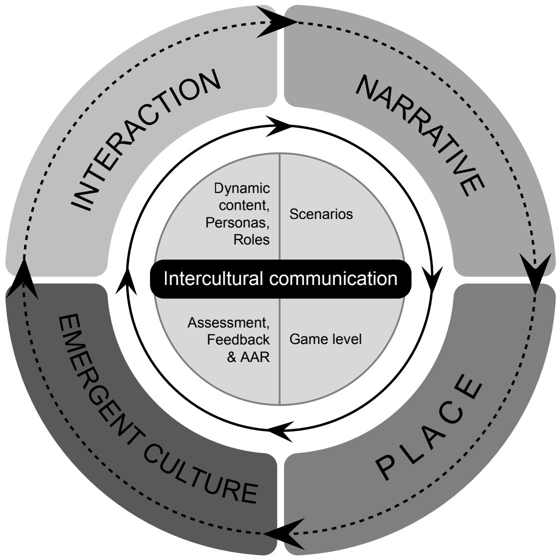


FIGURE 14.7: The simulation experience design framework. Adapted from Raybourn (2007, p. 210).

focus is on game design rather than serious gaming practices. What makes the framework interesting is that Raybourn (2007) does not single out the learner as the primary user group, but also recognises other stakeholders, including instructors. She writes (p. 207):

> The general design of an instantiation of adaptive training systems could include any or all of the following as component elements of a larger system experience or as stand alone serious game experiences: (1) single player game that addresses-specific training objectives, (2) multi-player games that address-specific training objectives, (3) real-time, in-game feedback or assessment functionality, (4) computer-based after action review system, and (5) instructor or stakeholder authoring functionality.

Furthermore, the framework includes several of the instructor-led GBT practices that are also key parts of the coaching cycle, which the following quote shows (Raybourn, 2007, p. 208):

> [I]nstructors create dynamic content/actions for scenarios in real-time or a priori through a scenario authoring interface. By introducing content in real-time the instructor can influence the actions taken by role-players in the scenario. This helps the instructor create opportunities for adaptive thinking and the demonstration in communication or leadership skills as the situation dynamically changes and becomes more stressful. Examples of introducing real-time content in the game include placing objects or clues in diverse locations for players to find, and initiating scripted events such as interactions with non-player characters. Instructors may modify textual content a priori to create scenario variations or new ones altogether.

In this paragraph, Raybourn (2007) alludes to several of the concepts in the coaching cycle. First, she mentions scenario authoring as part of the instructor's repertoire. Second, she adds that instructors facilitate dynamic content in-real time and influence actions taken by the participants. This is the role of the in-game facilitator; she even hints at the coaching-by-gaming concept. Moreover, the simulation experience design framework also includes assessment, feedback, and AAR as important components of a simulation experience.

In conclusion, while the simulation experience design framework does not model the phases of GBT practices, it includes many of the concepts inherent in the coaching cycle. As such, the two frameworks complement each other; one focuses on game *design* from an 'interaction out' approach, and the other on the *practices* of using games.

14.8 CHAPTER SUMMARY

This chapter has outlined the coaching cycle, a framework for instructor-led GBT, which is one of the objectives set, to answer the research question (namely, Objective 3). The coaching cycle framework is derived from empirical studies combined with best practices, as described in theoretical literature. It is both a *descriptive* model of instructor-led GBT practices from an instructor perspective, and a *prescriptive* one on how instructor-led GBT is best implemented. It constitutes three main phases: scenario authoring, gameplay and debriefing, as well as a minor briefing phase. Within these phases, instructors take on different roles which are linked to different challenges and needs for support. The chapter presents a few of these challenges in relation to the theoretical and empirical material presented in Parts II and III. There are several assumptions to the framework that practitioners and developers must consider before they try to implement the ideas and concepts within a serious gaming environment. In essence, the coaching cycle assumes that:

- GBT is synchronous and centralised,
- instructors (and management) buy into the whole concept of instructor-led GBT,
- instructors like to play games, and
- the games used for training are explicitly designed for instructor-led GBT.

CHAPTER 15

GUIDELINES FOR SYSTEM SUPPORT IN INSTRUCTOR-LED SERIOUS GAMING

This chapter outlines some implications for the design and delivery of SGs as a consequence of applying the coaching cycle in GBT practices. It is the results of a synthesis of the challenges identified and described in the case studies (Part III), here, presented as guidelines. As such, it constitutes the final step towards reaching Objective 4.

15.1 DIFFERENT TYPES OF INSTRUCTOR AIDS

One core implication of instructor-led GBT is that the system must include features, modules or procedures which aid instructors in their adoption and usage of SGs. Throughout the thesis, several examples of how to aid instructors have become apparent. The taxonomy presented in Table 15.1 is not an exhaustive list, but provides exemplars of instructor aids for in-game functionality, help for new instructors and peer-to-peer support.

For instance, all case studies involve SGs with some kind of AAR module; *Elinor* has a diagnostic screen, showing statistics from different play sessions (see Figure 9.4, p. 113), *Tactical Incident Commander* includes an assessment tool, in which the learners' gameplay can be studied in detail (see Figure 10.5, p. 126), and the simulation systems used at the SLWC contains AAR modules with features, such as bookmarking and re-play functions.

Furthermore, the studies also identify possible aids for instructors, such as being able to add a custom scoring system (Chapter 11) or to use the game in conjunction with other learning and evaluation tools, such as LMSs or spreadsheets. For instance, *Tactical Incident Commander* was only incorporated into the LMS used by SCCA by the means of a link to the game's web site, but the LMS cannot read data from the game and the game cannot receive data from the LMS. Integration with LMSs would require standards that currently do not exist, but which would make serious gaming practices easier for facilitators (Hendrix et al., 2012).

The case studies also identify challenges for inexperienced instructors who can be aided by online resources or databases, training workshops, as well as other guides on how to get started with serious gaming and identify suitable games. For instance, instructors at both SCCA and SLWC requested some kind of meeting or workshop to learn more about the game or share ideas with other instructors (see Chapters 10 and 11, respectively).

Lastly, the instructors also need tools for knowledge sharing among peers, in order to progress in serious gaming practices and discover novel ways to use games and facilitate GBT. Chapter 13 mentions online forums as an example of how experienced (and inexperienced) facilitators can share ideas and solutions for problems.

TABLE 15.1: Different types of instructor aids.

INSTRUCTOR AID	SOURCE
In-game functionality	
AAR module, including automatic assessment features, such as log functionality and summary functions	Ch. 9, 10, 11, 12 & 13
Replay functionality and bookmarking	Ch. 10, 11 & 13
Monitoring functionality (e.g. information displays) for increased instructor situation awareness	Ch. 12
Adaptable scoring system and embedded assessment	Ch. 9 & 11
Scenario and content creation tools	Ch. 10, 11 & 13
Pre-scripted exercises	Ch. 9 & 11
Support for interfacing with other (COTS) products (e.g. input devices, other games and LMSs)	Ch. 10 & 13
Tools for providing and receiving feedback	Ch. 11 & 13
Help for new instructors	
Online resources/databases which collect information about SGs, how, when and for whom they are designed to be used, and also include user ratings.	Ch. 8
(Annual) facilitator training workshops	Ch. 10 & 11
Step-by-step ‘Getting started’ exercises and instructions for novice instructors (for whole cycle)	Ch. 10
Instructions on which learning theories are compatible with a specific game and didactic model for integrating game in current setting	Ch. 13
Peer-to-peer support	
Knowledge management tool for knowledge sharing between instructors/facilitators (and for lessons-learned processes)	Ch. 8
Information sharing on the web (e.g. forums and online communities)	Ch. 13

15.2 GUIDELINES

Table 15.2 summarises guidelines for the design of SGs related to the coaching cycle. These guidelines mainly refer to in-game functionality, that is, features and functions designed into a SG to support facilitators in their various roles during instructor-led serious gaming.

In the first phase, scenario authoring, the facilitator intend to create a scenario based on specific learning or training goals. As seen in Chapter 11, these goals can be re-negotiated, which calls for easily adaptable and flexible scenarios, as opposed to fixed, non-editable scenarios. Thus, to meet these needs of easily accessible and flexible scenarios, a scenario authoring tool should include meta-data, to support quick identification and selection of appropriate scenarios (Guidelines 1, 2, and 3), allow facilitators to modify or tweak existing scenarios, both before and during training (Guidelines 5 and 9), and, if possible, allow online co-authoring (Guideline 4). Furthermore, SG developers should make sure scenario authoring tools are easy to use, even for less experienced instructors (Guidelines 6 and 7), as well as provide customers with online support forums or, at least, direct the facilitators to already existing ones (Guideline 8).

In the gameplay phase, instructors take on many roles, including off-game and in-game facilitator, puckster and coach. As was pointed out in Chapter 14, it is important the system supports combining off-game data with in-game data in a way that makes sense from a coaching perspective, for example, by enabling note-taking (Guideline 10), supporting instructors' SA and at-a-glance assessment (Guidelines 11, 12 and 13), and allowing in-game, as well as live, role-playing (Guideline 16). Furthermore, the system should support the instructor when providing feedback (Guideline 14) and in the role of puckster (Guideline 15). In addition, the game should be able to be played with some of the game rules and mechanics disabled or modified to account for the instructor's needs, such as providing a 'God mode' or easy access to administrative tools (Guidelines 17, 18 and 19).

Lastly, instructors have little time to prepare debriefing sessions and, thus, need system support to quickly and accurately summarise those gameplay events which require extra attention during debriefing (Guidelines 21, 22, 23 and 24). Furthermore, although self-assessment was advised against in Chapter 14.4, as the only method of debriefing, it can be useful in reducing the workload of the instructor, when interspersed with short gameplay phases (Guideline 20). Chapter 13 also introduce the issue of being able to share and evaluate data from scenarios and game logs with co-workers, who do not have access to the game itself. Thus, being able to extract data from the game and use it in other systems is a useful feature for some facilitators (Guideline 25).

TABLE 15.2: Guidelines for system support in instructor-led serious gaming.

PHASE	ACTIVITY	GUIDELINES	
Scenario authoring	Facilitator creates a scenario based on training plan and objectives	1	The scenario authoring tool should have access to a library of previously made scenarios.
		2	The scenario authoring tool should contain meta-data, such as keywords for easy search among previously created scenarios, and support importation of game data from existing scenarios.

Continued on next page...

