

Simulation and Advanced Gaming Environments (SAGE) for Learning

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Abstract: The *Simulations and Advanced Gaming Environments (SAGE) for Learning* project is a four-year investigation of the potential of advanced-technology games and simulations to support learning. A bilingual team of researchers and collaborating partners across Canada are developing and testing applications in several levels of health-related learning supported by foundational work on conceptual frameworks, evaluation methodologies and tools, and supporting Internet and handheld technologies. This project will add to our knowledge of and experience with digital game-based learning for K-12, university, and professional learners.

Introduction

The *Simulation and Advanced Gaming Environments (SAGE) for Learning* project is a \$3 million, bilingual, Pan-Canadian Collaborative Research Initiative funded primarily by Canada's Social Sciences and Humanities Research Council (SSHRC) with additional funding from partners and from the CANARIE Inc. Advanced Applications Program. 31 Canadian university-based researchers from 14 institutions, working in education, cognitive psychology, computer science, educational technology, new digital media, and research/ evaluation methodologies, are collaborating with Canadian and international partner representatives to better understand how SAGEs can support learning, particularly in their embodiment of current learning theories.

A key *SAGE for Learning* partner is Société d'apprentissage à vie (SAVIE) Inc. (www.savie.qc.ca), a research and development centre at Télé-université in Quebec City. SAVIE is directed by Dr. Louise Sauvé (SAGE network Co-Leader) and has been active for over ten years in research and development projects related to core competencies and creating web-based simulations and games. SAVIE is developer and host for the Carrefour Virtual de Jeux and Educational Games Central networks for the application of games to learning. (<http://www.savie.qc.ca/CarrefourJeux/fr/accueil.htm> and <http://egc.savie.ca>).

The *SAGE for Learning* project responds to four emerging trends in Canadian society and learning: (1) the shift in our culture's entertainment toward games and virtual environments; (2) the rapid emergence of simulations and games as popular education and training tools; (3) our growing understanding that learning is most effective when learners collaborate and practice in context; and (4) ever-expanding technologies for developing appealing, immersive, and engaging simulations and games. The project's research objectives are to:

- build and validate a *common multidimensional taxonomy and conceptual framework* to guide SAGE research;
- describe the *types and characteristics of learning* that take place through the use of SAGEs;
- identify, observe, document and model *key cognitive and social processes* that develop, promote or hinder learning in SAGEs;
- study the capacity of SAGEs to *support learning as described by key learning theories* through adaptation and creation of simulations and games for specific learner groups and tasks;
- develop and implement *research methodologies and tools* appropriate for describing and assessing SAGE learning processes and outcomes;
- develop and test *methods for specifying SAGEs as learning objects* for standards-based repositories;
- demonstrate the *application of knowledge* resulting from our research on SAGE impacts in the development, implementation, and testing of prototype SAGEs in the fields of health promotion, health care, and health education; and
- pilot the *implementation* of SAGEs in authentic contexts, e.g. schools, businesses, and community settings.

This project will add to our knowledge of and experience with digital game-based learning for K-12, university, and professional learners.

Key Definitions

To make a clear distinction among the often-confused ideas of games, simulations and simulation games, we begin with the following definitions (Crookall et al. (1987), Garris et al. (2002), Stolovitch (1981), Sauvé et al., 2005b and Sauvé et al., under review):

- *games* are activities that do not attempt to replicate reality, have clearly defined sets of rules including scoring systems, and produce winners and losers;
- *simulations* are activities that include exploration and practice within models of reality but without competition, scoring, and winners/ losers; and
- *simulation games* are games that are based on simplified but dynamic models of aspects of reality.

We have found that these distinctions are necessary for a conceptual framework that relates these distinct types of activities to their impacts on learning.

Motivation

Our research focuses on how the internet, handhelds and immersive environments can be used to support the delivery and evaluation of theory-based, often collaborative learning experiences. SAGEs can employ sophisticated, detailed virtual reality representations of physical settings, as in many of today's commercial video games; wireless handheld devices or cell phones that allow instant communication and feedback (e.g., Naismith et al. 2004); game boxes to bring games to the family living room; Internet-based multiplayer games; head-mounted displays; 3D immersive CAVE environments; or "exertainment" devices that sense and translate to the screen players' physical movements (Exergaming 2006). Moreover, video game SAGEs have become attractive, even addictive, fixtures of popular culture and vehicles for commercially and politically-motivated "learning" (e.g. Skyworks Technologies 2005, Soussi 2003).

