A Systematic Review of the Impact of Games and Simulations on Learning

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Based on the hypothesis that inconclusive research results with regard to the impact of games and simulations are linked to the absence of clear concept definitions, a systematic review of the research literature (1998-2007) was undertaken to fill this methodological gap. This paper presents the results of the study, which was led by researchers of the *Simulation and Advanced Gaming Environments (SAGE) for Learning* project (www.sageforlearning.ca). These results confirm that games and simulations promote structuring of knowledge, development of problem-solving skills, integration of information and development of cooperation, communication, and human relations skills.

The *Simulation and Advanced Gaming Environments (SAGE) for Learning* project (www.sageforlearning.ca) was funded in 2003 for five years by the Social Sciences and Humanities Research Council of Canada. The mission of the SAGE project is to study the impact of new technology games and simulations on learning in the broad domain of health. In March, 2004, researchers in the Conceptual Foundations domain of the SAGE project began a systematic review of research articles (1998-2008) to establish the essential attributes of games and simulations, as well as the impact of games and simulations on the learning process.

This paper presents the results of the study of game and simulation impacts on learning. An analysis of 217 articles on the learning impacts of games and simulations shows that they stimulate structuring and assimilation of knowledge, development of problem-solving skills, integration of information and development of cooperation, communication, and human relations skills. However, theses studies also show significant methodology weaknesses and a lack of indicators to estimate the actual effectiveness of games and simulations. We conclude the paper by recommending ways to resolve these methodological problems.

1. The Issues

Games and simulations are growing forces in our entertainment, culture and technologies, appearing in our cell phones, PCs, and online; Canada is a world player in this $30 billion international industry. The best simulation and gaming environments for learning take advantage of the popularity, engaging features, playfulness and social/ collaborative characteristics that make today's video games our fastest-growing entertainment media. But they do not ignore what we know about how people learn, how to effectively assess learning, and how collaboration and social networks matter.

As they become more widely accepted, games and simulations are emerging as tools for learning outside and within academia (e.g., see Prensky, 2006; Gee, 2003; Kirriemuir & McFarlane, 2004; Naismith et al., 2004; ELSPA, 2006); educators and trainers reason that the popularity, engagement characteristics, and wide accessibility of digital games and simulations can provide powerful learning tools if understood and properly exploited, particularly for newer generations of learners.

The growing movement toward games and simulations for learning leads to many unanswered research questions, in social science and computing science technology as well as in interdisciplinary work across their boundaries. Indeed, the Federation of American Scientists Summit on Educational Games (FAS, 2006) argues that: "A robust program of research and experimentation is needed to enhance development of educational games by stimulating transfer of the art and technologies of video games to education and learning systems" (p. 5).

Regarding learning outcomes and impact, evaluations and meta-analyses have shown mixed results for SAGEs but have produced many positive results. Garris et al. (2002) cite evidence of learning in three broad categories: skill-based (including technical and motor skills), cognitive learning (encompassing declarative knowledge, procedural knowledge, and strategic knowledge), and affective knowledge (attitudes).

However, researchers report stumbling blocks which need to be further addressed through research. Alessi and Trollip (1991) and Thurman (1993) argue that educational games and simulations developed with information and communications technologies are often badly designed and present ineffective learning environments. Hourst and Thiagarajan (2001) and Thiagarajan (1998) note that games and simulations are not tested as well as they should be in order to establish their technological performance, learning effectiveness, and efficiency. Bartholomew et al. (2001) argue that a lack of connection between theory and concrete, operational practices weakens the effectiveness of educational tools such as games and simulations. These analyses raise the question of whether divergent outcome results in game and simulation research could be caused by weaknesses in the theoretical frameworks of the studies, defective methodologies, or lack of connection between theory and practice. Moreover, we are only beginning to gain experience with, and evidence of, the impact of learning theory implementation using newer technology-based simulations and advanced gaming environments (SAGEs). Our study is aimed at establishing the theoretical basis and guidelines for an effective analysis of the impacts of games and simulations.

1.1 Mixed Results

Why can't the results of studies reject or confirm the fact that games and simulations stimulate effective learning? Consistent with Wolfe and Crookal (1998), Jones (1998), Feinstein *et al.* (2002), and Sauvé *et al.* (2005a), it appears clear that the absence of consensus on the terminology used and on the essential attributes when it comes to games or simulations has the direct consequence of providing contradictory research results on learning. By essential attributes, we mean the elements that are indispensable and common to all activities that we define as a game or a simulation. In order to clarify our field of research, a structured analysis of the literature (Sauvé *et al.*, 2005) allowed us to clearly define educational games and simulations.