TABLE 15.2: (continued)

PHASE	ACTIVITY	GUIDELINES	
		3	The scenario authoring tool should contain meta-data, such as a guide to other instructors on how to use the scenario.
		4	The scenario authoring tool should have features which enable online co-authoring of scenarios.
	Learning objectives or difficulty levels re-negotiated	5	Scenario authoring tool must allow for open-ended scenarios and quick last-minute changes.
	Instructors gets acquainted with the game / Champions coaching inexperienced instructors	6	An inexperienced instructor should be able to create a simple scenario within a few minutes and without scripting or programming skills.
		7	Scenario authoring tool must have good usability and UX.
		8	Instructors should have access to online user communities dedicated to serious gaming within their particular domain.
	Power users make modifications to game to fit new and specific training needs	9	Skilled instructors should have access to parts of the game's source code through simple scripting procedures.
Gameplay	Off-game facilitator assess learner performance by direct observation	10	The instructors should be able to add notes into the AAR tool and associate it with other notes or in-game data.
	In-game facilitator assess learner performance by indirect observation	11	Monitoring tools should be designed to support instructors' SA.
		12	Monitoring tools should support at-a-glance assessment of in-game events.
		13	Support systems should be designed to reduce facilitators' cognitive workload.
	Facilitator provide explicit formative feedback to learners	14	The system should allow feedback (through text or speech) in real-time to individuals or groups.

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TABLE 15.2: (continued)

PHASE	ACTIVITY	GUIDELINES	
	Coaching-by-gaming	15	The game should be able to be played by one or several instructors, but with added features to enable coaching and other pedagogical activities, such as being able to alter certain aspects of the game through gameplay or being able to quickly place new entities in game and to control them (i.e. puckstering).
		16	The game should allow for in-game and live conversations with role-playing instructors.
		17	It should be easy to switch between administrative mode and coaching-by-gaming mode during runtime.
		18	The user interface of the game should provide extra clues to instructors to help them navigate the game space.
	Facilitators add additional gaming characteristics to a simulation	19	The system should provide features to automate a custom scoring system based on simple game state rules.
Debriefing	Learners assess their own performance	20	The AAR tool should include self-assessment modules that can be used for between-game debriefings.
		21	The AAR tool should include data which are organised and aggregated to support self-assessment.
	Facilitators prepare the debriefing session	22	The AAR tool should include visualisation software which aid instructors by pattern recognition and triangulation of data.
		23	The game should include built in scenarios for routine tasks that do not need human monitoring, to allow instructors more time to prepare.
	Facilitators run a debriefing	24	The AAR tool should include easy-to-use features, such as time stamps for video and sound clips, and replay of selected events.
	Facilitator saves game data for lessons-learned evaluations	25	The AAR tool should include an export function which downloads selected log contents into a spreadsheet or plain text document.

15.3 CHAPTER SUMMARY

This chapter has outlined some implications for the design and delivery of SGs, as a consequence of applying the coaching cycle in GBT practices. Thus, it addresses a key part of the research question, namely, how instructor roles can be facilitated within an instructor-led GBT environment; by presenting the results of a synthesis of the theoretical and empirical material, in the form of instructor aids and design guidelines. In doing so, Objective 4 has been reached. Supporting instructors in their adoption, learning and usage of SGs includes instructor aids for in-game functionality, help for new instructors and peer-to-peer support. For example, AAR tools help instructors plan and carry out a well-structured debriefing and recurrent workshops provide opportunities for instructors to familiarise themselves with the game and to share knowledge with other instructors. Furthermore, the design and use of SGs is affected by the activities of instructors, as a result of applying the coaching cycle. The chapter presents some guidelines for each of the three phases of the coaching cycle (scenario authoring, gameplay and debriefing). By following these guidelines, SG developers can design a system adapted to instructor-led serious gaming, where the facilitators are supported in their roles and tasks. As a consequence, GBT can be carried out in a more efficient and enjoyable manner.

CHAPTER 16

SUCCESS FACTORS FOR INSTRUCTOR-LED SERIOUS GAMING

The previous chapter presents guidelines for system support in instructor-led serious gaming. These guidelines aim to increase the overall quality of SGs and related systems. The quality of the game itself is one determinant on the success of serious gaming. While this has not been a focus of this thesis, it should not be ignored as insignificant or negligible. Many researchers have already looked into it (see e.g. Gunter et al., 2008; van Kessel & Datema, 2008; Ma et al., 2012) and I would claim that many SGs developed today are good enough in terms of game quality. However, other factors are also important to consider when developing and implementing serious gaming practices. This chapter outlines six success factors for the development and use of SGs in settings which employ instructor-led serious gaming. It is the result of a synthesis of the theoretical and empirical material presented in Part II and III, which was carried out to reach Objective 5. These success factors are at a higher abstraction level than the guidelines in Chapter 15.

To arrive at a number of success factors for serious gaming, the case data were revisited and analysed based on what was thought to influence the successfulness of GBT. Moreover, factors influencing failure were found to be as important to explore as those leading to a successful system. This also entailed comparing the findings to previous descriptions of the cases in previous publications, thus comparing the new conclusions with previous ones, as well as grounding the findings in related theoretical research. The synthesis relates to areas, such as development processes, training practices, support and organisational context.

As mentioned in Chapter 4.1.1, SGs can be viewed as part game, part productivity system, since they share characteristics of both types of system. Thus, the development of SGs is a challenging endeavour that requires a mix of competences and stakeholders, including game designers, instructional designers and subject matter experts (Appelman & Wilson, 2006; Hubal & Pina, 2012). Harteveld et al. (2010) outline a design philosophy that summarises a majority of the challenges that SG developers face (see Figure 16.1). In particular, they present nine dilemmas or trilemmas that relate to the three key components: play, meaning and reality. For example, the detail dilemma relates to the trade-off of high fidelity (discussed in Chapter 4.1.3), and the reflection dilemma refers to the problem of breaking the player's flow for the benefit of providing formative feedback and foster reflection-in-action that (discussed in Chapter 6.2.2).

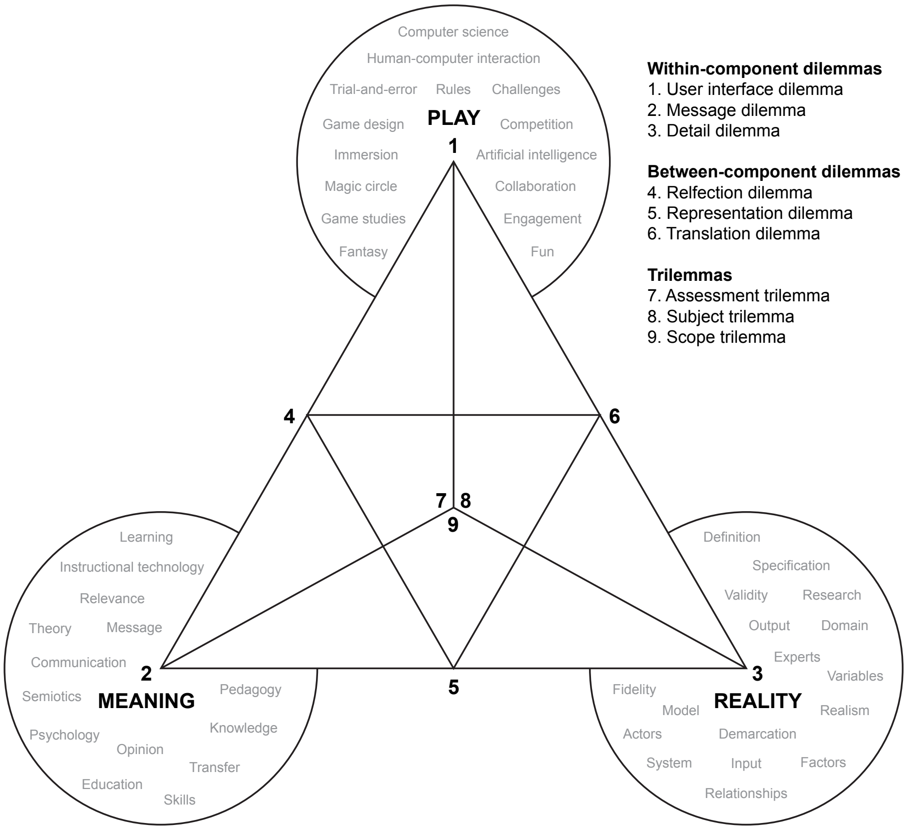


FIGURE 16.1: The design philosophy of Harteveld, Guimarães, Mayer, and Bidarra (2010, p. 325).

Berg Marklund (2013) has classified common design approaches into four camps: the learning-in-gameplay camp, the gameplay-in-learning camp, the gameplay-first camp and the learning-first camp. Each approach has it specific focus and view on learning which informs SG design. For instance, my own view of SG development falls into the gameplay-in-learning camp, in which the game is just one part of the educational context. The game alone is seen as something useful, but insufficient, for learning and transfer. Within this camp, one of the main challenges is fitting the game within the physical, social and organisational context of the learning experience, such as defining the role of the instructor, arranging gameplay around limited time slots, and organising debriefing sessions (Berg Marklund, 2013; Frank, 2007). Most SG theorists and practitioners regard a parallel process of instructional design and game design as a more successful approach, since that would increase the likelihood of the instructional content being endogenous with the game content (see e.g. Gunter et al., 2008; Tan et al., 2012). However, the classification by Berg Marklund (2013) also highlights the tug-of-war between the elements of fun versus the elements of learning (e.g. learning objectives controlled by curriculum). Game designers tend to rate fun as more important than learning, whereas the opposite is true for subject matter experts and instructional designers (Coleman et al., 2010). This poses a potential problem when these roles are supposed to collaborate.

Furthermore, instructional designers and game designers follow quite different design approaches, which in itself poses a challenge for SG development. Instructional design is “a system of procedures for developing education and training curricula in a consistent and reliable fashion” (Branch & Merrill, 2012, p. 8). As opposed to entertainment game design, instructional design is characterised as being systematic, where great care is taken to lay the groundwork through needs assessment before initialising design (Ma et al., 2012). Thus, even if some amount of redesign is allowed, new directions and features should not be introduced too late in the process (Coleman et al., 2010; Wagner & Wernbacher, 2013). Game design can be viewed as “the formal methods utilized in the specification and planning of a game’s content and features” (Gunter et al., 2008, p. 514). Entertainment game design centre around incremental and iterative prototyping (Salen & Zimmerman, 2004) and agile design approaches are especially popular, since the aim is to quickly create a prototype that can be playtested, but still rough enough to allow for changes in direction and new features (Berg Marklund, 2013). Continuous testing means that game design require access to players who are unacquainted with the game, which can pose a potential problem, especially for games with a narrow scope, which is common for SGs (Wagner & Wernbacher, 2013). Short development cycles are also needed, since training needs change continuously and might change dramatically over the course of days or hours, as was observed in the SLWC case (see Chapter 11). A similar conclusion was made by Chatham (2005).

In sum, developing SGs is a particular challenge that cannot be ignored when synthesising success factors for instructor-led serious gaming. In the next sections, the following success factors are presented and discussed:

1. Efficient development process with interdisciplinary teams
2. Participatory design with power-users
3. Well thought out pedagogy
4. Instructors with both domain knowledge and technical know-how
5. System support for instructors’ situation awareness and assessment
6. Organisational culture for knowledge sharing

16.1 EFFICIENT DEVELOPMENT PROCESS WITH INTERDISCIPLINARY TEAMS

A successful SG is efficiently developed when involving experts from a range of competencies, as long as these have mandate to make decisions within their expert area. In addition, early and continuous testing and access to the public are also important. Just as information systems development underwent a transition from programmers developing systems for themselves to developing systems for users distinctively different from them (Petter et al., 2012), SGs development has to undergo a similar journey.