There are a number of arguments that would seem to support these game and simulations as learning tools, including:

- **Popularity and access:** Games and simulations are widely *popular and accessible* as entertainment, with North American video game sales reported as \$10.5 billion in 2005 (Gamasutra 2006). A 2002 US survey found that 92% of children and adolescents ages 2-17 played video games, and more than two-thirds of all children ages 2 to 18 lived in a home with a video game system (Kaiser Family Foundation 2002). As well, 61% of Canadian households and 75% of US households used mobile phones in 2005 (Wright, 2006). Using games for learning builds on their familiarity and relatively easy access.
- **Player engagement:** Computer games are highly *engaging*. Today's games offer motivating, absorbing, interactive, collaborative experiences that draw in players and keep them playing for many hours, learning in order to succeed in the game and often developing complex social networks in the process (Asgari and Kaufman, 2004; Gee, 2003; Prensky, 2001; Squire, 2005). Educators ask what we can learn from games about engagement that can be brought to learning activities.
- **Cognitive and social questions:** It is suggested that the "game generation" has developed a new cognitive style characterized by multiprocessing, a short attention span, learning through exploration and discovery; several researchers argue that today's games and simulations, with their immersive social experiences, provide the ideal environment for this group's learning (Asakawa and Gilbert 2003, Gee 2003, Prensky 2001, Seely Brown 2002).
- **Experience:** Simulations and games have long been popular and proven tools for trainers and educators in various venues (Stolovitch 1981, Stolovitch and Thiagarajan 1980). Examples using newer technologies are emerging as powerful tools for learning complex concepts and behaviours (e.g., Cornell Management Game 2006, Virtual U 2006).
- **Potential for integrating theory, experience and best practice:** Games and simulations appear to offer many opportunities to improve learning engagement and effectiveness by embodying accepted learning theories. Networked, collaborative simulation and gaming environments can provide interactivity, immersion, iation,

learner control, repeated practice, feedback, and opportunity for reflection, especially useful where authentic experiential learning is infeasible for reasons of cost, access or safety (Kinzie et al. 1996, Ruben 1999, Schank and Neaman 2001).

- **Learning outcomes:** A number of studies have demonstrated the effectiveness of games and simulations for cognitive, emotional and psychomotor learning (e.g. Baranowski et al. 2003, Kirriemuir and McFarlane 2004, Sauvé et al. 2005c). According to these, games and simulations motivate learning, offer immediate feedback, consolidate knowledge, support skills development and application, aid learning transfer, and influence changes in behaviour and attitudes, all pointing to greater learning effectiveness with simulations and games.

Unanswered Questions

Research on SAGEs needs to explore many aspects of their objectives, design, embedded models, learner characteristics, media and technology characteristics, learning processes, and learning outcomes, most often in the context of a specific learning application (see, for example, Garris et al. (2002)'s model of game-based learning). To fully understand and improve learning with SAGEs, we need to identify important variables at all stages of the framework and to investigate their relationships, particularly those that lead to improved learning outcomes and positive impacts. Key to doing this are rigorous evaluation methodologies that test evolving learning strategies and new, more complex learning environments (Kneebone 2003, Wideman et al., in press). Extensive research is needed to develop theory-based, rigorous evaluation tools and methodologies that are appropriate to these new learning environments.

Research Phases and Domains

To begin to answer these questions, *SAGE for Learning* research is being conducted in *descriptive*, *developmental* and *evaluation* phases across its four-year mandate. Individual projects are grouped into three Application domains (*Games*, *Simulations*, and *Simulation Games*); and three Foundation domains (*Conceptual Foundations*, *Methodologies and Tools*, and *Technologies*). Research in the foundation domains supports and integrates research in the application domains, as illustrated in Figure 1 below.