Based on this analysis, we define a game as a fictitious, whimsical or artificial situation in which players are put in a position of conflict. At times, players square off against one another; at other times, they are together and are pitted against other forces. Games are governed by rules which structure their actions in view of an objective or a purpose which is to win, to be victorious or to overcome an obstacle. They are integrated into an educational context when the learning objectives are associated formally to the content and the game enhances learning in the cognitive, affective and/or psychomotor domains.

We define a simulation as a simplified, dynamic and accurate model of reality that is a system used in a learning context. Through its model, judged by its fidelity and its similarity to the reality it represents, a simulation is distinguished from a game, which makes absolutely no reference to reality. These attributes of a simulation are essential to its use in addressing educational objectives and to allowing learners to study complex and real phenomena, which is not the case with a game.

1.2 What Differentiates Games and Simulations

Upon examination of their essential attributes, it is clear that games and simulations are distinctive concepts.
A, simulation is a simplified, dynamic and precise representation of reality defined as a system. A simulation is a dynamic and simplified model of reality and it is judged by its realism, by its correspondence to the system which it

represents. A game is created without any reference to reality, what is never the case for a simulation or a simulation game. A simulation does not necessarily involve conflict or competition, and the person who uses it is not looking to win, as is the case in a game. All educational games, as distinct from other learning activities, add the notion of winner/loser in a competition. For example, imagine a person who responds to questions and receives points. Once the activity ends, there is nothing to indicate that (s)he has won. All games establish rules that allow the determination of a winner and one or more losers. These are the same rules that provide the challenge and competition in the game.

Many educational simulations, unlike games, can function without human intervention as for example, the dynamic representation a planetary movement in the solar system. Even if certain simulations identify one or more "winners" or "losers," this attribute (inherent in games) is not essential to its definition. If one or more players participate in a simulation and interact with its various components and the notion of a winner and loser is introduced, this activity defines a new concept of "simulation game." This concept will be discussed in a later paper.

We wish to underscore that the identification of the essential attributes of "game" and "simulation" is important because this avoids the methodological weaknesses of many studies that we examined during our review of the literature on the impacts of games and simulations on learning.

1.3 Research Questions

Considering these methodological weaknesses, which lead to mixed research results on the actual learning impact of games and simulations, this study answers the questions "What type of learning are educational games and simulations stimulating?" and "If a survey of the literature on games and simulations takes into account their essential attributes as discriminated factors, will the results obtained be positive?".

To answer these questions, we have conducted a survey of the literature using the method that Aktouf (1987, p.55) calls "current state of knowledge." In other words, the "current state of knowledge" is a […] review, exhaustive if possible and criticizing the specific work done on the problem that we want to work on (in fact, it is a review of the main research on the subject)". Our approach consisted in reviewing the research articles on educational games, simulation games and simulations published since 1998[1] obtained from twenty bibliographic databases, and in categorizing articles based on the variables in our analysis (essential attributes of the game and simulation, and the impacts on learning). We define impacts on learning as positive or negative effects on learning or consequences created by the use of a game or simulation that affect the knowledge, attitudes or psychomotor abilities of the participant. We will now review the studies related to the impacts of games and simulations on learning.

2. Impacts of Game and Simulations on Learning

What does the literature say about the impacts of games and simulations on learning? For the purposes of this paper, we will discuss the following main impacts found in the literature: knowledge structuring, information integration, problem-solving abilities development, and the development of cooperation, communication and human relations skills.

2.1 Knowledge Structuring

By knowledge structuring, we mean the construction and organization of diagrams or representations in learners in order to understand a concept or a given situation. Twenty-eight (28) articles on games concluded that games have positive impacts on knowledge structuring. These can be regrouped in four indicator categories: (1) learning of different types of links established by the learner according to Gagné[2]; (2) improvement of reinforcement of knowledge[3] without an operational definition; (3) assimilation of information[4] without an operational definition; and

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[1] This year's choice is consistent with the ten-year analysis objectives of the knowledge corpus (from 1998 to 2007).

[2] Aspinwall & Shaw (2001); Eyraud (1998); Gee (2003); Kafai (2001); Koirala & Goodwin (2000); Meel (2000); Steinman & Blastos, (2002).