The design team must also make user acceptance a priority. If the user (learner or instructor) rejects the game, it is condemned to fail (van der Heijden, 2004). In the work presented in this thesis, attitudes of individual users have been shown to have a profound impact on the success or failure of a game. For instance, in the *Elinor* case (Chapter 9), the system suited some participants well, while one stroke patient remained skeptical throughout the study, which resulted in less time spent gaming (Alklind Taylor, Backlund, Engström, Johannesson, Krasniqi, & Lebram, 2009). Similarly, the instructors at the SCCA (Chapter 10) did not participate in the learning experiences as intended, due to a lack of familiarity with the game.

A number of models and frameworks have been developed to unify game and instructional design, such as the game object model (GOM) version II (Amory, 2007), the Input-Process-Outcome game model (Garris et al., 2002), the RETAIN design and evaluation model (Gunter et al., 2008), the Simulation-Game Instructional Systems Design (SG-ISD) model (Kirkley, Tomblin, & Kirkley, 2005), the Game design component Relationship Model (CRM) (Ma et al., 2012), the Educational Game Design methodology (Tang & Hanneghan, 2010), and the Iterative Didactic Design process (Wagner & Wernbacher, 2013). Still, none have so far gained wide acceptance and SG developers continue to use a by and large ad-hoc process (Coleman et al., 2010). Ma et al. (2012) argue that this is due to the innovative nature of SGs, which means that SG development mostly has to deal with open-ended design problems that lack clear goals or existing design plans. Thus, every SG design project is unique, which makes it difficult to generalise findings into a framework that is detailed enough to be useful for practitioners.

16.2 PARTICIPATORY DESIGN WITH POWER-USERS

Within the field of HCI, it is often emphasised that development should be user-centred and that users should be part of the development process. Users can be divided into domain experts or subject matter experts, who have in-depth knowledge in the usage context and tasks to be performed, and end-users, who are representative of the people who actually will use the system, but not necessarily experts in the domain. Both groups serve important purposes in the development process. Domain experts should be employed throughout the development process, whereas end-users are used for interviews, observations, and evaluations (Gulliksen et al., 2003).

The development of a SG may be viewed as a mutual learning process in which the designers learn about the domain and, more importantly in this case, in which the subject matter experts learn about the possibilities of serious gaming. Subject matter experts have practical experience in teaching a specific subject, although they might not have come in contact with games or gaming technology (Whitton, 2010).

In the cases described in this thesis (especially the ones encompassing participatory design), the development team worked very consciously to engage subject matter experts through prototyping and workshops. The strategy for prototyping was to start with a very crude prototype that by small means would convey the concept of serious gaming (see e.g. Chapter 9.2). Prototyping can however be a risky strategy in that the users underestimate the complexity of making late changes while, at the same time, simple early prototypes may be somewhat hard for them to relate to. As seen in both the *Elinor* case and the *Tactical Incident Commander* project (Chapter 9 and 10, respectively), communicating design ideas through prototyping is challenging when the users are new to the concept of games and game development. It is therefore important to acknowledge the fact that while the development team has to become familiar with the domain in which the SG is to be implemented, subject matter experts also need to learn the strength and weaknesses of serious gaming. In the *Tactical Incident Commander* case (Chapter 10), the development team worked closely with instructors and arranged workshops that were aimed at informing them of how games can be used for training and to spur creative discussions on how games could be used in their own courses. Despite this, it was challenging to get instructors who are inexperienced with games to understand the difference between games and the simulation and visualisation systems currently in use in their organisation.

In the *VBS2* case (Chapter 13), the situation was different. The subject matter experts employed in the development process, were not just experts in the context of use, but also had varying degrees of experience in working with earlier versions of the game. Individuals like this can be very beneficial during the requirements gathering and formulation, as well as during testing. Of course, power-users' enthusiasm and competence is a double-edged sword; while they can use their in-depth knowledge of the system to make valuable requirements that enhance the quality of the game, developers must recognise that these users are not likely to be representative of average end-users. Therefore, while it is valuable to include power-users if possible in the development process, other user groups must also be involved, especially during testing.

16.3 WELL THOUGHT OUT PEDAGOGY

Whereas the quality of the game itself is important for the success of serious gaming, a game alone cannot solve the educational puzzle, no matter how well it is designed. As should be evident from the previous chapters, the setting in which the game is used and the way it is used also plays an important role. This especially involves having a thought out pedagogy; that is, designing a learning experience that concurs with current learning theories. Unfortunately, as outlined in Chapter 6.2.1, few SG studies take specific learning theories into consideration (Gunter et al., 2008; Kebritchi & Hirumi, 2008; Wu et al., 2012).

The coaching cycle (Chapter 14) is an attempt to present a framework based on sound pedagogical principles and best practices observed at the SLWC. As such, it aims to provide practitioners with a starting point from which to discuss possibilities of incorporating serious gaming into their own training practices. The design and development of SGs should always be grounded in well thought out pedagogy and not rely solely on the motivational power of games. SG developers are also advised to reject the notion of stealth learning as an argument for serious gaming (see Chapters 4.1.1 and 6.2.3).

16.4 INSTRUCTORS WITH BOTH DOMAIN KNOWLEDGE AND TECHNICAL KNOW-HOW

In the studies presented in this thesis, it has become clear that instructors not only have to deal with the pedagogical issues related to GBT, but also have to solve technical issues, such as creating (digital) scenarios, operating the game during exercises, dealing with bugs and other unforeseen problems, and documenting/saving logs for later use. Additionally, dealing with formative assessment during gaming can easily lead to information overload, especially in games where automation on these tasks is kept to a minimum (see Chapter 12). One way to handle this problem, if the instructors have low computer experience, is to employ technical staff members who work side by side with the instructors. Ignoring the financial implications of that solution, it still has the disadvantage that the instructor will continue to have difficulty grasping the full potential of SGs. The technical operator might also not be well-grounded in the pedagogy behind the exercises so the two educators must cooperate closely.

Ideally, instructors should be "well oriented to technology that supports GBL tools and virtual spaces to maximise the usefulness of this new technology" (Bauman, 2013, p. 77). Thus, there is an increasing need for instructors with technical know-how, and, in parallel, an increasing need for systems that are easy to use for non-technical educators. Moreover, instructors' broad skill set should, ideally, also include role-playing skills, since serious gaming can include coaching-by-gaming (see Chapter 14.3.1), which can advantageously be realised through role-play.

16.5 SYSTEM SUPPORT FOR INSTRUCTORS' SITUATION AWARENESS AND ASSESSMENT

One of the greatest challenges for serious gaming is to adapt a game to the individual learner and make it dynamic and challenging (Lopes & Bidarra, 2011). The coaching cycle promotes coaching-by-gaming as a way to create this adaptivity (see Chapter 14.3.1). A requirement for this to occur is that the instructor knows what is going on during the simulation, in order to assess the situation (see Chapter 15). Although Chen and Michael (2005) called for "improved support for completion assessment, in-process assessment, and teacher evaluation" almost a decade ago, it has evoked little attention among SG academics. As argued in Chapter 12.1, there has been a great effort in enhancing SA for learners, especially in the military simulation training domain (e.g. Livingston et al., 2011), but few have investigated how to increase situational awareness for instructors. Chapter 12 presents a set of guidelines for the design of system support for instructors' SA and assessment. The need for system support has also been identified as a key success factor for instructor-led serious gaming.

The need for analysis of players' performance occurred in all case studies. In the *Elinor* case and the *Tactical Incident Commander* case (Chapter 9 and 10, respectively), post-game analyses were included as important features. The challenge with providing relevant support for AAR in SGs transcends the mere presentation of a game score/result, as it also has to support the evaluation of the expected training goal. This is a problem of making the implicit explicit as stated by Bente and Breuer (2009). However, huge care has to be taken when trying to translate game variables to training results, so that we measure what we think we are measuring. Soft skills, such as leadership, creativity, adaptability, collaboration etcetera, are difficult to measure directly, and require the formulation of constructs that consist of a combination of observable or measurable behaviours (Belland, 2012; Shute, Ventura, et al., 2009). Thus, the work of a human assessor can be eased by automatic assessment that uses these constructs (Johnson & Gonzalez, 2008).

Another type of system support lies within communities, such as online support forums and tight-knit instructor teams. Such communities of practice (Wenger, 1998) can share knowledge among practitioners to make GBT more efficient.

16.6 ORGANISATIONAL CULTURE FOR KNOWLEDGE SHARING

As mentioned in Chapter 8, knowledge about how to conduct GBT often lies with individuals with a special interest in simulation-based training and this knowledge is passed on from individual to individual in an informal manner (Dessne, 2013; Frank, 2012). Knowledge about serious gaming practices is more often tacit rather that explicitly documented, especially if personnel resources are scarce and instructors lack time, opportunity or enough incentive to document the detailed methods they use (Dessne, 2012). For instructors to adopt SGs as a new learning tool, they need to enable instructors in recognising how other instructors are benefited from serious gaming (Egenfeldt-Nielsen, 2010).

Sharing of knowledge is considered a key success factor for organisations, especially in those that are knowledge intensive (Bock et al., 2005; Verburg & Andriessen, 2011). For an organisation to benefit from an individual's knowledge, it needs to be transformed into organisational knowledge through a process of knowledge sharing within a CoP (Alavi & Leidner, 2001; Cabrera, Collins, & Salgado, 2006). Based on this, serious gaming is more likely to succeed in an organisation that promotes knowledge sharing. This means that individuals within that organisation have a positive attitude towards sharing their knowledge about which games are appropriate for certain training goals, how to conduct gaming sessions in those games, as well as sharing of scenarios, log files and so on. Furthermore, the organisation must have an IT infrastructure that enables knowledge management and the SG(s) used must be compatible with the knowledge management system employed. One source for inspiration about how to deal with knowledge sharing is to look at the general gaming community and the open source community, in which sharing of knowledge is common (Burger-Helmchen & Cohendet, 2011). For instance, gamers share mods and create wikis and fan fiction of their favourite games. Practitioners and researchers have to recognise, however, that not all gamers are modders and not all SG players are gamers, so conclusions drawn from these communities must be adapted to the conditions of a specific organisation.

At the SLWC (see Chapter 11), knowledge sharing is implicit and largely based in informal structures, although some formal structures exist (Dessne, 2012). Consequently, SG practices depend on the individual instructor's attitude, self-efficacy and belief towards SGs and their value as a training tool. At the SLWC, instructors are not obliged to employ SGs; it is up to the individual instructor to decide how much of cadets' education is spent playing SGs.