Research Projects

SAGE research projects are addressing a variety of specific health and medical education applications and foundational issues. Projects include:

- *The impact of online educational games for illness prevention and health promotion* (Project Leader Dr. Louise Sauvé, Télé-université): This project is working identify and document game characteristics that help or hinder learning, and to analyze the connections between important game variables and health-related learning impact. Researchers are now testing existing Educational Games Central “frame games” (game shells such as Tic Tac Toe and Snakes and Ladders (Figure 2)) and are developing and evaluating a multi-player game shell for Parcheesi as well as two others. Their ultimate goal is to help teachers to easily create proven, effective and enjoyable games for teaching health concepts.

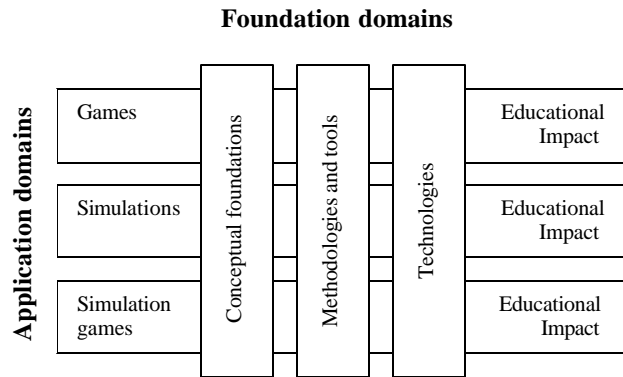


Figure 1: SAGE for Learning Research Domains

- *Educational games on the Internet: Tools for trainers in illness prevention and health promotion* (Project Co-leaders Dr. Claire IsaBelle, University of Ottawa, and Dr. Margot Kaszap, Université Laval): Researchers in this project are working to identify, observe, inform and model the main cognitive processes and learning transfer which games can develop or restrict, from the point of view of teacher training related to learning in the health field. They are working with groups to build and test games for training health teachers and students based on a socio-constructivist methodology (Kaszap et al. 2005). They have completed a review of 40 games (Sauvé et al. 2005a) as well as a needs assessment and curriculum analysis; the results are now being incorporated into specific games intended to ultimately improve health outcomes for students.

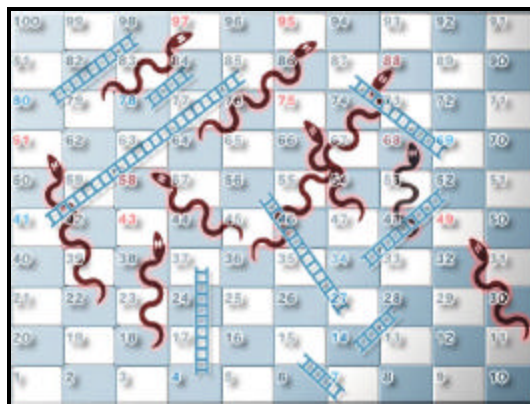


Figure 2: Snakes and Ladders Game Shell in Educational Games Central

- *Collaborative, Online, Multimedia, Problem-based Simulations (COMPS)* (Project Leader Dr. David Kaufman, Simon Fraser University): This project team is exploring the potential of COMPS to support problem-based learning (PBL) for medical student education and for continuing medical education for health professionals. They are designing, developing and testing a set of full scale, media-rich, narrative-based simulations in which learners can role-play medical professionals and access realistic resources to guide their diagnoses and treatments (Schell and Kaufman 2006). This project especially emphasizes patient-centred health care. Simulations are being developed and tested their case simulations in different forms in WebCT and in the CANARIE-funded simulation software platform entitled ENJEUX-S (see below).
- *HEALTHSIMNET* (Project Leader Dr. Michael Dobson, Simon Fraser University): This project is exploring how to create and apply visualization and simulation tools based in activity theory to facilitate learning based on models of complex sets of interactions among interprofessional teams. Their initial case study demonstrates that modelling, with graphic presentations, communications about an HIV/AIDS case enables learners to develop insights into the competencies and gaps in the professional practices of nurses, physicians, and child welfare workers, as well as legal obstacles and areas in which public health outcomes could be improved through more effective interactions (Dobson et al. 2004).