[3] Benne & Baxter (1998); Carroll (1998); Din (2001); Evreinova, Evreinov & Raisamo (2006); Fukuchi, Offutt, Sacks & Mann (2000); Kreutzer (2001); Lennon (2006).Lieberman (2001); Miller, Lehman & Koedinger (2000); Mondozzi & Harper (2001); Owens & Sanders (2000); Rosas & *al.* (2002); Saxe & Gubermans (1998); Shaftel, Pass & Schnabel (2005).

(4) structuring knowledge without defining its concept or presenting the results of experiments[5]. Note that the measuring of knowledge structuring in a game is based on questionnaires on the material covered in the game, completed after gameplay, formal tests, satisfaction questionnaires, and finally, pretests and post-tests about the material transmitted by the game.

Similar results can be found in eighteen (18) articles [6] on simulation, but the impact indicators are described more clearly: the way in which the learner assimilates the information and masters its different possible representations in order to integrate it in an coherent knowledge set; and the way in which the learners integrate new information, deepen their understanding by envisioning, build their own understanding and interpretation, develop a more sophisticated and larger understanding, and generalize and improve their understanding of the principles that can apply during simulations.

In these study conditions, it becomes difficult, even if the results are positive, to determine the type of learning stimulated by gaming when it come to knowledge structuring. In the studies on educational stimulation, some indicators are more specific.

2.3 Information Integration

By information integration, we refer to the use of theoretical notions or concepts in practical situations stimulated by a learning activity. Specifically, we study the possibilities that gaming offers to link acquired (but still abstract) knowledge with concrete knowledge. This integration refers to the notion of information retention, which is the memorization of information over a longer period than the one that immediately follows the learning activity. Fourty-five (45) articles on games mention positive results at the level of information integration. The articles show three trends. First, some authors operationalize the concept as the learner's capacity to establish links, intuitively or not, and to transfer acquired knowledge to other contexts[7]. These results are compatible with our interpretation of the concept of information integration. Second, other authors associate information integration to the overall improvement of the learners' knowledge, based on statistics and results obtained by learners after having learned using games[8], but they don't describe how this improvement occurred. We believe that this concept of information integration validates the notion of knowledge structuring. Third, other authors link the notion of integration and the positive results obtained by learners with a specific game in an academic context[9] or in a particular subject[10] (mathematics, French, medicine), without defining or operationalizing the concept of integration.

Thirteen articles[11] find that learners develop their ability to refer to concepts, definitions and theories acquired previously in order to apply them to concrete situations during the simulation. Also present is the notion of knowledge reinforcement through repetition and variation of actions, ensuring the acquisition and comprehension of concepts by the learner.

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[4] Blum et Yocom (1996); De la Cruz, Cage & Lian (2000); Holton, Ahmed, Williams & Hill (2001).
[5] Asakawa & Gilbert (2003); De Grandmont (2004); Dempsey, Haynes, Lucassen & Casey (2002); Roubidoux, Chapman & Piontek (2002).
[6] Apkan (2002); Bos, Shami & Naab (2006); Feinstein, Mann & Corsun (2002); Galatas (2006); Kiegaldi & White (2006); Linsk & Tunney (1997); Mechling & Gast (2003);Mechling, Gast & Langone (2002); Medley & Horne (2005); Moseley (2001); Olsen (2000); Pei (1998); Rachman-Morre & Kenett (2006);Repine & Hemler (1999); Schmidt (2003); Schnotz & Rasch (2005); Storrs & Inderbitzin (2006); Vanhoucke, Vereecke & Gemmel (2005).
[7] Aspinwall & Shaw (2000); Gee (2003); Green (2002); Heenan (1999); Kafai (2001); Moyer & Bolyard (2003); Noone (2000); Quinn, Koca & Weening (1999); Shi (2000); Snively, Counsell, Gilbert & Ross (1996); Wiest et Quinn (1999).
[8] Barta & Schaelling (1998);De Grandmont (2004); Fukuchi, Offutt, Sacks & Mann (2000); Garret, Busby & Pasnak (1999); Higgins & Barkley (2004); Jones, Jasperson & Gusa (2000); Koirala & Goodwin (2000); Kreutzer (2001); Lieberman (1998); Lieberman (2001); Markey, Power & Booker (2003); Ravenscroft & Matheson (2002); Silverman, Holmes, Kimmel & Branas (2002); Steinman & Blastos (1999); Vandeventer & White (2002); Westbrook & Braithwaite (2000).
[9] Baker, Navarro & Van der Hoek (2004); Dempsey, Haynes, Lucassen & Casey (2002); Dkeidek (2003); Eyraud (1998); Hamalainen & *al.* (2006); Hostetter & Madison (2002); Morris, Fritz, & Buck (2004); Padgett, Strickland & Coles (2005); Ruben (1999); Source : Curriculum view (2004); Virvou, Katsionis & Manos (2005); Ward & O'Brien (2005).
[10] Haas, Quiros, Hyman & Larson (2006); Jensen, Sims & Reventos (2004); Moreno & Duran (2004); Purushotma (2005); Shaftel, Pass & Schnabel (2005); Source : Curriculum review (2004).
[11] Alberto, Cihak & Gama (2005); Apkan (2002); Bobek, Robbins & Gore (2005); Cioffi, Purcal & Arundell (2005); Feinstein, Mann & Corsun (2002); Goldenberg, Andrusyszyn & Iwasiw (2005); Minasian & Alameh (2002); Morse & Schuster (2000); Moseley (2001); Olsen (2000); Schmidt (2003); Schnotz & Rasch (2005); Vanhoucke, Vereecke & Gemmel (2005).