Moreover, one specific type of knowledge and information sharing is the creation and sharing of scenarios. Building scenarios can be compared to creating learning materials, that is, scenarios are used to (i) provide the students with an introduction to gameplay, (ii) show the typical/atypical situations to encourage participants to reflect upon specific aspects of their profession, and (iii) assess participants in a specific course segment where serious gaming is an integral part. Scenario creation was one of the core features of *Tactical Incident Commander* (see Chapter 10). In this case, both the instructor and the learners were expected to build and share scenarios. Building good scenarios is far from trivial, however; it requires both domain knowledge and knowledge about the capabilities of the scenario builder. Participants found it difficult to reuse someone else's material, especially if there were no clear notes about the educational purpose of the scenario. They also did not perceive scenario building and sharing within *Tactical Incident Commander* as means to share experiences. This means that the same scenario will be rarely reused in different exercises.

Both the SLWC and the *Tactical Incident Commander* case indicate that knowledge management within serious gaming requires clear procedures on how to share scenarios. To enable scenario sharing, instructors should be able to document and embed information aimed at other instructors within new or modified scenarios. As a military organisation, the SLWC also has the added obstacle of high security which makes utilising new technology to the fullest (e.g. distributed training) difficult. Thus, issues of confidentiality and security must also be included in a knowledge management system for SGs.

16.7 CONCLUDING REMARKS

Coleman et al. (2010) have also listed a number of success factors for SGs, namely, input from subject matter experts, assessment and feedback, how the game is implemented, and using a multidisciplinary approach. This list fits well with the success factors described here, with the addition of technical know-how, system support for instructors' SA, and organisational culture for knowledge sharing. As researchers try to uncover which ingredients make up a good SG, they can sometimes lose track of contextual factors concerning serious gaming practices and instructional settings. In order to capture these issues, they need to broaden their view of serious gaming to one that encompasses factors pertaining to the development and execution of SGs and how these fit into the organisation that utilises SGs.

One success factor that is so far largely ignored by academics in the SG field is knowledge sharing. This is a common non-trivial problem that many within the IS field look into. While there are efforts in constructing games around communities of practice, few have investigated the benefits and challenges of knowledge management in this field. Research is especially lacking in finding ways to solve the problem. Knowledge sharing is linked to practices and attitudes at both the individual, as well as the organisational level.

Developers should also be prepared to defend the fun in SGs. While I emphasise the importance of participatory and user-centred design, the development team must include a role that has mandate to ensure that the characteristics of games and gaming are balanced against the instructional content. The design philosophy put forward by Harteveld and Bidarra (2007, see Figure 16.1) captures this balancing problem in a comprehensive way.

16.8 CHAPTER SUMMARY

This chapter has outlined six success factors for instructor-led serious gaming:

1. *Efficient development process with interdisciplinary teams.* SGs should be developed by an interdisciplinary team of game designers, instructional designer and subject matter experts, who have mandate to ensure that their area of expertise is integrated into the development.
2. *Participatory design with power-users.* Not all subject matter experts have experience in working with SGs and, therefore, using a participatory design approach with more experienced users (so-called power-users) add more value to the design of SGs. Developers should be wary, however; power-users are not typical users and not rely solely on their views as users.
3. *Well thought out pedagogy.* The design and development of SGs should always be grounded in sound pedagogical theory and not rely solely on the motivational power of games. The coaching cycle framework presented in Chapter 14 can be used as a starting point for discussions on how to implement serious gaming practices in a particular organisation.
4. *Instructors with both domain knowledge and technical know-how.* Working with (digital) SGs means that instructors are required to have technical know-how or be supported by people who can deal with technical issues. Thus, instructors with both domain knowledge and technical know-how are valuable assets to instructor-led serious gaming.
5. *System support for instructors' situation awareness and assessment.* Designing SGs to support instructors' SA improves instructor-led serious gaming and make the gaming experience more dynamic and effective.
6. *Organisational culture for knowledge sharing.* The organisational culture in which serious gaming is implemented plays an important role in the uptake and execution of gaming activities. Specifically, the organisation should support knowledge sharing among instructors and other practitioners.

Thus, Objective 5 has been reached. Along with game quality, these factors constitute key elements in the development and implementation of SGs and their use in a training context. They also pinpoint areas in which further research is needed, especially knowledge sharing and management.

PART V

CONCLUSIONS

CHAPTER 17

IMPLICATIONS AND FUTURE WORK

This chapter summarises the main findings of this thesis and its contributions. It also presents directions for future work.

17.1 MAIN FINDINGS AND CONTRIBUTIONS

The aim of this thesis has been to explore instructor-led serious gaming, specifically with adult learners. The research question stated at the beginning of this thesis is:

How can instructor role(s) be facilitated within an instructor-led game-based training environment?

The answer is presented in three steps:

1. A framework for instructor-led serious gaming (Chapter 14)
2. Guidelines for system support (Chapter 15)
3. Success factors (Chapter 16)

The first part of the answer, the coaching cycle framework, states the conditions for instructor-led serious gaming; which instructor roles that are involved in the actual training situation and what instructor-led serious gaming entails, given the conclusions drawn from the theoretical and empirical material presented in Parts II and III. The framework is both descriptive and prescriptive; it describes actual GBT practices that has been observed, but also makes use of sound theoretical principles from SG literature and can thus be used to inform inexperienced practitioners on how to implement a serious gaming experience. In short, the framework describes three main phases: scenario authoring, gameplay and debriefing. For each phase, best practices are presented from an instructor perspective, which are then used as a basis for the next two steps of the answer.

By identifying and describing best practices, several challenges for instructors and instructor-led serious gaming are also identified. The second part of the answer presents a set of guidelines to meet these challenges. Specifically, they answer the question how instructor roles can be facilitated in terms of instructor aids, design features and support functions, which can be implemented as part of a SG system within an organisation.

In the third part of the answer, the same question is revisited from a different perspective, namely by identifying a set of success factors for the development, implementation and execution of instructor-led serious gaming. These factors determine how well serious gaming will succeed in creating a learning environment that accommodates for the needs of both learners and instructors.

It is important to reiterate the three premises on which this thesis is based (see Chapter 1.4). First, I argue that *instructors take an active role in GBT*. Throughout this thesis, I argue for why this is the case and why it should be a core prerequisite in a framework for serious gaming practices. Second, I study serious gaming from a socio-technical perspective, and assume *GBT is an activity situated within a socio-cultural context*, that is, involving more than the here-and-now gameplay and the game artefact. The thesis shows several examples of off-game activities which are performed before, during or after the actual gaming activity and affect the end result in profound ways. For instance, debriefing helps learners to de-role or detach from, as well as critically reflect upon, the gaming experience. Without this activity, transfer of knowledge from the gaming situation to the real world is unlikely to occur.

The third premise is that *IT can facilitate several of the instructors' tasks, but not act as a substitute*. I argue, from several perspectives, why it would be a mistake to leave instructors out of the loop and propose a framework based on an instructor-in-the-loop perspective. From this position, IT is viewed as having the potential, by careful and deliberate design, to alleviate cognitive workload and support instructors in their roles and tasks, such as their situation awareness.

17.1.1 CONTRIBUTIONS

The thesis has made several contributions to the field of serious games. Table 1.1 (p. 8) summarises the knowledge contributions. First, the thesis has made a theoretical contribution by presenting a thorough review of the state-of-the-art of serious gaming theory (see Chapters 4–7). This was necessary in order to familiarise myself with the area and to position myself within it. It also serves to increase the understanding of serious gaming as a socio-technical phenomenon, which is of value for both scholars and practitioners. The review of instructor roles, as described in SG literature (see Chapter 8), is also valuable and contributes to an understanding of instructor-led serious gaming and the benefits and barriers it entails. It also reveals that the study of instructor roles in GBT is a neglected area of study, which this thesis aims to remedy.

Furthermore, the thesis offers insights from a range of case studies in various domains, from stroke rehabilitation to incident commander training as well as military training. They contribute to the understanding of serious gaming practices and instructor roles from different perspectives. For instance, I have shown that (in-)experience with games and serious gaming affects the way that instructors and other facilitators approach their role(s). It reveals different types of challenges for SG developers to overcome, such as supporting instructors in their role as subject matter experts and designing systems to meet their needs.

The coaching cycle framework constitutes the core contribution of this thesis, as it outlines best practices of instructor-led serious gaming and forms the basis from which other conclusions are drawn. As part of the framework, two new concepts are introduced: *coaching-by-gaming* and *instructors' situation awareness*, as well as two new roles: learner author and instructor player. Furthermore, the syntheses, which resulted in the guidelines and success factors presented in Chapters 15 and 16, respectively, can provide guidance on the the development and design of SGs and serious gaming environments.

Overall, the thesis contributes to the general SG community, since it augments the view of serious gaming as more than simply technology-enhanced learning. It rejects the notion of stealth learning and promotes a systemic perspective of serious gaming, where SGs are explicitly designed for learning and training, including support tools for instructors. Moreover, the three case studies carried out over five years at the SLWC (Chapters 11–13) also contribute to SG research in general, since there is a lack of longitudinal studies of serious gaming. Thus, several of the issues presented in Chapter 6.3 have been addressed in the thesis.

17.2 REFLECTIONS ON RESEARCH METHODOLOGY

As already discussed in Chapter 3, a qualitative approach was chosen to answer the research question. Moreover, case study research was employed to collect empirical data. Although the cases differ in terms of scope, aim, domain and researcher roles, they all contribute in the understanding of instructor roles and the challenges instructors face in relation to serious gaming.

However, working with cases is far from trivial. Field and case studies involve less control over the phenomenon studied, compared to experimental studies. For example, in the SLWC case (Chapter 11), some observations were delayed due to an extensive reorganisation, carried out as a result of a conversion of the Swedish military from compulsory military service to voluntary recruitment. Although this did not, to a large extent, affect the conclusions drawn from the study, it did put back the time plan somewhat. Another complication occurred in the SIP study (Chapter 12), where the ideal approach would have been to develop a working prototype, implement it at the BTA and test it under naturalistic conditions. As it turned out, this was not possible in practice, within the time and budget frame of the project, which meant that another approach had to be chosen. The *Tactical Incident Commander* project (Chapter 10) was similarly affected by unforeseen obstacles, when new instructors where introduced into the project at short notice. These deviations from the original project plans limited the conclusions that could be drawn from the collected data.

However, experiencing and dealing with these challenges has given me an opportunity to learn from them. An important lesson learned is to be pragmatic with data collection strategies and to manage risks. Although the optimal method might not be applicable, useful and interesting data can still be extracted. For instance, although I was not able to evaluate the SIP user interface, merely working on the prototypes and discussing them with subject matter experts provided a valuable understanding of the challenges that instructors face in the type of environment that the BTA constitutes. The *Tactical Incident Commander* project also contribute to interesting insights of why some SG projects fail. While it is easy to fall into the trap of blaming the client, the real reasons are usually more intricate and thus interesting from a research perspective.

Another possible drawback of some of the studies is the fact that I was the sole researcher to collect and analyse the data. This is the case in studies involving the SLWC (Chapters 11–13), and working with a team of researchers could possibly have contributed to a more in-depth study, since it could involve more observational data and a decreased risk of researcher bias. To counteract these disadvantages, I performed an extensive validation study in order to cross-check my interpretations from the observations (see Chapter 11.3.3). Furthermore, this strategy to accomplish credibility has the advantage of cross-case consistency. In addition, I have made an effort to provide more perspectives by discussing the interpretations and conclusions drawn with both practitioners and other researchers throughout the work.