- *Building classes of entertaining games for health education* (Project Leader Dr. Carolyn Watters, Dalhousie University): Researchers in this project are designing games for children who need to learn to manage chronic diseases. Their goals are to identify factors in game design that motivate children and to build and test generic game shells that can incorporate content from physicians, health educators, or parents, resulting in games that are tailored to the needs of individual children or groups dealing with different diseases (Watters et al. 2005, 2006).
- *Contagion!* (Project Co-leaders Dr. Suzanne de Castell, Simon Fraser University and Dr. Jennifer Jenson, York University): The researchers in this project are exploring questions of education game design, gender and gaming, content development, and narrative frame through the design, development, and testing of an internet-based educational simulation game (de Castell et al, 2006, Grozav et al. 2005). Through anonymous role-play and collaboration, the game is intended to encourage affective, somatic, and procedural dimensions of habitual self-care for health promotion. The game, targeted at 9-12-year-olds, directly complements and extends prescribed learning goals for grades 7-9, with emphasis on human, social, and health sciences.
- *Conceptual foundations of games, simulations and simulation games* (Project Leaders Dr. Louise Sauvé and Dr. David Kaufman): This project is seeking answers to a number of questions, including understanding the characteristics which let us distinguish games, simulation games, and simulations; the cognitive, affective, and motivational aspects of games, simulations, and simulation games; and aspects of a multidimensional framework to guide future research on games and simulations for learning. Based on a major database search, the researchers completed a detailed grid-based analysis of over 450 recent papers on educational games and simulations, focusing on terminology and learning impact. They have completed several major literature review papers (e.g. Sauvé et al. 2005d) and a searchable database for SAGE members.
- *New methods for the evaluation of SAGEs* (Project Leader Dr. Ron Owston, York University): Researchers in this project are focusing on measurement and evaluation of activities, interactions, and choices that take place while learners use simulations and games online. They have designed and developed the Virtual Usability Lab (VULab) (www.vulab.ca, Owston et al. 2005, Wideman et al. in press). VULab is a software tool to remotely capture and analyze a wide variety of usage data on Web-based educational games and simulations. The VULab automates remote collection and integration of such data as user activity logs and online demographic questionnaire responses; it incorporates the use of remotely delivered, automated online queries customized to capture critical use experience and perceptions at key points in the use of gaming and simulation environments. VULab testing has demonstrated that remote collection of a variety of forms of usability data is feasible and the tool can provide valuable feedback to designers of games, simulations, and any interactive website to help them improve their products.
- *Evaluation and analysis of eye movements related to learning in SAGE environments* (Project Leader Dr. Patrice Renaud): Researchers in this project are seeking to develop a methodology, based on the detection of users' eye movements in learning situations in 2D and 3D environments, which will allow researchers to better understand learning within SAGE environments (Renaud et al. 2004).
- *ENJEUX-S: An advanced on-line educational gaming and simulation environment* (Project Leader Dr. Louise Sauvé): Funded by a \$357,000 grant from CANARIE Inc., this project has developed an advanced multimedia, on-line, multi-player game and simulation environment. The web environment (Figure 3) integrates multimedia components (video, voice) with 2D / 3D games and simulations, allowing for instantaneous and simultaneous interaction so that users in any location can play and collaborate (Sauvé et al. 2005c and <http://www.savie.qc.ca/enjeux/>).



Figure 3: ENJEUX-S Interface

Knowledge Dissemination

In addition to traditional dissemination channels, the SAGE network has implemented and continues to expand its bilingual public web site (www.sageforlearning.ca) to make its goals, project descriptions and results available to all interested readers. A 2005 SSHRC Outreach Grant is also making it possible for the network to expand into a web-based television/ video site, SAGETV, to further showcase our knowledge about SAGEs for learning.

Conclusion

The *SAGE for Learning* project is nearing the end of its development phase and focusing on testing and evaluation for the remainder of its mandate. Researchers expect to be able to share knowledge, case studies, best practices and evidence about designing and implementing effective games and simulations as learning support tools. SAGE project descriptions and publications, as well as current project news, are available at the project web site, www.sageforlearning.ca.

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