In these study conditions, it is not easy to determine whether games stimulate information integration; the authors tackle the subject in quite different ways. Nevertheless, based on the analysis of the literature, we can identify trends that allow us to assert that information integration stimulated by games is an impact that is consistently put forward. In regard to simulations, the analysis shows that authors use similar indicators to measure their impact on learning, and that this impact is positive.

2.2 Development of Problem-Solving Skills

Thirty-five (35) articles show positive results in regard to the development of problem-solving skills. Games develop these skills in the following ways: recognition of familiar problem elements by means of diagrams, transfer (ability to establish links with similar problems), enunciation of one or more solution assumption (new or not), realization of strategies allowing the learner to apply the solution, problem explanation (comprehension) and its resolution (evaluation).

For most authors in the field of gaming, learning by problem solving in a game stimulates the development, in learners, of strategies and of abilities to make decisions, to understand a problem, to formulate solution assumptions, and to solve a studied problem[12]. The same analysis variables can be found in simulations[13]. Some mention that there has been learning by problem solving without defining the operational variables that allowed them to identify the changes generated by the computer game[14].

In these study conditions, it seems that the educational games and simulations are effective in regard to learning by problem solving.

2.4 **Development of Cooperation, Communication, and Human Relations Skills**

Sixty (60) articles[15] find that gaming in general or a specific game (used as a part of an experiment, for example) stimulates the development of cooperation, communication, and human relations skills. Analysis of the articles shows that the most used indicators are human relations skills (the ability to establish contact with others, to

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[12] Armory, Naicker, Vincent & Adams (1999); Bankauskas (2000); Barta & Schaelling (1998); Blake & Goodman (1999); Bottino, Ferlino, Ott & Tavella (2006); Brozik & Zapalska (1999); Ciancio, Sadowsky, Malabonga, Trueblood & Pasnak (1999); Corbeil (1999); De Grandmont (2004); Dempsey, Haynes, Lucassen & Casey (2002); Facer (2004); Facer, Stanton, Joiner, Reid, Hull & Kirk (2004); Feinstein & Cannon (2002); Gee (2003); Green (2002); Hamalainen & *al*. (2006); Holbrook (1998); Hostetter & Madison (2002); Hsiao (2006); Ingram, Ray, Keane & Landeen (1998); Jones, Jasperson & Gusa (2000); Kasvi (2000); Koirala & Goodwin (2000); Kreutzer (2001); Lauer (2003); Meel (2000); Miller, Lehman & Koedinger (2000); Quinn, Koca & Weening (1999); Roubidoux, Chapman & Piontek (2002); Sakshaug (1999); Saxe & Gubermans (1998); Vandeventer & White (2002); Wargo (2000); Welsh (2003); Wiest & Quinn (1999).

[13] Brozik & Zapalska (1999); Cioffi, Purcal & Arundell (2005); Feinstein, Mann, & Corsun (2002); Gaba, Howard, Fish, Smith & Sowb (2001); Goldenberg, Andrusyszyn & Iwasiw (2005); Gredler (2004); Jacobs, Caudell, Wilks, Keep, Mitchell, Buchanan, Saland, Rosenheimer, Lozanoff, Saiki & Alverson (2003); Jones (1997); Kiegaldi & White (2006);Mechling & Gast (2003); Medley & Horne (2005); Milrad (2002); Muhamed-Jibrin (1992); Rodriguez (1998); Schmidt (2003); Squire et Jan (2007); Starkey (2001); Wilson (2005); Zhu, Zhou & Yin (2001).