17.3 FUTURE WORK

SG research is still a young field and it is only recently scholars have turned their attention to other stakeholders than the learners, especially for GBT with adult learners. Fortunately, this is changing, probably as a result of a larger diffusion; more people are beginning to use games for learning and training purposes and are experiencing various challenges related to their use. As a researcher, it is important to give a nuanced and level-headed account of serious gaming practices. SGs are no panaceas, but offer great opportunities for designing learning experiences – in the hands of a skilled facilitator. Although I cannot claim to have exhausted these issues, the thesis gives some insights into the factors involved. It also provides the basis for future work within the area of serious gaming.

One area that needs more attention is how to adapt SGs to instructors' tasks. In order to do that, we need to understand how and in which setting the game will be used, as well as how to most efficiently facilitate the instructor. This includes analysing what information is needed to achieve SA and formative/summative assessment and how feedback should be delivered to learners. Today, most work in this area is concerned with AAR and solutions involving AI (see e.g. Lopes & Bidarra, 2011). Although these efforts are worthwhile, we must also consider how these solutions will work in conjunction with instructors. Clients are inclined to focus on issues of physical fidelity and 3D representations, even if other factors might be more important for learning (Alexander et al., 2005; Wilson et al., 2009). Generally, clients tend to be naïve towards the costs of creating high physical fidelity. More research is needed into the importance of fidelity and the consequences of different levels of fidelity for various types of training. For instance, low fidelity might increase the need for a good AAR system and debriefing practices, since the simulation will not capture aspects of the real world, which, in turn, will lead learners to assume certain things are easier to perform than they actually are, in reality.

Furthermore, more studies are needed on UXD-related issues pertaining to supporting instructors. This entails both visualisation issues (e.g. how to present and represent learner performance in a condensed and comprehensible way to support instructors' SA), as well as matters of PX, such as facilitators experiencing different degrees of engagement, immersion, presence and flow. A related question is user acceptance and buy-in of SGs, which is important for both the uptake of serious gaming and its execution in a particular context. For example, in Chapter 14.1, I mentioned that active scenario authoring increases the degrees of freedom that instructors have to adapt a game to new learning goals. However, some instructors might experience scenario authoring as increasing their workload, even if a static game would require more effort in modifying other aspects of the learning experience instead (Brennecke & Schumann, 2009). Thus, research into what factors affect instructors and other stakeholders to use or even enjoy using SGs is a much needed area of study.

Another area that has just begun to receive the attention of scholars, is the integration of SGs in LMSs. A LMS keeps track of most student-related activities within a course or learning module which should also include serious gaming activities. Today, instructors can, at most, post a link to the game, but all other activities, such as in-game facilitation, have to be done within the SG itself. Studying this issue further would increase the ease with which a game can be distributed and facilitated and reinforce the use of games as one of many tools that instructors can use to create a learning experience.

This dissertation mainly deals with digital SGs. However, some of the conclusions can be translated to serious gaming activities involving board games, role-play and mixed reality games. Another delimitation is culture. Several authors have shown that characteristics such as culture and personality will influence how a game is played and interpreted (e.g. Hofstede, 2008; Lee et al., 2013), which would also include how it is facilitated.

In the case studies described in the thesis, most participants belong to organisational cultures commonly perceived as being male dominant and competitive, such as military and emergency services (e.g. fire-fighters and incident commanders). In this regard, the *Elinor* case study is an outlier, which offers some breadth to the empirical work. Therefore, there is still a need for more in-depth studies of serious gaming practices, especially within a broader range of cultures and contexts. For instance, more research is needed into issues, such as how trust, attitude, subjective norm, and organisational climates, affect knowledge sharing within serious gaming communities.

In sum, we need to view serious gaming from a wider perspective than merely the game artefact or issues pertaining to the learner. Although these are important issues, the contexts and manners in which a game is employed, also affect the success of games as learning and training tools. Returning to the scenario that initiated the introductory chapter and the question asked: *What does the instructor do during serious gaming?*, one conclusion is clear: one cannot overstate the importance of the instructor and that the activities carried out by instructors have implications for how to design and use SGs.

APPENDICES

APPENDIX A

SUBGROUPS AND ALTERNATE TERMS FOR SERIOUS GAMES

TABLE A.1: Subgroups and alternate terms for SGs and serious gaming. Please note that this is a rough categorisation and some terms might be applicable for several purposes. For instance, religious games can be used for education about religion or as religious propaganda.

PURPOSE	TERM	SOURCES
Hypernym	Computer games	Tobias et al. (2011)
	Games for simulating work conditions	Klabbers (2009)
	Gamesims	de Freitas (2006)
	Serious games	Aldrich (2009), Annetta (2010), Djaouti et al. (2011), Iuppa and Borst (2007), Michael and Chen (2006), Petrovic and Brand (2009), Ritterfeld et al. (2009), Smith (2009)
	Sim games	de Freitas (2006)
	Sims	Aldrich (2009)
	Simulation games	Hofstede et al. (2010), Johnston and Whitehead (2009)
	Video games	Tobias et al. (2011), Squire (2011)
Artistic expression	Art games	Michael and Chen (2006)
Advertising/marketing	Advergames	Alvarez and Michaud (2008)
	Gamification	Deterding et al. (2011), Zichermann and Cunningham (2011)
Corporate training and innovation	Corporate games	Michael and Chen (2006)
	Organisational-dynamic games	Wikipedia "Organizational-dynamic game" (n.d.)
Crowdsourcing/human computation	Games with a purpose (GWAPs)	von Ahn and Dabbish (2008), Quinn and Bederson (2011)
	Human-based computation game	Wikipedia "Human-based computation game" (n.d.)
	Human computation game	Man-Ching et al. (2009)
Health and rehabilitation	Exergames	Cannon-Bowers et al. (2011)
	Games for health	Papastergiou (2009b)
	Healthcare games	Michael and Chen (2006)

Continued on next page…

TABLE A.1: (continued)

PURPOSE	TERM	SOURCES
	Virtual rehabilitation	Broeren (2007)
Information and communication	Edumarket games	Alvarez and Michaud (2008)
	Government games	Michael and Chen (2006)
	Newsgames	Bogost (2007)
Learning and training	Action learning simulations	Aldrich (2009)
	Digital game-based learning	Brennecke (2009), Prensky (2001)
	Educational games	Egenfeldt-Nielsen (2007a), Johnston and Whitehead (2009), Michael and Chen (2006), Kiili (2007), Thomas et al. (2003), Wideman et al. (2007), Virvou and Katsionis (2008)
	Educational simulations	Aldrich (2002), Ulicsak and Wright (2010)
	Edutainment	Charsky (2010), Egenfeldt-Nielsen (2007a), Habgood et al. (2005), Johansson et al. (2009)
	E-learning simulation games	Quinn (2005)
	Epistemic games	Shaffer (2006)
	Game(s)-based learning	Corti (2006), Ifenthaler et al. (2012), Prensky (2001)
	Game-based training	Hussain et al. (2010), Whitney et al. (2013)
	Immersive learning simulations	Caspian Learning (2008), Wexler (2008)
	Instructional games	Garris et al. (2002), Habgood et al. (2005), Kafai (2006), Malone (1980)
	Learning games	Tobias et al. (2011)
	Military games	Michael and Chen (2006)
	Performance simulations	Wenzler (2009)
	Practiceware	Aldrich (2009)
	Serious educational games (SEGs)	Annetta (2010)
	Synthetic learning environments	Ulicsak and Wright (2010)

Continued on next page...

TABLE A.1: (continued)

PURPOSE	TERM	SOURCES
Propaganda	Militainment	Payne (2009), Stahl (2010)
	Political games	Michael and Chen (2006)
	Religious games	Michael and Chen (2006)
Social change and awareness	Games for change	Ulicsak and Wright (2010)
	Games for good	Ulicsak and Wright (2010)
	Persuasive games	Bogost (2007)
	Social impact games	Corti (2006), Ulicsak and Wright (2010)

APPENDIX B
DEFINITIONS OF SERIOUS GAMES

TABLE B.1: Common definitions of serious games, sorted by year of publication.

DEFINITION	SOURCE
"Games may be played seriously or casually. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining."	Abt (1970, p. 9)
"a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives."	Zyda (2005, p. 26)
"An interactive computer application, with or without a significant hardware component, which has a challenging goal; is fun to play and/or engaging; incorporates some concepts of scoring; and imparts to the user a skill, knowledge, or attitude that can be applied in the real world."	Bergeron (2006, p. xvii)
"Games-based Learning (a.k.a. 'Serious Games') is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills. Games-based Learning enables learners to undertake tasks and experience situations which would otherwise be impossible and/or undesirable for cost, time, logistical and safety reasons."	Corti (2006, p. 1)
"games that use the artistic medium of games to deliver a message, teach a lesson, or provide an experience."	Michael and Chen (2006, p. 23)
"the use of interactive digital technologies for training and education in private, public, government, and military sectors"	Raybourn (2007, p. 207)

Continued on next page...

TABLE B.1: (continued)

DEFINITION	SOURCE
"games that engage the user, and contribute to the achievement of a defined purpose other than pure entertainment (whether or not the user is consciously aware of it). A game's purpose may be formulated by the user her/himself or by the game's designer, which means that also a commercial off-the-shelf (COTS) game, used for non-entertainment purposes, may be considered a serious game."	Susi et al. (2007, p. 5)
"An optimized blend of simulation, game element, and pedagogy that leads to the student being motivated by, and immersed into, the purpose and goals of a learning interaction. Serious Games use meaningful contextualization and optimized experience to successfully integrate the addictive nature of well-designed games with serious learning goals."	Wexler et al. (2007, p. 303)
"IT applications that combine aspects of tutoring, teaching, training, communications and information, with an entertainment element derived from videogames. By offering this combination, the programs aim to make practical, utilitarian content (serious) enjoyable (game)."	Alvarez and Michaud (2008, p. 11)
"electronic/computer-access games that are not designed for commercial purposes but rather for training users on a specific skill set."	Annetta (2010, p. 105)
"digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning. The quality or success of serious games is characterized by the degree to which purpose has been fulfilled. Serious games are identified along a continuum from games for purpose at one end, through to experiential environments with minimal or no gaming characteristics for experience at the other end."	Marsh (2011, p. 63)
"simulations of real-world events or processes designed for the purpose of solving a problem. Although serious games can be entertaining, their main purpose is to train or educate users, though it may have other purposes, such as marketing or advertisement. Serious game will sometimes deliberately sacrifice fun and entertainment in order to achieve a desired progress by the player. Serious games are not a game genre but a category of games with different purposes. This category includes some educational games and advergames, political games, or evangelical games. Serious games are primarily focused on an audience outside of primary or secondary education."	Wikipedia "Serious game" (n.d.)

APPENDIX C
FIELD NOTE EXCERPTS

The following figures are excerpts from my field notes during *VBS2* requirements meetings (see Chapter 13). The excerpts have been chosen based on their representativeness of the field notes and the content's relevance to the research question. Please note that the notes represent my understanding of the contents of the meeting and may not correlate to the final design solutions implemented in *VBS2*.

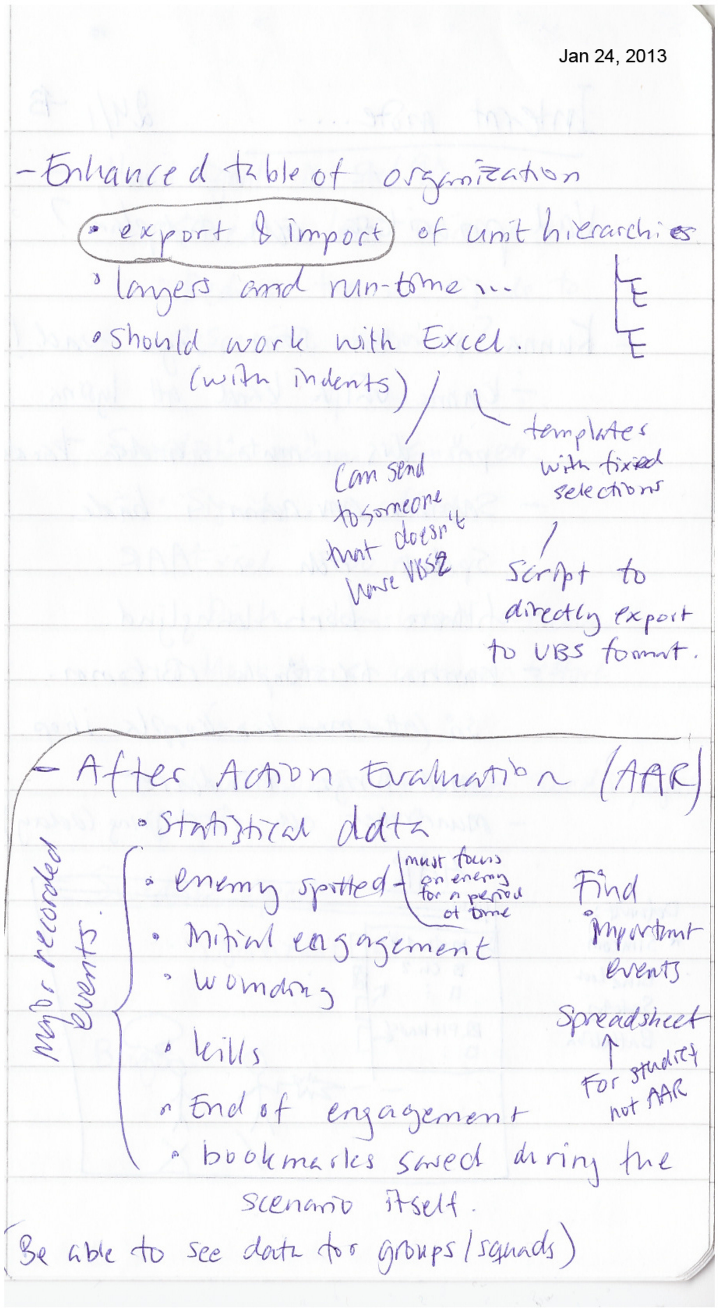


FIGURE C.1: Excerpt from field notes in January 2013.

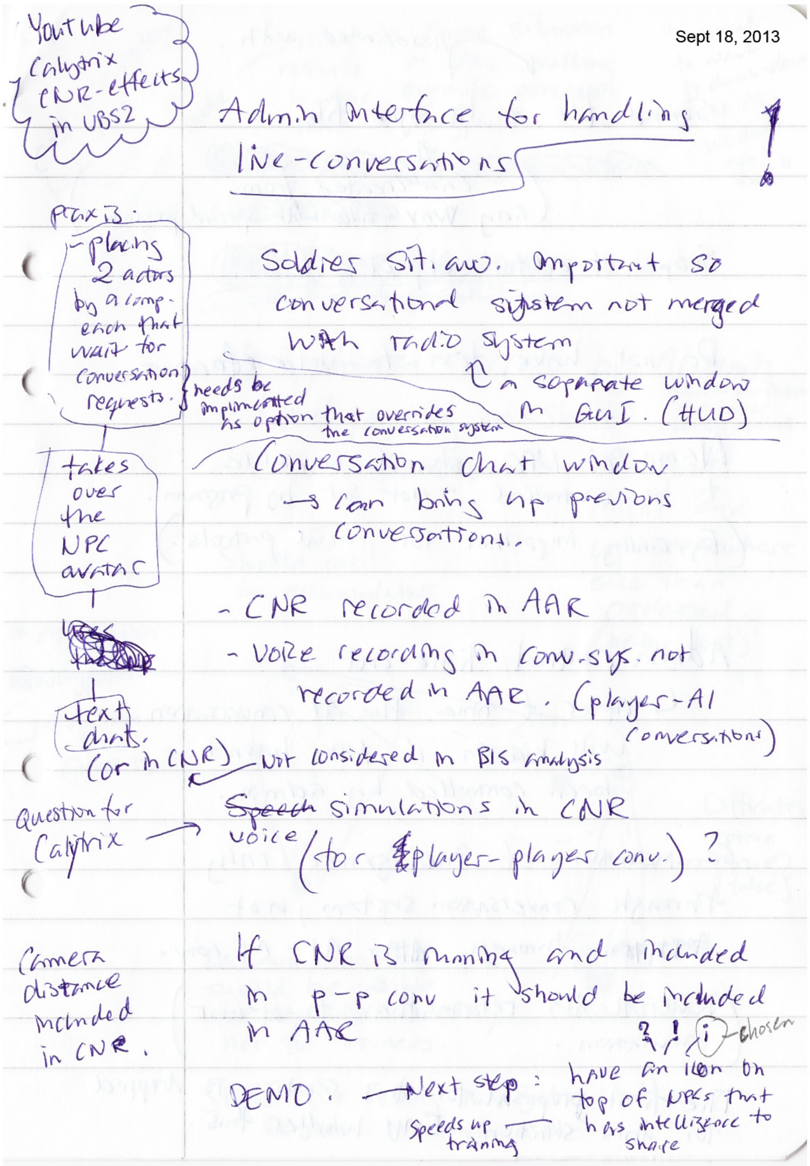
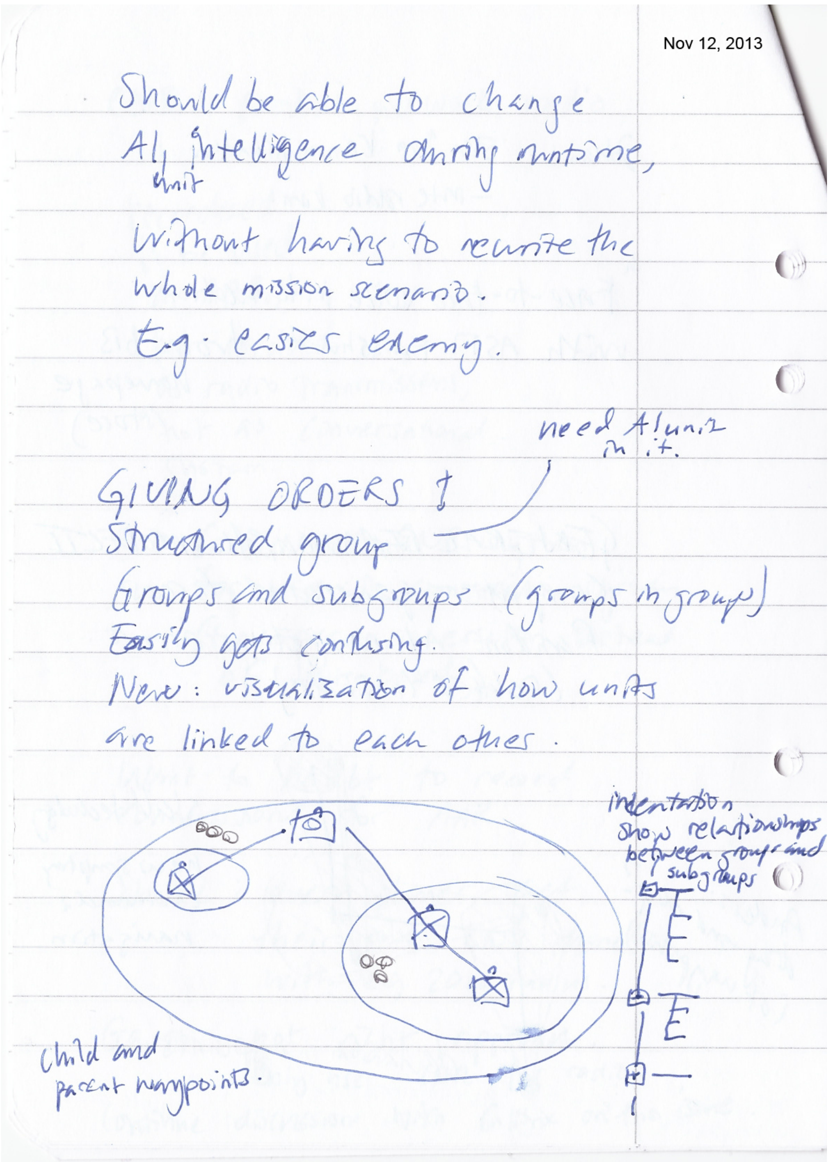


FIGURE C.2: Excerpt from field notes in September 2013.


Nov 12, 2013

Should be able to change
AI, intelligence during runtime,
unit
without having to rewrite the
whole mission scenario.
E.g. easier enemy.

need AI unit in it.

GIVING ORDERS &
Structured group
Groups and subgroups (groups in group)
Easily gets confusing.
New: visualization of how units
are linked to each other.

FIGURE C.3: Excerpt from field notes in November 2013.

APPENDIX D
VALIDATION QUESTIONNAIRE

Most questions were presented as statements using a 7-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (7) and also included a ‘don’t know’ option. The questionnaire’s original language was Swedish (written in *italics*); English translations were added later for non-Swedish speaking readers of this thesis.

TABLE D.1: Questions used in the validation questionnaire.

	ORIGINAL QUESTION	TRANSLATED QUESTION
1.	***Dina erfarenheter som instruktör i samband med spel - och simulatorövningar***	**Your experiences as instructor in the context of gaming and simulation exercises**
1.1	*Hur länge har du varit instruktör? (Alternativ: <2 år; 2–5 år; 6–10 år; >10 år)*	How long have you been an instructor? (Alternatives: <2 years; 2–5 years; 6–10 years; >10 years)
1.2	*Hur länge har du använt dig av simulatorer/spel som träningsverktyg? (Alternativ: <2 år; 2–5 år; 6–10 år; >10 år)*	How long have you been using simulations/games as training tools? (Alternatives: <2 years; 2–5 years; 6–10 years; >10 years)
1.3	*Vilka/vilket simuleringssystem har du mest använt dig av i träningssammanhang (där du varit instruktör)?*	What simulation system(s) for training have you used the most (where you have been an instructor)?
1.4	*För vilken typ av träning har du använt dig av simulatorer/spel?*	For what kind of training have you used simulation/games?
1.5	*Vad är den främsta anledningen till att du använder dig av simulatorer/spel för träning?*	What is your primary reason for using simulation/games for training?