[14] Griffin & Butler (2005); Shaftel, Pass, & Schnabel (2005);Shreve (2005); Virvou, Katsionis, & Manos (2005); Ward & O'Brien (2005).

[15] Asakawa & Gilbert (2003); Atkinson & Gold (2002); Baldaro, Tuozzi, Codispoti & Montebarocci (2005); Baldor, Field & Gurwitz (2001); Barnett, Everly, Parker & Links (2005); Barta & Schaelling (1998); Blake & Goodman (1999); Corbeil (1999); De Grandmont (2004); Dieleman (2006); Eagan (1996); Eyraud (1998); Facer & *al.* (2004); Facer (2004); Feinstein, Mann & Corsun (2002); Fredericksen (1999); Fukuchi, Offutt, Sacks & Mann (2000); Gary, Marrone & Boyles (1998); Gee (2003); Gray, Topping & Carcary (1998); Gublo (2003); Guillot (2004); Higgins & Barkley (2004); Holbrook (1998); Hostetter & Madison (2002); Howard, Collins & DiCarlo (2002);Jones, Jasperson & Gusa (2000); Kasvi (2000); Koether (2003); Kreutzer (2001); Lieberman (1998); Lieberman (2001); Loney, Murphy & Miller (2000); MacKinnon, Gallant & Herbert (2000); Markey, Power & Booker (2003); Martin (2006); Moisy (2004); Morris, Fritz & Buck (2004); Morton & Tarvin (2001); Moyer & Bolyard (2003); Ortmann (2003); Price, Rogers, Scaife, Stanton & Neale (2003); Purushotma (2005); Quinn, Koca & Weening (1999); Robinson, Lewars, Perryman, Crichlow, Smith & Vignoe (2000); Rosas *& al.* (2002); Ruben (1999); Shaftel, Pass & Schnabel (2005); Shapiro (1998); Skinner (2000); Steinman & Blastos (2002); Vail (2002); Vandeventer & White (2002); Ward & O'Brien (2005); Wargo (2000); Wiest & Quinn (1999); Williamson, Land & Butler (2004); Wissman & Tankel (2001); Zagal (2006); Zumwalt (2003).

negotiate, to share emotions or ideas, to develop links and friendships), followed by the cooperation skills (the ability to discuss, to cooperate or to develop a team spirit, and to appreciate the competition inside the team). Communication skills are not often used in game situations.

In regard to simulations, ten analyzed articles mention more specific indicators related to human relations skills[16]: awareness and the understanding of human relations, development of tolerance with others, empathy and identification feeling (deeper understanding of the other and increase of concern for others), creation of a individual professional values system, as well as the initiation of interactions with others. The articles are not explicit about indicators related to cooperation skills, except for teamwork, and impacts are linked to communication skills, except for discussions between peers and the listening that occurs.

3. Recommendations

According to Brougère (see Fournier *et al.*, 2004), the scientific research in the field is not conclusive and the "evidence" of the educational value of games is not adequate, but, at the same time, he thinks that it is possible to learn while playing. Our systematic analysis of the literature on the learning impacts of games and simulations unfortunately confirms the finding of this author. Methodological weaknesses of the studies related to the definition of the studied concepts, lack of operational variables to analyse the impacts, other methodological problems, etc) preclude us from identifying the actual impacts of games and simulations. Taking these results into account, it is of paramount importance to establish indicators that will allow us to effectively measure the impacts of games and simulations on learning.

3.1 Knowledge Structuring

Knowledge structuring is defined as the construction and organization of diagrams or representations by learners in order to understand a concept (concrete or defined) or a given situation. The authors aren't clear about this impact. For the purpose of our study, we have selected as analysis indicators the links that the learner is able to create between elements, concepts or diagrams (see Larcher and Crindal (2003)). These links are of different natures, as follows (from simplest to most complex):