Continued on next page...

TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
2.	***Instruktörsrollen***	**The instructor role**
2.1	*Det är för det mesta flera instruktörer närvarande och aktiva under spel- och simulatorbaserade övningar*	It is usually several instructors present and active during game- and simulation-based excersises
2.2	*Systemoperatören är en instruktör som också är insatt i handhavandet av simulatorn/spelet*	The system operator is an instructor who is also trained in operating the simulator/game
2.3	*Systemoperatören ansvarar enbart för tekniska aspekter (dvs. "tangent-bordskontakten") av övningen*	The system operator is responsible only for the technical aspects (i.e. operates the computer) of the exercise
2.4	*Systemoperatörens främsta roll är att skapa scenarier och styra spelet under övningen*	The primary role for the system operator is to create scenarios and to control the game during the exercise
2.5	*Systemoperatören behöver enbart vara insatt i spelet/simulatorn och kan därmed vara civil*	The system operator only have to be familiar with the game/simulator and, thus, can be a civilian
2.6	*Övningsledaren ansvarar för att det pedagogiska syftet med övningen uppnås*	The unit instructor is responsible for ensuring that the pedagogical purpose of the exercise is achieved
2.7	*Övningsledaren och systemoperatören kan vara en och samma individ*	The unit instructor and the system operator can be the one and the same individual
3.	***Skapa scenarier***	**Create scenarios**
3.1	*Jag återanvänder oftast övningsscenarier som jag själv skapat/varit med att skapa*	I usually re-use exercise scenarios that I have created myself / helped create
3.2	*Jag använder oftast scenarier som andra instruktörer har skapat*	I usually use scenarios created by other instructors
3.3	*Varför/varför inte?*	Why/why not?
3.4	*Jag skapar själv övningsscenarier från grunden, med utgångspunkt i en av kartorna sparade i systemet*	I create my own scenarios from scratch, starting with one of the maps saved on the system
3.5	*Jag låter systemoperatören skapa scenarier åt mig, baserat på kriterier jag ställt upp för övningen*	I let the system operator create scenarios for me, based on the criteria I set for the exercise

Continued on next page...

TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
3.6	*Det är lätt att förstå det pedagogiska syftet med ett övningsscenario som man själv inte varit involverad i att skapa*	It is easy to understand the educational purpose of an exercise scenario that you yourself have not been involved in creating
3.7	*Jag skulle vilja lära mig mer om hur man skapar nya scenarier i simulatorn/spelet*	I would like to learn more about how to create new scenarios in the simulator/game
3.8	*Jag tycker det är lätt att skapa nya scenarier i simulatorn/spelet*	I think it is easy to create new scenarios in the simulator/game
4.	***Briefing/information innan träningen***	**Briefing/information before the exercise**
4.1	*Det är viktigt att deltagarna är så informerade som möjligt innan övningen börjar*	It is important that the participants are as informed as possible before the exercise begins
4.2	*Goda lärandeeffekter kan uppnås även om deltagarna inte är insatta i allt innan övningens början*	Good learning effects can be achieved even if the participants are not familiar with everything before beginning the exercise
4.3	*Sätt 1–3 kryss för den typ av information som du anser är* viktigast *att övningsdeltagarna har kunskap om innan övningens början (Alternativ: Målet med övningen; Hur prestationen kommer att bedömas; Aktuella regler och metoder relevanta för övningen; Simulatorns/spelets funktionalitet; Simulatorns/spelets begränsningar; Hur simulatorn/spelet styrs; Inga förkunskaper är nödvändiga)*	Tick 1–3 items that match the type of information that you consider *most important* for the participants to know before beginning the exercise (Items: The goal of the exercise; How performance will be assessed; Current policies and procedures relevant to the exercise; The functionality of the simulator/game; The limitations of the simulator/game; How the simulator/game is operated; No prerequisites are required)
4.4	*Sätt 1–3 kryss för den typ av information som du anser är* minst viktig *att övningsdeltagarna har kunskap om innan övningens början (Alternativ: Målet med övningen; Hur prestationen kommer att bedömas; Aktuella regler och metoder relevanta för övningen; Simulatorns/spelets funktionalitet; Simulatorns/spelets begränsningar; Hur simulatorn/spelet styrs; Inga förkunskaper är nödvändiga)*	Tick 1–3 items that match the type of information that you consider *least important* for the participants to know before beginning the exercise (Items: The goal of the exercise; How performance will be assessed; Current policies and procedures relevant to the exercise; The functionality of the simulator/game; The limitations of the simulator/game; How the simulator/game is operated; No prerequisites are required)

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TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
5.	***Aspekter av pågående övning***	**Aspects of the ongoing exercise**
5.1	*Jag ändrar förutsättningarna (t.ex. mängden fiender, intensitet) i simuleringen medan den pågår*	I modify the conditions (e.g. number of enemies, intensity) in the simulation as it progresses
5.2	*Det är viktigt att kunna ändra förutsättningarna (t.ex. mängd fiender/utmaningar, svårighetsgrad) i simuleringen medan den pågår*	It is important to be able to modify the conditions (e.g. number of enemies/challenges, difficulty level) in the simulation as it progresses
5.3	*Svårighetsgraden på utmaningarna ändras dynamiskt under övningens gång baserat på deltagarnas tidigare prestationer*	The difficulty level of the challenges change dynamically during the exercise based on the participants' previous performance
5.4	*En eller flera instruktörer spelar rollspel (t.ex. antar en roll som civil/fiende/överordnad officer) i den virtuella världen under övningen*	One or several instructors role-play (e.g. plays the role of a civilian/enemy/superior officer) in the virtual world during the exercise
5.5	*En eller flera instruktörer spelar rollspel i det fysiska rummet under övningen*	One or several instructors role-play in physical space during the exercise
5.6	*Jag vill helst att någon annan med mer datorvana än jag styr fiendesidan (dvs. sköter "tangentbordskontakten") under övningen*	I would prefer that someone else with more computer experience than I control the enemy side (i.e. operates the computer) during the exercise
5.7	*Jag låter systemoperatören styra virtuella objekt under övningen*	I let the system operator control virtual objects during the exercise
5.8	*Jag styr själv virtuella soldater/fordon/fiender under övningen*	I control virtual soldiers/vehicles/enemies myself during the exercise
5.9	*Jag låter simulatorns förprogrammerade AI styra soldater/fordon/fiender under övningen*	I let the simulator's preprogrammed AI control soldiers/vehicles/enemies during the exercise
5.10	*Markera vilka metoder du* till största del *använder för att bedöma deltagarnas prestation under övningen (Alternativ: Lyssnar och iakttar vad som händer i det fysiska rummet; Lyssnar vad som sägs över radio; AAR-funktionalitet eller andra typer av loggningsfunktioner i spelet/simulatorn; Övrigt)*	Select which methods you *mostly* use to assess participants' performance during the exercise (Items: Listen and observe what happens in the physical space; Listen to what is said over the radio; AAR functionality or other type of logging features in the game/simulator; Other)

Continued on next page...

TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
5.11	*Om du kryssat i "Övrigt" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
5.12	*Sätt 1–2 kryss för den typ av information som du* i störst utsträckning *använder dig av när du bedömer deltagarnas prestation (Alternativ: Egna observationer; Andra instruktörers observationer; Innehållet i loggarna; Sammanfattande information från AAR-modulen i simulatorn/spelet; Annat)*	Tick 1–2 items that match the type of information you make *the greatest* use of when you assess the participants' performance (Items: My own observations; Other instructors' observations; The contents of the logs; Summary information from the AAR module in the simulator/game; Other)
5.13	*Om du kryssat i "Annat" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
5.14	*Jag försöker få en överblick över hela händelseförloppet under pågående övning*	I try to get an overview of the entire course of events during an exercise
5.15	*Jag tycker att det är lätt att få överblick över allt som händer i simuleringen*	I think it is easy to get an overview of everything that happens in the simulation
5.16	*Vad tror du underlättar/hindrar dig från att få överblick?*	What do you think facilitates/prevents you from getting an overview?
5.17	*Jag koncentrerar mig på att följa några få individer/grupper under pågående övning*	I concentrate on following a few individuals/squads during an exercise
5.18	*Deltagarna får genomföra övningen på egen hand, utan tillsyn från instruktörer*	Participants may complete the exercise on their own, without supervision from instructors
6.	***Utvärdering/AAR***	**Evaluation/AAR**
6.1	*Det är viktigt för lärandet att lägga ner mycket tid på utvärdering*	It is important for learning to spend much time on evaluation/debriefing
6.2	*Utvärderingen bör vara lärarledd*	The evaluation/debriefing should be instructor-led
6.3	*Jag upplever att det saknas underlag från systemet för att använda i utvärderingen*	I find that there is data missing from the system for use in the evaluation/debriefing
6.4	*Vilket underlag saknas i systemet?*	What data are missing?

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TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
6.5	*Jag upplever att jag får onödig information från systemet inför utvärderingen*	I find that I get unnecessary information from the system for the evaluation/debriefing
6.6	*Sätt 1–3 kryss för den typ av information som du anser är* viktigast *att ta upp efter övningen (Alternativ: Målet med övningen; Deltagarnas prestation/resultat; Hur prestationen har bedömts; Aktuella regler och metoder relevanta för övningen; Simulatorns/spelets funktionalitet; Simulatorns/spelets begränsningar; Hur simulatorn/spelet styrs; Annat; Ingen information är nödvändig efteråt)*	Tick 1–3 items that match the type of information that you consider *most important* to bring up after the exercise (Items: The goal of the exercise; Participants' performance/results; How performance has been assessed; Current policies and procedures relevant to the exercise; The functionality of the simulator/game; The limitations of the simulator/game; How the simulator/game is operated; Other; No information is required afterwards)
6.7	*Om du kryssat i "Annat" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
6.8	*Sätt 1–3 kryss för den typ av information som du anser är* minst viktig *att ta upp efter övningen (Alternativ: Målet med övningen; Deltagarnas prestation/resultat; Hur prestationen har bedömts; Aktuella regler och metoder relevanta för övningen; Simulatorns/spelets funktionalitet; Simulatorns/spelets begränsningar; Hur simulatorn/spelet styrs; Annat; Ingen information är nödvändig efteråt)*	Tick 1–3 items that match the type of information that you consider *least important* to bring up after the exercise (Items: The goal of the exercise; Participants' performance/results; How performance has been assessed; Current policies and procedures relevant to the exercise; The functionality of the simulator/game; The limitations of the simulator/game; How the simulator/game is operated; Other; No information is required afterwards)
6.9	*Om du kryssat i "Annat" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
6.10	*Jag skulle vilja att deltagarna hade tillgång till AAR-modulen i simulatorn/spelet, för själv-utvärdering*	I would like the participants to have access to the AAR module in the simulation/game, for self-evaluation
6.11	*Jag skulle vilja att deltagarna hade tillgång till samtliga loggar, för själv-utvärdering*	I would like the participants to have access to all logs, for self-evaluation