- **Sequential link**: chronological link between two sentence sequences and their information, concepts and propositions**.**
- **Discriminatory link**: link based on the principle of contradiction. It is used for operations involving discrimination, selection, sorting and classification. It invites the learner to a methodological or conceptual classification.
- **Conditional link**: link involving an assumed relation between two logical elements. It invites the learner to formulate or explore an assumption, to reconsider his knowledge.
- **Causal link**: link that identifies a cause/effect relation between two ideas, pieces of knowledge or concepts. It can also work in the opposite way, that is from the effect to discover or establish the cause (depends on the approach of the tutor).
- **Transfer link**: link leading to the use of a piece of knowledge outside its initial validation field. It mainly applies to concepts and different knowledge sources, because it implies the transfer of an acquired knowledge. It raises the problem of the meaning: conservation or modification of the initial meaning, and modification of the educational contents.
- **Problematized link**: link establishing a relation between a piece of knowledge and the learner's problem. This link prevails on the others, which are comprised inside its scope. This link is often proposed for the formal aspects of the organization or the approach.

We suggest that the identification of these links as indicators of the impact of games on knowledge structuring would be an interesting avenue of analysis.

3.2 Information integration

[16] Cioffi, Purcal & Arundell (2005); Feinstein, Mann & Corsun (2002); Fredericksen (1999); Goldenberg, Andrusyszyn, & Iwasiw (2005); Houser (2005); Kiegaldie & White (2006); Milrad (2002); Oh & Van der Hoek (2001); Pittaway et Jason (2007); Ramirez (2001); Rosenbaum, Klopfer & Perry (2007); Schewitzer, Gonzalez & Curl (2001).

As noted above, authors refer to information integration as the use of theoretical notions or concepts in practical situation, and to the establishment of links between acquired abstract knowledge and concrete knowledge. This definition seems to be quite different than Gagné's (1985), who links information integration and the acquisition of declarative knowledge. This knowledge is represented by propositions and information such as definitions and dates (history). The learner shows that he knows how a specific thing is, that another thing is something else; in other words, the learner can identify and recognize information. This knowledge is said to be significant (or integrated) if the learner is able to explain the "why" of the proposition that he has learned (for example, if he is able to explain why horses are mammals).

Other authors also refer to the notion of retention or ownership of the information; a memorization of notions over a longer period than the one that immediately follows the learning activity. It is still too soon to describe in detail the indicators that would allow us to identify this impact; our research on this subject is still under way.

3.3 Problem Solving Skills

Problem solving skills are the best described of the impacts identified in our study. Indicators are used for many aspects of cognition: diagrams (recognition or familiar elements and problems), transfer (ability to establish links with similar problems), creativity (development of new solutions), and critical thinking (reflection). The learner can identify the components of a problem, formulate one or more solution assumptions, establish strategies to implement the solution, discover new possible solutions, and explain the problem (understanding) and its solution (evaluation).

3.4 Cooperation, Communication, and Human Relations Skills

Most authors are more or less clear on these skills. They talk about them in a general way, without regrouping them by functions for each skill, which we have tried to do:

- Cooperation: identification of actions for which people must train and work together, completion of others' tasks, sharing of files or objects or, simply, participation in brainstorming sessions, development of a feeling of confidence in others in regard to understanding and reaching the learning objectives, team decision-making, and observance of democratic attitudes in participants.
- Communication: intuitive or learned knowledge of communication mechanisms, integration of the basic mechanisms of a group discussion, taking into account of others' points of view, listening, observance of a feeling of empathy and identification.
- Human relations: awareness and understanding of human relations, development of tolerance in regard to others, empathy (deeper understanding of the other and increase of the concern for others) and identification, as well as the ability to initiate interactions with others (identification of interactions),ability to negotiate, to discuss, to share feelings and ideas, and to develop links and friendships.

4. Conclusion

Our systematic analysis of the learning impacts of games and simulations (Sauvé *et al.*, 2007), based on 524 studies since 1998, confirms the absence of consensus on the terminology used (the concept of game is loosely defined) and on the essential attributes of games differs across studies, weakness of the theoretical framework of the studies, deficient methodology (lack of operational definitions of the studies variables), lack of connection between the theory and the application in the research environments (often, the activity being studied is not a game), results too often different and impossible to compare. More specifically, the studies use few, or no, analysis indicators to measure the effectiveness of games and simulations, especially when it comes to knowledge structuring, information integration and cooperation and communication skills. However, there are notable efforts for problem solving and human relations skills.

Faced with these findings, we have done a first review of the educational literature in order to identify some indicators for these impacts. We are presently working on their operationalization inside an analytical grid, which will be the first methodological milestone for demonstrating the effectiveness of games and simulations in an educational context. We also know that these indicators must be validated, which we will try to do in the three case studies that will be conducted after September 2007.

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