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TABLE D.1: (continued)

	ORIGINAL QUESTION	TRANSLATED QUESTION
7.	***Allmänt om spel- och simulator-baserad träning***	**General information about game- and simulator-based training**
7.1	*Sätt 1–2 kryss för de delmoment i träningen som du anser borde ges mer tid för (Alternativ: Förbereda/skapa scenarier; Förinformation/briefing; Simulering/spelande; Förberedelse inför utvärdering; Utvärdering; Annat; Inget)*	Tick 1–2 items that match those training phases for which you think more time should be dedicated (Items: Preparing/creating scenarios; Pre-information/briefing; Simulation/gaming; Preparation for evaluation/debriefing; Evaluation/debriefing/AAR; Other; None)
7.2	*Om du kryssat i "Annat" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
7.3	*Sätt 1–2 kryss för de delmoment i träningen som du anser att det i nuläget ägnas för mycket tid åt (Alternativ: Förbereda/skapa scenarier; Förinformation/briefing; Simulering/spelande; Förberedelse inför utvärdering; Utvärdering; Annat; Inget)*	Tick 1–2 items that match those training phases for which you think too much time is currently dedicated (Items: Preparing/creating scenarios; Pre-information/briefing; Simulation/gaming; Preparation for evaluation/debriefing; Evaluation/debriefing/AAR; Other; None)
7.4	*Om du kryssat i "Annat" på föregående fråga, ange vad*	If you ticked "Other" in the previous question, please specify what
7.5	*Det specifika syftet med övningen kan ändras strax innan övningen*	The specific purpose of the exercise can be changed just before the exercise
7.6	*Det specifika syftet med övningen kan ändras under övningen*	The specific purpose of the exercise can be changed during the exercise
7.7	*Framtidens spelbaserade träning kommer i första hand att ske online, genom distansundervisning*	In the future, game-based training will primarily be carried out online, through distance education
8.	***Övrigt***	**Other information**
8.1	*Övriga kommentarer kring spel- och simulatorträning*	Other comments about game and simulation training
8.2–8.4	*Det går bra att kontakta mig via e-post för intervju kring spelbaserad träning / Namn och E-postadress (fyll ej i om du vill vara anonym)*	It is okay to contact me via email for an interview about game-based training / Name and email address (leave blank if you prefer to remain anonymous)

GLOSSARY

GLOSSARY

AAR After-Action Review. *See also debriefing*.

Acceptance is the level of positive attitude users have towards using a system. It is also known as user acceptance and buy-in.

AI Artificial Intelligence.

ARG stands for Alternate Reality Game, that is "a fictional game world and narrative that is interwoven with real people, places and events" (Whitton, 2008).

Avatar is the virtual embodiment of a person or artificial intelligence (AI) entity that enables interaction with a virtual world, including other avatars. *See also non-playable character (NPC) and Puckster*.

BISim stands for Bohemia Interactive Simulations and is a company that develops serious games (SGs) and simulation technologies to military and civilian organisations worldwide. Their headquarters are in Prague, Czech Republic.

BTA is an acronym for BesättningsTräningsAnläggning, which is a facility at the Swedish Land Warfare Centre in Skövde that provides a number of virtual platoon trainers for tanks and combat vehicles, including the BTA 122 system (a Leopard 2 tank simulator), the BFT 90 system (for position training in combat vehicle 90), and the TBTA system (for training turret crews).

CAVE Cave Automatic Virtual Environment, that is, a specific type of virtual environment (VE) made up of projection screens that surround the user to create immersion into the virtual world.

CNR Combat Network Radio.

CoP stands for Communities of Practice and is used to explain (situated) learning in adults, especially within organisations. A CoP is a special type of community that can be understood in terms of mutual engagement, a joint enterprise, and a shared repertoire.

COTS stands for Commercial Off-The Shelf and denotes products or product components that are available commercially and can be bought "as is". *See also MOTS*.

CSCW stands for Computer-Supported Cooperative Work, or Computer-Supported Collaborative Work.

Debriefing is an activity where people who have had an experience are led through a purposive discussion of that experience (Lederman, 1992).

Deliberate practice means practising in a specific and purposeful way, constantly stretching oneself beyond one's comfort zone and persistently striving for improvement (Ericsson, 2006).

Elinor is a home-based gaming system for stroke rehabilitation developed by researchers at the University of Skövde in collaboration with Skaraborg Hospital, Skövde, and the Sahlgrenska Academy, Göteborg.

Fidelity is the level to which a virtual world or simulation emulates some aspect(s) of the real world.

FMV is an abbreviation of Försvarets materielverk, Swedish Defence Materiel Administration, which is a Swedish civil organisation that deals with defence logistics and provides Sweden's defence and military with technology and other equipment. One of their responsibilities is to manage public purchasing projects for the Swedish Armed Forces (SwAF).

FPS First-Person Shooter.

Gameplay is the interaction between a player and a game or between players. Gameplay is often characterised as a continuous action-feedback loop where the player's choices have immediate consequences.

Gamer mode is an attitude of the player, where winning the game becomes more important than reaching the learning objectives. In gamer mode, the learner is "gaming the system" by exploiting the underlying rules of the game regardless of the real-world applicability of the same actions. The term was coined by Frank (2012).

GBL Game-Based Learning.

GBT Game-Based Training.

GUI Graphical User Interface.

HBM Human Behaviour Modelling.

HCI Human-Computer Interaction.

HUD Head-Up Display.

Instructional design is "a system of procedures for developing education and training curricula in a consistent and reliable fashion" (Branch & Merrill, 2012, p. 8).

IS Information System.

IT Information Technology.

LMS Learning Management System.

LTA is an acronym for LedningsTräningsAnläggning, which is a facility at the Swedish Land Warfare Centre in Skövde that utilises a virtual environment for command and control training for military staff.

MMOG massively multiplayer online game.

Modding is the practice of creating game mods, that is, doing modifications or customisations of the graphical user interface (GUI), creating new missions, or creating completely new games from existing game engines.

MOTS stands for Modified Off-The-Shelf and denotes commercially available products or product components in which some alterations have been made. *See also commercial off-the shelf (COTS).*

NPC stands for Non-Playable Character and is usually an AI-controlled or scripted avatar in a game.

P2 Presence Pedagogy, developed by Bronack et al. (2008).

Puckster is a human controlling one or several non-trainee avatars (Colonna-Romano et al., 2009). To act as a puckster is called puckstering.

PX Player eXperience.

RPG Role-Playing Game.

SA is an abbreviation of Situation Awareness, that is, "being aware of what is happening around you and understanding what that information means to you now and in the future" (Endsley & Jones, 2012, p. 13).

SCCA is an acronym for Swedish Civil Contingencies Agency (Myndigheten för Samhällsskydd och Beredskap, MSB), which is a governmental organisation responsible for augmenting and supporting societal capacities in preparing for and preventing emergencies and crises.

SG Serious Game.

Sidh is a CAVE-based fire-fighter training game developed by researchers at the University of Skövde in collaboration with the Swedish Rescue Services Agency (SRSA).

SIP Status Information Panel.

SLWC is an acronym for Swedish Land Warfare Centre (Markstridsskolan, MSS), which is an educational organisation devoted to the command and tactical training of individual soldiers, squads and platoons, as well as command and control training at the battalion and company levels for army units. It is located in Skövde and Kvarn in Sweden.

SRSA Swedish Rescue Services Agency, now known as the Swedish Civil Contingencies Agency (SCCA).

STA is an acronym for StridsTräningsAnläggning, which is a mobile combat training centre at the Swedish Land Warfare Centre in Skövde that trains an evaluates military units using a variety of simulation systems, including the laser-based simulation system BT 46.

Steel Beasts Pro is a SG developed by eSim Games and used for military tank crew training.

StriSimPC is a classroom-based virtual command and situation trainer at the Swedish Land Warfare Centre in Kvarn that utilises PC games such as *Virtual Battlespace 2 (VBS2)* and *Steel Beasts Pro*.

Subject Matter Expert is a domain expert who have content expertise in something to be learned or practised, usually an instructor or teacher.

SwAF Swedish Armed Forces.

SWEDINT Swedish Armed Forces International Centre, located in Kungsängen, Sweden.

Syntell is a Swedish consulting company specialising in complex industrial systems and/or operations. SwAF is one of their customers. Their headquarters are in Stockholm, Sweden.

System Operator a facilitator in charge of managing the game or simulation system.

Tactical Incident Commander is an online game developed by SG researchers at the University of Skövde in collaboration with the Swedish Civil Contingencies Agency. The game is intended to be used in an introductory course for incident commanders and has a focus on tactical thinking and enabling learners to engage in a new community of practice (CoP) through playing and creating incident scenarios.

TAM the Technology Acceptance Model.

UTAUT the Unified Theory of Acceptance and Use of Technology.

UX User eXperience is "the totality of of the effect or effects felt by a user as a result of interaction with, and the usage context of, a system, device, or product, including the influence of usability, usefulness, and emotional impact during interaction, and savoring the memory after interaction" (Hartson & Pyla, 2012, p. 5).

UXD User eXperience Design.

VBS2 stands for *Virtual Battlespace 2* and is a SG used for military training in many nations worldwide. It is developed by Bohemia Interactive Simulations (BISim).

VE Virtual Environment.

ZPD stands for 'zone of proximal development', which denotes "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

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ANNA-SOFIA ALKLIND TAYLOR FACILITATION MATTERS 2014

ANNA-SOFIA ALKLIND TAYLOR

Anna-Sofia Alklind Taylor has a background in cognitive science with a focus on human-computer interaction and user experience design. She holds a Bachelor of Science degree in cognitive science from the University of Skövde, Sweden, a Master of Science degree in cognitive psychology from the University of Exeter, UK, and a Licentiate of Science in information technology from Örebro University, Sweden. Her current research is within the field of serious gaming, especially from a socio-technical perspective.

In her thesis, she explores the use of serious games from an instructor perspective. More specifically, she studies the roles of instructors and how they can be facilitated within an instructor-led game-based training environment. Research within the field of serious games has mostly focused on the learners' perspective, but little attention has been paid to what the instructors do and what challenges that entails. Anna-Sofia argues that serious games, as artefacts used for learning and training, cannot fully replace the instructors' tasks, but must rather be designed to facilitate the various activities of the instructors. Thus, instructors form an important target audience in serious game development – not just as subject matter experts, but also as users and players of the game – with a different set of needs than the learners. Moreover, serious gaming (the actualisation of a serious game) involves more than in-game activities, it also involves actions and events that occur off-game. These activities must also be considered when designing and utilising games for learning and training.

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